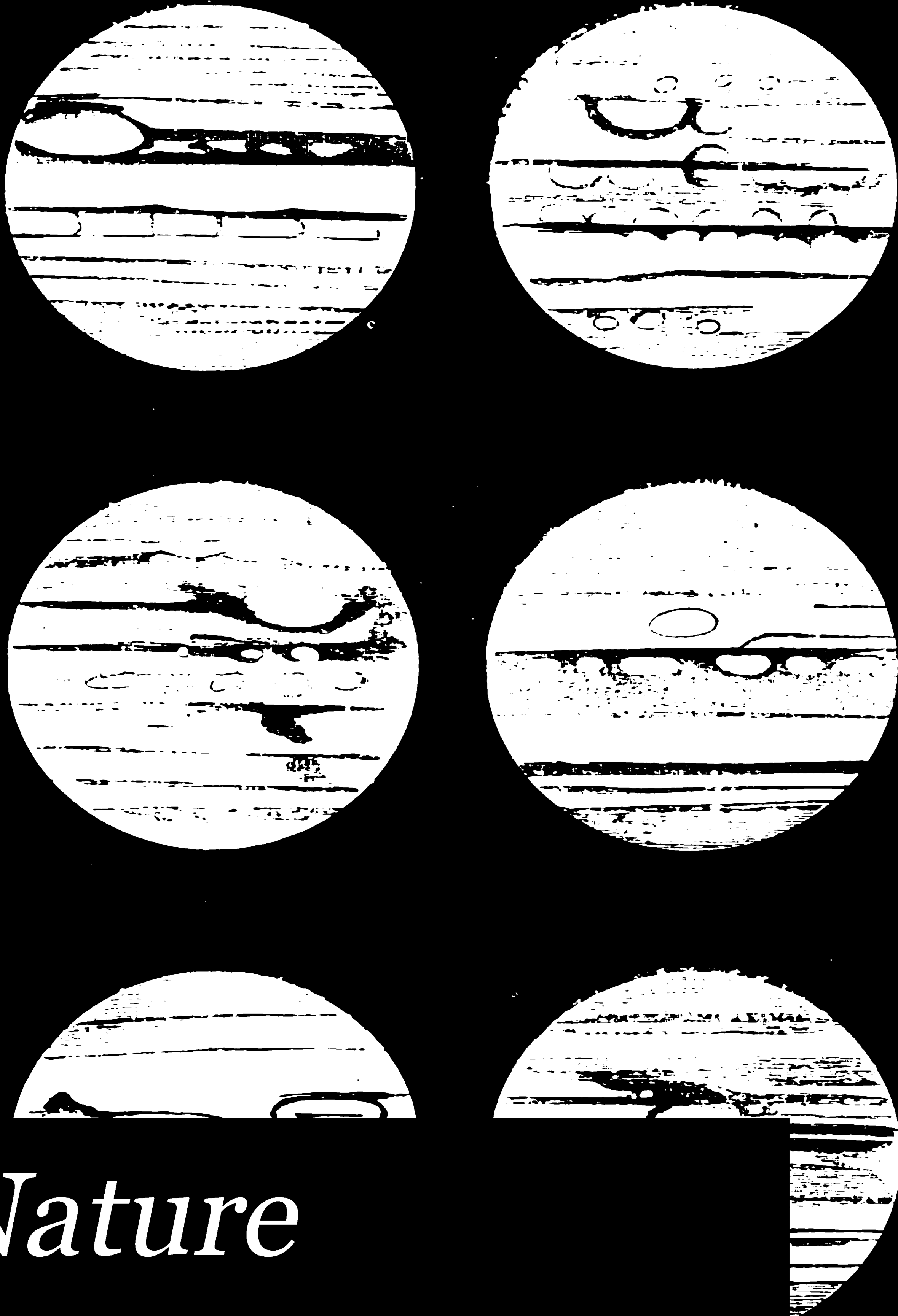

Nature

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A WEEKLY

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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

"To the solid ground
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THURSDAY, MAY 7, 1885

GREEK MATHEMATICS

A Short History of Greek Mathematics. By James Gow, M.A. (Cambridge University Press, 1884.)

"THERE are three classes of persons who, being mathematical students, require to know something of the history of their pursuit. The first want only a general view of leading points, such as can be furnished by one writer in a few volumes. The second wish to be able to compare the accounts given by different persons, and, up to a certain point, to examine the authorities used by those persons, or at least to keep watch upon their mode of using them. The third are desirous of being the critics of the historians, and of amending their works, if need be."[1] The catalogue, which the writer of this paragraph drew up, was intended for the second of the above classes. In some further remarks he arranges the histories under two heads—those which are written on the plan of Montucla, Bossut (we may now add M. Marie's "Histoire des Sciences mathématiques et physiques"), in which a general account is framed out of the writer's notes or remembrances of miscellaneous reading; or in that of Delambre, Woodhouse (we may add here the name of Todhunter, whose great historical treatises the late Henry Smith pronounced to be "so suggestive of research, and so full of its spirit"), in which the successive writings of eminent men are examined and described one after the other, so that each chapter or section is a description of the progress of science in the hands of some one person, and is complete in itself. The latter, De Morgan goes on still further to say, is the plan which is most favourable to accuracy and most interesting to the inquirers of the third class; the former, while it better suits the first and second class, leaves the writer open to many sorts of error which the latter avoids.[2]

[1] De Morgan, "References for the History of the Mathematical Sciences," Companion to "British Almanac" for 1843.

[2] Both M. Marie and Mr. Gow might profit by De Morgan's remarks on Indices. "No writer is so much read as the one who makes a good index, or so much cited." The former author may intend to give a thoroughly full index at the end of his seven volumes; the latter gives a fair index, but it is very far from being complete and satisfactory; for instance, "*et passim*" is not such a reference as one desires.

Mr. Gow's work being upon a special branch, viz. Greek mathematics—which he himself further limits to arithmetic, algebra, and geometry—comes under the second of the above two divisions, though for reasons which are more than once put forward, it is not so thorough a treatise as we could have wished. When, however, we learn that the book "represents part of a collection of notes which I have for many years been making with a view to a general history of the great City of Alexandria," and that "the materials for an account of the Alexandrian Mathematical School grew to exceed the reasonable limits of a chapter," we are glad that Mr. Gow determined to publish his results at an earlier date than he would otherwise have done. What of accuracy or perfection is sacrificed by a perhaps too early publication, he will have, we expect, an early opportunity of making good in a second edition, which we hope will be called for in the near future. It is a great reproach to English mathematicians that such books as this and M. Marie's have hitherto been conspicuous by their absence in this country. We can happily point to papers by De Morgan, to special treatises by Todhunter, to monographs by Allman, and to an interesting *résumé* by Dr. C. Taylor, but we look in vain for anything of the nature of a history of mathematical or physical science in the English language. A tendency of late years to give small historical notices of mathematical discoveries in our school text-books has been displayed, and we trust the time is not far distant when we shall have, if not a great original work, for which we can hardly look, yet a primer or primers founded upon the works of Bretschneider, Cantor, Hankel, Marie, and others.

Almost every page puts in evidence how greatly Mr. Gow is indebted to German and French writers; yet it is also evident, on a perusal of his work, that he is no blind follower of those predecessors in the field—he calls no one of them master—but when occasion arises he boldly differs from them, and gives good reasons for so differing. We note here that he does not appear to be acquainted with M. Paul Tannery's work in the same directions as his own. He refers to him but once (p. 101), and then he states he has not been able to find the article (quoted by Cantor). The journal in which the paper is published, viz. *Bulletin des Sciences Math. et Astronomiques*, is an easily accessible one, and we think from the analyses we have from time to time given in these columns of other papers by M. Tannery (in *Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux*) on Greek arithmetic and geometry, our author would have gathered useful material in the *Bulletin* paper and in the *Mémoires* also.[1] But this is the only case of omission we have come across; the reading is apparently most thorough, and the author's Greek scholarship enables him to improve upon the translations given by some of these foreign authorities.

The work consists of three parts. The first part, entitled "Prolegomena to Arithmetic," discusses the decimal scale and Egyptian arithmetic in a very thorough manner. Here, of course, much use is made of the "Rhind papyrus," a book written by one Ahmes (now put at 1700 B.C.), entitled "Directions for Obtaining the Knowledge of all Dark Things," which consists mainly of statements of results. One could wish some safe means could be discovered by the Museum authorities for unfolding the "olden leather-roll on a mathematical subject" which is "apparently too stiff to be opened"! (note, p. 16).

There are naturally statements in these early chapters which are fairly open to objection, but they are clearly put, and the results, as Mr. Gow gets them, are summarised on pp 20, 21.

The second part treats of Greek arithmetic under "Logistica, or Calculation and Arithmetica, or Greek Theory of Numbers." This part is very carefully done, and enables the reader to get a clear idea of the processes employed. Plato's appreciation of *logistic* may be inferred from his direction (Legg, 819 B) that "free boys shall be taught calculation, a purely childish art, by pleasant sports, with apples, garlands, &c."[2]

The third part treats of Greek geometry, and upon it we could expatiate at some length, but that is hardly our business on the present occasion. We need only say that there is much good work. Dr. Allman's powerful rectification of the position of Eudoxus did not appear in time to be of service to Mr. Gow (he mentions the fact of its publication on p. x. of the Addenda). Most of the geometers appear to have justice done them. We miss some of the touches which appear in M. Marie's work, but again we find a compensation in the fuller account given of Menelaus, and of the proposition now usually cited by the name of that geometer. Chapter V. discusses "prehistoric and Egyptian geometry," in which is given an account of Ahmes' work. Chapter VI. takes "Greek Geometry to Euclid" in five sections. Of the Pythagoreans, the Eudemian summary (which has in previous numbers been referred to in our notices of Dr. Allman's papers) says they made geometry "a liberal education;" and other writers, referred to by Mr. Gow, attribute to them the maxim, "A figure and a stride: not a figure and sixpence gained" (p. 153). In connection with this characteristic maxim we may give the story, which, in the Greek, forms the motto on the title-page of Mr. Gow's book, viz. "A youth who had begun to read geometry with Euclid, when he had learnt the first proposition, inquired 'What do I get by learning these things?' So Euclid called his slave, and said: 'Give him threepence, since he must make a gain out of what he learns.'" Many such boys there are, even in this nineteenth century, who are ever asking, "What is the use of learning Euclid?" We thank Mr. Gow for his story from Stobæus, which will possibly make us better prepared to answer the question the next time we are asked it. There is much other quotable matter, but we hasten to a close.[1] Chapter VII. gives an account of Euclid (what little is known of him, his writings, history of text of "Elements," and modern history of the book[2]), Archimedes, and Apollonius. Chapter VIII. is on "Geometry in Second Century B.C.;" Chapter IX., "From Geminus to Ptolemy;" and Chapter X., "Lost Years," principally occupied with an account of Pappus and his "Mathematicæ Collectiones."

Some matters of interest are illustrated, as the introduction of the *signs* in algebra, of the *sine* in trigonometry (it does not seem to be generally known that the first occurrence of "tangent" and "secant" is traced by De Morgan to a work by T. Finkius, "Geometriæ rotundi libri xiiii.," Basileæ, 1583), the derivation of "almagest" (cf. Chaucer's Clerk Nicholas, who had—

> "His almageste and bokes grete and small,
> His astrelabre, longing for his art,
> His augrim stones, layen faire apart
> On shelves couched at his beddes head")

and a few others.

On page 290, line 9 up, for λη read αη.

[1] In the *Bulletin* for March, 1885, there is a paper by M. Tannery, "Sur l'Arithmétique Pythagorienne" (pp. 69-88).

[2] It is curious to note that there was a Cocker before Cocker: cf. the Lucianic compliment, "You reckon like Nicomachus of Gerasa"; see also, in the opposite direction, "Budget of Paradoxes," p. 30.

[1] Hippocrates of Chios was one of the greatest geometers of antiquity; he lost his property, as a merchant, by piracy or chicanery. Aristotle speaks of him as "slow and stupid." "There seems to be no other ground for the criticism than that a Greek would call a man a fool who was cheated of his property. There are still extant mathematicians who are singularly deficient in ability for any studies but their own."

[2] In his "English Mathematical and Astronomical Writers" (companion to "British Almanac for 1837," p. 38), De Morgan made one of his shrewd guesses that Billingsley's (first English) Euclid was certainly made from the Greek, and not from any of the Arabico-Latin versions. This surmise has been found correct by G. B. Halsted in the *American Journal of Mathematics*, vol. ii. pp. 46-48. We notice that Mr. Gow gives the same reference in his Addenda. Mr. Gow gives a proof of a prop. (xxii.) of Euclid's optics which recalls a passage in the recent *brochure* "Flatland:" it is, "If a circle be described in the same plane as the eye, it will seem to be a straight line."

OUR BOOK SHELF

The Zoological Record for 1883, *being Volume XX. of the Record of Zoological Literature.* Edited by E. C. Rye, F.Z.S., &c. (London: John Van Voorst. 1884.)

ALTHOUGH bearing on its title-page the date 1884, it was not until the end of January in this year that the "Zoological Record for 1883" was, in its entire form, laid before the public. It comes to us with a melancholy interest, as being the last under the editorship of the late Mr. Rye, whose untimely death we have so recently recorded and deplored. Again in this volume we have to mention still further changes in the staff of the Recorders. Prof. Sollas takes Mr. S. O. Ridley's place as recording the sponges, and Prof. Haddon that of Mr. W. Saville Kent in recording the Protozoa. Other engagements have prevented the Rev. O. P. Cambridge recording the literature of the Arachnids for 1883, and it has been arranged that Mr. T. D. Gibson-Carmichael is to record the literature of this group for 1883 and 1884 in the next volume of the "Record."

A rapid glance over the contents of the volume brings to light the fact that in all the leading groups of the animal kingdom a goodly amount of work has been accomplished in the year 1883, and that many of the lacunæ in our knowledge are being steadily filled in. The Molluscoidea seem to have had more than ordinary attention paid to them, and the record of this group by Prof. E. von Martin appears to be extremely well done. As usual, Messrs. W. H. Kirby and R. McLachlan record the enormous section of Insecta, the lion's share falling to the former, the latter confining his attention to the Neuroptera and Orthoptera. In his treatment of the general subject (Insecta) the recorder frequently quotes memoirs relating to the structure, &c., of the groups recorded by Mr. McLachlan, and it is not without interest to note that, while some of these are the subjects of a double record, others are not. One interesting fact, showing the importance which a "Zoological Record," when complete, is to the working naturalist, is alluded to by Mr. McLachlan in his remarks introducing us to H. de Saussure (" Mémoires pour servir à l'Histoire naturelle du Mxeque des Antilles, et des États-Unis. Orthoptères de l'Amérique moyenne: Famille des Blattides." Genève, 1864): — " This very important memoir is noticed at the request of the author. It escaped notice in the early volumes of this 'Record' (which commenced with the year 1864), and also in the German *Bericht*. It would also appear to have escaped the notice of workers on Blattidæ generally, for none of the new terms employed therein for generic, &c., division are included in Scudder's just-published laborious 'Universal Index' which extends down to 1879." Scudder's New Index is, however, far from being a full record of generic names in any one group.

The new names proposed for genera or sub-genera, as recorded in this volume, amount, the editor informs us, to 1079, as against 1015 of last volume, and this without including any of the Arachnidæ. Of these, no less than 115 require re-naming, having been already in use. This number affords no clue to the amount of new species described, which is considerably larger, thus indicating for the present no lack of work for the systematic zoologist.

The British Association for the Advancement of Science still continues its grant of 100*l*., and the Government Grant Committee of the Royal Society renewed its vote of 150*l*., while the Zoological Record Association itself keeps up both the number of its members and subscribers.

A Treatise on Practical Chemistry and Qualitative Inorganic Analysis. By Frank Clowes, D.Sc. Lond. Pp. xv., 376. Fourth Edition. (London: J. and A. Churchill, 1885.)

THIS well-known manual has reached a fourth edition. It very thoroughly fulfils the aim which is set forth in the preface, viz. to place trustworthy and practical methods of qualitative analysis in the hands of the student. If the chemical student must still devote a large amount of his time to qualitative testing, then he certainly could not do better than follow the directions of this book. But the very excellence of the tables and methods of the book before us makes us more than ever doubt the wisdom of attempting to teach the science of chemistry by a course of "test-tubing." The art can be learnt by rules and formulæ, but the science comes not by such as these.

This book only includes what "directly bears on the ordinary requirements of the laboratory student"; its directions are those of a man who knows what he is writing about, and who has learnt what he teaches by good honest work in the laboratory. It contains many of those results of laboratory experience which are usually preserved in the private note-books of the teacher, and which may almost be regarded as trade secrets. The only fault we have to find is that the book tends too much in the direction of recipes. Were a student to work conscientiously through the book he would certainly be an accomplished analyst, but we are afraid he might have ceased to be a chemist. However excellent rules and tables may be in their own way, it is possible to have too much of them. In fact, the better they are the less one wants to be bound by them. The "tables of differences" given in the book are excellent; in the hands of a good teacher they might be made the basis of a really scientific training. But the ordinary student will not trouble to develope methods from the facts set before him in these tables; he will pass on to the systematic examination of simple salts, and be caught in the fatal whirlpool of "experiment," "observation," "inference."

M. M. P. M.

Original Researches in Mineralogy and Chemistry. By J. Lawrence Smith. Edited by J. B. Marvin. (Louisville, 1884.)

IN a recent number (vol. xxxi. p. 220) we gave a statement of the life and work of the late Prof. J. Lawrence Smith condensed from a memoir prepared at the request of the National Academy of Sciences, Washington, by Prof. B. Silliman, who was so soon to follow his friend to his long rest. The papers containing the original investigations of Prof. L. Smith have now been collected together and reprinted as a memorial volume intended for presentation to his friends. Three memoirs prepared by Mr. Marvin, Mr. Michel, and Prof. Silliman respectively, form an appropriate introduction, and give one a good glimpse into his life and character. The work is clearly printed on good paper, and will be highly appreciated by his numerous friends, to each of whom a copy has been presented by his widow.

Lehrbuch der Mineralogie. Von Dr. Gustav Tschermak. Zweite, verbesserte Auflage. (Wien: Alfred Hölder, 1885.)

WE are glad to find that a second edition of this work is already called for, although the latter part of the first edition appeared so lately as 1884. In our notice of the first part of that edition (vol. xxiv. p. 355) we directed attention to the excellent character of the work, and gave a brief statement of its contents; we now need only remind our readers that the author is a thorough master of his subject, who has done a large amount of original and valuable work, and further, has had a long teaching experience as Professor of Mineralogy in the University of Vienna. The work is but slightly changed in the present edition; the length is increased by a few pages through the incorporation of the results of investigations made since the first part left the press in 1881; the contents are well up to date. If some University Professor would provide us with an equivalent work written in our own tongue the study of mineralogy in this country would begin to revive.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Mr. Lowne on the Morphology of Insects' Eyes

I DESIRE to give an unqualified denial to the imputation made by Mr. Lowne in his letter to NATURE of April 9 (p. 528), that my opinion with regard to his paper on the structure of the eye in Arthropods was formed under the influence of my colleague, Prof. Lankester, or that any consultation upon the paper took place between us. References of papers for the Royal Society are strictly confidential, and I did not know the name of the second referee until after I had come to a conclusion upon the subject—a conclusion which was only arrived at as the result of a long and patient investigation of Mr. Lowne's preparations, and the nature of which may be inferred from the fact that I advised the author to withdraw his paper and submit the subject to a renewed investigation, with the aid of improved methods.

With regard to the question, which Mr. Lowne raises, as to my competency to form any opinion at all, on the ground that I had not myself devoted any special attention to the literature of the subject, I may remark that the points which had practically to be decided were (1) whether Mr. Lowne's statements were in themselves probable, and (2) whether they were corroborated by his preparations. Had I not felt myself qualified to form an opinion on these points I should not have accepted the reference. E. A. SCHÄFER

The Late Prof. Clifford's Papers

IN the "Mathematical Papers" (pp. 628–37) I was able to print the syllabuses of a series of ten lectures delivered by Prof. Clifford to a class of ladies at South Kensington in the spring and summer of 1869. Whilst turning over a collection of miscellaneous papers, in a box, Mrs. Clifford and I had the good fortune to light upon a manuscript quite ready for printing, and this ("Mathematical Papers," p. 628) subsequently formed part of the volume on "Seeing and Thinking;" but we could not find any trace of any more manuscript of the above-mentioned series of lectures. Just before the recent Easter holidays Prof. Karl Pearson returned to me a few pages of manuscript bearing on the International Scientific Series volume which I had lent him, and with them he sent me a large note-book which had been in the late Prof. Rowe's hands. On opening this book I at once saw that it contained very full notes of other lectures of the course. In fact, Lecture II. ("On Plane Surfaces and Straight Lines") is quite ready for press, as is also, I think, Lecture III. ("On the Rotation of Plane Figures"); Lecture IV. ("Of Similar Figures") is a fragment, and still more fragmentary is Lecture V. ("The First Principles of Calculation"). Of Lecture VI. ("The Theorem of Pythagoras") there are two loose sheets of figures: on one sheet is "the Bride's Chair," and the figures on this and the other sheet show that my information was correct, and that the remarks on pp. 633, 637 are *ad rem*. As Lecture IX. ("On the Shadows of a Circle") is very fully illustrated in the recent volume edited by Prof. Pearson, we see that we are in possession of a fairly complete presentment of Prof. Clifford's views on the subjects of the course of lectures.

Messrs. Macmillan have stated their willingness to publish the MS. of the second part of "The Elements of Dynamics," and I hope to be able, after a re-examination of it, to put the work into their hands for printing. When this book is got out, and the above lectures published in some shape yet to be determined, the mathematical world will be in possession of all that we can now look for from the hands of this great master.

University College School, April 25 R. TUCKER

Sir Wm. Thomson and Maxwell's Electro-magnetic Theory of Light

SHORTLY after writing my former letter I saw a copy of the verbatim report of Sir Wm. Thomson's lectures in Baltimore, and would have written to you to that effect and to apologise to Mr. Forbes for having doubted the accuracy of what I thought was his report, only that I met him in London about that time, and he then desired me not to do so. Sir William Thomson has now himself stated that the passage is correctly quoted, and I can only regret that he has expressed himself in the way he did.

I certainly think that anybody reading the passage would imagine that the velocity of propagation of electro-magnetic disturbances upon Maxwell's electro-magnetic theory of light, which he showed to be the same as the velocity of propagation of light, and to be a true velocity of wave-propagation—any one, I say, would suppose that this was the same thing as that Sir Wm. Thomson calculated in the year 1854.

Sir Wm. Thomson certainly says, "That is a very different case," but the rest of this sentence is rather ambiguous as to what the "it" after "putting" refers to, and I am afraid that many people will imagine that, in Sir William Thomson's opinion, Maxwell has made some unjustifiable assumption. I believe, however, that all he thinks is that Maxwell has not made a satisfactorily definite thing of the so-called electro-magnetic theory of light.

In Sir Wm. Thomson's article in Nichol's "Cyclopædia" he puts the matter very clearly indeed. He says:—"The law of this phenomenon [transmission of electric signals] is identical with that which Fourier . . . found as the law of propagation of summer heat and winter cold to different parts of the earth," *i.e.* it obeys the laws of a diffusion and not of a wave-propagation; and again:—"Now it is obvious from these results [experimental results] that the supposed velocity of transmission of electric signals is not a definite constant like that of light:" and afterwards he says that, when an initial current is started, the potential rises simultaneously at all points, and that the apparent velocity would depend on the delicacy of our instruments. All these obviously distinguish between the propagation of a variable current in a conductor and a true wave-propagation.

He has also clearly pointed out a direction in which to look for a true wave-propagation. It will make his position clearer, and also Maxwell's, to use his analogy between water in an elastic tube and a conductor of electricity. I will suppose the water contained in a tube bored out of a very large lump of india-rubber. He enumerates three electric qualities concerned, and their hydrodynamic analogues:—(1) "Charge" or electrical accumulation in a conductor subjected in any way to the process of electrification. (2) "Electro-magnetic induction" or electromotive force excited in a conductor by variations of electric current. (3) Resistance to conduction through a solid. The hydrodynamic analogues are:—(1) Accumulation of a greater or less quantity of water in any part of the canal or tube. (2) Inertia of the water. (3) Viscosity or fluid friction. He explains that a true wave-propagation arises from the compressibility of the water, combined with its inertia, and that if the tube be elastic, like india-rubber, there would also arise a wave-propagation. "Accordingly," he says, "a definite velocity of propagation of electric impulses, depending on the inertia and the capacity for charge, is to be looked for, as has been done in a first article, published by Kirchhoff, on the subject."

Now, in all this discussion Sir Wm. Thomson omits to mention the only thing that is at all analogous to Maxwell's propagation of wave disturbances in non-conductors, and it arises from his considering the water as contained in a tube like ordinary india-rubber tubes, instead of in a tube bored in an indefinitely large lump of india-rubber. If we consider this case it is evident that one of the conditions to be considered is the propagation of waves in this lump of india-rubber. In Sir Wm. Thomson's tube there would of course be a velocity of wave propagation in the india-rubber, but that is a very different matter from the propagation of disturbances away from the neighbourhood of the tube by which energy would be carried away from it. To do this Sir Wm. Thomson should have included the propagation of sound in the air or whatever he supposed surrounding the outside of his tube. Without including this, he was not including anything a bit analogous to Maxwell's electromagnetic theory of light. In Sir Wm. Thomson's tube the whole state of affairs at any time could be expressed in terms of variables that represented bodies near the tube, while in the other case it would be absolutely necessary to introduce variables representing every part of the india-rubber which I have supposed of indefinite extent. This is just the difference between Sir Wm. Thomson's and Maxwell's views. According to Maxwell's view there is a great deal more going on outside the conductor than inside it, and it is evident that the inertia of the water is a very bad analogue to electromagnetic induction, for this latter depends essentially upon the form of the circuit, and not only upon its section and length. Maxwell has shown that light may be a wave-propagation of what are on his theory *analogous*, though probably utterly *unlike* the distorsional waves propagated in the india-rubber, and has shown that a medium which would only transmit disturbances analogous to these would explain electric and magnetic phenomena. It is to be remembered that Maxwell's theory gets rid of all action at a distance, and that the only *experimentum crucis* between theories of action at a distance and of action through a medium is that in this latter case the energy may be propagated in time through the medium, while in the former it cannot.

I cannot conclude without protesting strongly against Sir Wm. Thomson's speaking of the ether as *like* a jelly. It is in some respects *analogous* to one, but we certainly know a great deal too little about it to say that it is *like* one. May be Maxwell's conceptions as to its structure are not very definite, but neither are any body's as to the actual structure of a jelly, and there is no real difficulty in supposing a medium whose condition is represented by symbols that obey the laws that Maxwell has shown should be the laws of symbols representing the condition of a medium that would explain electric and magnetic phenomena. It seems very unlikely that any jelly is at all *like* the ether that Maxwell supposes. It seems much more likely that what he called "electric displacements" are changes in structure of the elements of the ether, and not actual displacements of the elements. He guards against this being supposed a necessary part of his theory when he defines polarisation in terms that certainly require a change of structure rather than a change of position, so that I think the word "displacement" was unfortunately chosen. I also think that Sir Wm. Thomson, notwithstanding his guarded statements on the subject, is lending his overwhelming authority to a view of the ether which is not justified by our present knowledge and which may lead to the same unfortunate results in delaying the progress of science as arose from Sir Isaac Newton's equally guarded advocacy of the corpuscular theory of optics. GEO. FRAS. FITZGERALD

40, Trinity College, April 25

The April Meteors

IN 1882 the Lyrid meteor shower (epoch, April 19–20) was noticed to be far more conspicuous than usual. The display had been quiescent for some years; it appeared to have degenerated into a third rate shower, scarcely deserving the trouble of observation. But in the year mentioned the stream gave distinct intimation of greater intensity, and showed the necessity of continuing annual observations of periodical showers such as this, even though they may exhibit, during a comparatively long interval, but a very feeble sustenance of the richness recorded in former times.

On April 20, 1882, Mr. Corder, at Chelmsford, watching for three hours between dusk and 12h. 30m., counted 26 Lyrids and 8 meteors belonging to other contemporary radiants of minor character. He regarded the horary rate of apparition on that occasion as about two or three times as high as on any other occasion since 1877, when he had been able to watch for the display. He found the radiant at 268° + 37°, and remarked that four of the meteors seen were as brilliant as first-magnitude stars, but he had never found them a very interesting species in respect to their visible appearances.

No observations of the shower were obtained in 1883, the moon being near the full at the time of its occurrence; but in 1884 the conditions were more favourable. On the night of April 19, in the hour preceding midnight, 17 Lyrids were observed by the writer at Bristol. During the last quarter of an hour of the watch the sky was much clouded, and only one Lyrid seen. The horary number was computed as 22 for one observer—evidently, therefore, the display of 1884 was a notable one, and it was very unfortunate that a clouded sky prevented the development of the shower being watched through the morning hours of April 20, when possibly it may have attained a richness without parallel in late years. On the evening of April 20 it had evidently become exhausted, for in a watch of twenty minutes not a single shooting-star appeared, though the sky was very clear.

The present return of the Lyrids occurred under very auspicious circumstances. The moon offered no impediment to morning observations, which is far the best time to watch for these meteors, as the radiant, west of α Lyræ, is very low in the evening hours. The nights of April 17, 18, 19, and 20 were cloudless throughout, and on the three latter dates observations were made here with the following results:—

Date		Period h. m. h. m.		Duration of Watch Hours		Meteors seen		Lyrids seen		Radiant Point ° °
April 18	...	12 0 to 14 30	...	2½	...	16	...	6	...	260 + 33½ [1]
" 19	...	10 30 to 14 0	...	3½	...	26	...	10	...	267½ + 33 [2]
" 20	...	11 30 to 15 30	...	4	...	39	...	14	...	274 + 33½ [3]
Ap. 18-20	...	10 30 to 15 30	...	9½	...	81	...	30	...	267·2 + 33·3

After April 20 moonlight and cloudy weather effectually prevented further work.

The table furnishes us with some interesting facts. It shows that during the three nights the proportion of Lyrids to unconformable meteors was very nearly the same, namely, as 3 to 5, and that the horary rate of their apparition was little more than 3. It also shows a very marked displacement of the radiant (in the direction of east longitude) from night to night. I regard this as the most interesting and certain feature observed. The three centres resulting from the paths of short meteors, observed with the utmost care, may each be relied on as very accurate. It therefore appears most conclusive that the radiant point of the Lyrids, similar to that of the August Perseids, increases in right ascension from night to night, and the extent of this displacement is even greater for the Lyrids than for the Perseids.

[1] Sky clear; slight haze. [2] *Ib.* [3] Sky very clear.

On April 19, 1884, 11¼h., I found the radiant at 269° + 33°, and on April 19, 1885, 12½h. (the middle time of the observation), at 267½° + 33°. Allowing for the difference (about 12′) in the sun's longitude at the two epochs in applying the correction for the displacement of the radiant (7° of R.A. daily) observed this year, we shall find that the two positions are in *exact* agreement.

The recent display has been decidedly meagre in point of numbers. There is a great falling off since last year, when the horary rate was nearly eight times as great. But some of the meteors observed this year were very bright and in a great measure compensated for their scanty apparitions. It is curious that three of the most brilliant Lyrids, equal to or exceeding Jupiter, appeared in nearly the same region of the western boundaries of Virgo. On April 18, at 12h. 57m., one of these fell, with a bright flash and streak, 10° east of Spica Virginis. Another on April 20, at 13h. 14m., came out very suddenly 7° above that star; and a third, at 14h. 1m., descended, with a swift, diving motion, about 13° east of the star, so that the path was nearly similar to that of the first of the three. These five meteors gave transient

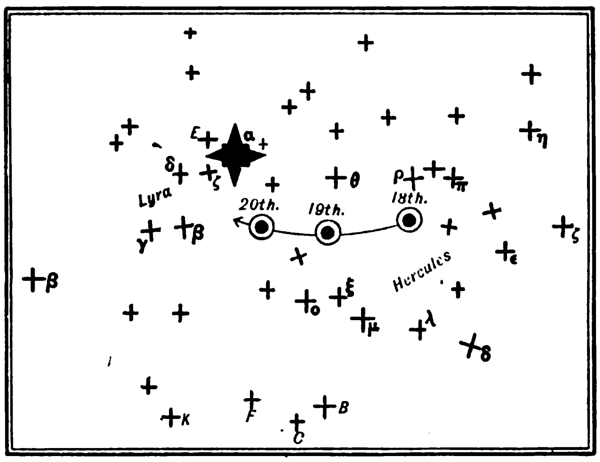


Diagram exhibiting the displacement in the radiant point amongst the stars of Hercules and Lyra on the nights of April 18, 19, and 20, 1885.

flashes of yellowish-white light, which brightly illumined the mist lying along the horizon, and left short streaks of very brief duration. I saw four other Lyrids, quite equal to first-magnitude stars, and these, together with the fainter members of the same shower, were nearly all registered amongst the stars surrounding Lyra, especially those of Hercules, Draco, and Aquila. Altogether I regard the April display of this year as one of considerable importance, for though much less rich than in 1884, it furnished meteors of greater interest and brilliancy. The low position of the radiant during observations last year may have influenced the visible aspect of the meteors from Lyra, especially as regards the swift, flashing characteristic so invariably noticed this year in the brighter members, or, possibly, the explanation may be that near the richer portion of the stream the corpuscles are smaller in almost the same ratio as the increased condensation. It will be advisable to regard this question during future observations of this shower, and especially the new feature detected this year as to the evident shifting of the radiant point from night to night. I believe the maximum of the shower is usually attained with the radiant at 269½° + 33° (the radiant point of its allied Comet I. 1861 is 270¼° + 32°). If the display extends over as long as seven days, and the radiant shifts 7° in R.A. every day, it is curious that the meteors will be *Herculids* on April 17, 18, and 19, *Lyrids* on April 20, 21, 22, and 23, and then *Cygnids* on April 24.

Contemporary with the special periodical display of this epoch there are vast numbers of feeble systems which annually give some indication of their presence. This year I ascertained the positions of several of these showers with great care. The number of meteors from them averaged from 3 to 5 only, but the paths intersect nearly at a point in the individual cases, so that the centres are entitled to the same value as positions resulting from a large number of tracks. I give the best of these co-Lyrid showers, and the nearest confirmations from previous observations:—

Observed 1885		Previous Observations	Authority
April 18	181 + 35½	184 + 35	March 31-April 12, D.S., 1872.
19	236 + 62	240 + 55	April 14, Schiaparelli and Zezioli.
20	226 + 41	223 + 40	March 12-April 30, Greg and Herschel.
18-20	296 ± 0	294 ± 0	April 16-19, 1877, D.
19-20	230 + 17	230 + 26	April 20-24, Heis.
18-20	299 + 24	298 + 25	April 16-19, 1877, D.
		300 + 20	April-May, Corder.
18-20	213 + 9	206 + 13	April 13-May 11, Heis.
18-20	226 ± 0	228 − 2	April 16-19, 1877, D.

The two radiants observed here in 1877 and 1885, with mean position at 295° ± 0° and 298°·5 + 24°·5, are very interesting. The former, just preceding η Aquilæ on the equator, supplies meteors of very great velocity, the latter in Vulpecula gives swift, streak-leaving meteors. This pair of showers, directed from points near the apex of the earth's way, are now, I believe, very exactly determined in regard to their centres of radiation. That they have hitherto evaded frequent detection is not surprising, as they only become well visible in the morning hours. It will be useful to watch for these special streams during future exhibitions of the Lyrids, as well as to note the several other interesting features closely associated with this well-known display.

W. F. DENNING

Chinese Insect Wax

THE beetle alluded to in connection with this subject in the last number of NATURE (vol. xxxi. p. 615) is a probably undescribed species of *Brachytarsus*, a genus of the family *Anthribidæ*, allied to the *Curculionidæ*. Through the courtesy of the authorities at Kew I have had specimens before me. The idea that it acts as a sort of midwife to assist at the birth of infant *Coccidæ* is quite erroneous. The genus *Brachytarsus* is a true parasite on *Coccus*, and its habits, in this connection, in Europe, have long been known. It is of course interesting to find "unity of habit" prevailing in the case of *Coccus Pè-la*, even to its parasite; but with regard to the latter there is nothing new; some points in the general economy of the wax insect, in the notes published, are of far greater importance.

Lewisham, May 1 R. MCLACHLAN

The New Bird in Natal

THERE can be little doubt from the description given by Mr. Turnbull in your issue of April 16 (p. 554) that the bird lately obtained by him in Natal is the Standard-winged Nightjar, *Cosmetornis* (seu *Macrodipteryx*) *vexillarius*, Gould. It has not been met with in Cape Colony, which accounts for Mr. Turnbull's inability to find mention of it in Layard's "Birds of South Africa;" but in Mr. Sharpe's new edition of Layard's work (which Mr. Turnbull would do well to procure) he will find an account of this bird given at p. 89. It appears to have a wide geographical range, being found both on the west and east coasts of Africa; in Angola and Damaraland, in Natal, on the Zambesi (where 300 miles up the river Dr. Kirk found it quite common), in the islands of Bourbon and Madagascar, along the Red Sea shore, and on the island of Socotra. With this extended range it is somewhat remarkable that it has not yet been met with in Cape Colony. According to the observations of Dr. Kirk the singular prolongations of the primaries are peculiar to the males, and a seasonal peculiarity observed only during the months from October until January. The habits of this bird, like those of other nightjars, are crepuscular. An excellent coloured figure of the male is given in Gould's "Icones Avium."

J. E. HARTING

Wild Bees

A FEW words respecting a colony of wild bees (a species of *Andrena*) which I have just discovered in our garden, may interest your entomological readers. A day or two ago, on walking beside a low-turfed mound which supports two trees on one of our towns, I noticed that the grassy surface on the south—therefore the sunny—side was covered with little hillocks of earth, such as ants throw up after rain. On examination each little heap showed the circular hole which denotes a bee's nest, and the bees themselves were seen in many places going in and out. Some holes were level with the ground, but most had the tiny mound of soil cast up in the process of excavation. The peculiarity of the case seems to me to lie in the great number of nests forming a complete colony. It is difficult to count them, but there cannot be less than eighty or ninety in an area—roughly calculated—of about sixty square feet. Have any of your readers noticed a similar city of these busy people? and can any one supply the specific name? E. BROWN

Further Barton, Cirencester, May 2

ON M. WOLF'S MODIFICATION OF FOUCAULT'S APPARATUS FOR THE MEASUREMENT OF THE VELOCITY OF LIGHT

NO one who has the true interests of scientific accuracy at heart can fail to welcome any innovation whereby the elements of a research may be varied, for thereby the ever-lurking constant error is most readily eliminated. It seems, therefore, that this in itself is sufficient reason for the interesting paper communicated by M. Wolf to the Académie des Sciences (*Comptes Rendus*, 9 Février), describing a very ingenious arrangement of Foucault's experiment, and that there was no occasion for disparaging other work in order to justify its publication. It is to be hoped that this was done rather through inadvertence than design, but I feel called upon to correct some of the misapprehensions under which the author labours, and particularly those concerning the appearance and distinctions of the image of the slit in my work on the velocity of light.

M. Wolf remarks that, under the conditions which I selected, this image, even under the most favourable circumstances, must be bordered with very large diffraction fringes, which the atmospheric disturbances transform into a badly-defined "*tache lumineuse*." In reply to this, though I grant that the fringes *ought* to be present, yet I can affirm as a matter of fact that they were not to be seen. Possibly M. Wolf and others may have been somewhat misled by a drawing of the appearance of the image given in my work (p. 124, *Astr. Papers*, *American Ephemeris*, and *Nautical Almanac*, vol. i. Part 3) where the image proper, which is quite clear, is surrounded by a luminous haze, from which, however, it is very easily distinguished.

I hardly think that if M. Wolf had given the "specimen observations" (p. 133 of my work) due consideration, he would have characterised as a "*tache lumineuse*" an image whose position was measured with the following results (each result is the mean of ten observations made by one observer, and recorded without divulging the result by another):—

No. 1	112·801 mm.	0·020 mm.
,, 2	112·773 ,,	0·006 ,,
,, 3	112·769 ,,	0·010 ,,
,, 4	112·772 ,,	0·007 ,,
,, 5	112·779 ,,	0·000 ,,
Average difference from mean =		0·0086 ,,

These are measurements of the *deflected* image, so that the differences are not merely errors of linear measurement, but include errors in the estimate of the speed of the revolving mirror.

Now, M. Wolf, in his most sanguine statement, does not hope for a greater degree of accuracy than one part in 3500 in this particular measurement, whereas the above results are on the average closer than one part in 10,000.

But let us examine the data on which he bases this most favourable estimate. In the first place, the image whose position is to be measured to within one-hundredth of a millimetre is the result of seventy-nine reflections from concave mirrors!

Secondly, one of these mirrors is to be 2 decimetres in diameter. Such a mirror used in a reflecting telescope would show signs of distortion if not carefully mounted—even at rest. But this mirror is required to make fifty revolutions per second, and the distortion is multiplied by forty reflections from its surface!

Finally, notwithstanding the avowed purpose of diminishing the path of the light ("*sans augmenter le trajet de la lumière*"), the distance required is *greater* than in my own experiments in the proportion of 1600 to 1200, and hence atmospheric disturbances would come into play in the same proportion—unless especial precautions were taken to guard against them.

And here, I am free to concede, is an important advantage, but one which is by no means limited to M. Wolf's arrangement, but is universally applicable—for by repeated reflection by plane or by concave reflectors the whole path, either in Fizeau's method or in Foucault's, may be confined to a limited space. But I think the chief object of such an arrangement—namely, to control easily the homogeneity of the air-column—could be more advantageously effected by a long underground tunnel containing a pipe, surrounded, if necessary, by running water, or, better still, exhausted of air.

At Prof. Newcomb's request I have repeated, with some alterations, the experiments described in the paper referred to, and occasionally the appearance of the image was better than in that work. On one occasion the width of the image was carefully measured, and found to be 0·25 mm. Evidently there is nothing remarkable in measuring the position of the centre of an image of this width within a hundredth of a millimetre.

Again, the "probable error" of my final result, 5 kilometres, would seem to show a somewhat greater degree of consistency than would be possible had I only a "*tache lumineuse*" to bisect.

I cannot forbear remarking that by astrononomical methods—if M. Wolf entirely mistrusts the results obtained by Cornu, Newcomb, and myself—the velocity of light is known certainly within 1 per cent., and that it would, therefore, denote rather an excess of caution to deduce a formula for the elimination of a possible uncertainty of from 5 to 10 per cent., as M. Wolf does in determining "*l'ordre* M *de cette déviation*."

In conclusion, I think M. Wolf is to be congratulated on the very happy combination he has devised for the solution of this most fascinating problem—a problem which, notwithstanding its difficulties, will ultimately yield a result correct not merely to one part in 3500, but, I firmly believe, one in 300,000—perhaps one in 1,000,000.

ALBERT A. MICHELSON

SELF-INDUCTION IN RELATION TO CERTAIN EXPERIMENTS OF MR. WILLOUGHBY SMITH, AND TO THE DETERMINATION OF THE OHM

IN a lecture delivered by Mr. Willoughby Smith before the Royal Institution in June last (see *Proceedings*) some experiments are detailed, which are considered to afford an explanation of discrepancies in the results of various investigators relating to the ohm, or absolute unit of electrical resistance. As having given more attention than probably any one else in recent years to this subject, I should like to make a few remarks upon Mr. Willoughby Smith's views, which naturally carry weight corresponding to the good service done by the author in this branch of science.

In the first series of experiments a primary circuit is arranged in connection with a battery and interrupter, and a secondary circuit in connection with a galvanometer and commutator of such a character that the make and break induced currents pass in the same direction through the instrument. Under these circumstances it is found that at high speeds the insertion of a copper plate between the primary and secondary spirals entails a notable diminution in the galvanometer deflection, and this result is regarded as an indication that the molecules of copper need to be polarised by the lines of force—an operation for which there is not time at the higher speeds. The orthodox explanation of the experiment would be that currents are developed by induction in the copper sheet, which thus screens the secondary spiral from the action of the primary, and the result is exactly what might have been anticipated from known electrical principles. I have the less hesitation in saying this, because as a matter of fact I did anticipate from theory the action of a combination very similar in character. The experiment is described in the *Philosophical Magazine* for May, 1882, and differs from Mr. W. Smith's only in the substitution of a telephone for the galvanometer, and of a microphone for the interruptor, no reverser in the secondary circuit being required. By the interposition of a thick copper sheet the sound is greatly enfeebled.

The second series of experiments were made with Faraday's "new magneto-electric machine," in which a copper disk rotates about its centre between the poles of a horse-shoe magnet. The currents developed are examined with a galvanometer whose electrodes touch two points upon the disk—in Mr. W. Smith's experiments, one at the centre, and the other at the circumference. At low speeds the distribution is symmetrical with respect to that diameter of the disk which is passing at any moment between the poles; but, as the speed is increased, a certain "drag" is observed, disturbing the symmetry. This drag, or lagging, was noticed by Nobili in a very similar arrangement as long ago as 1833 ("Wiedemann's Electricity," third edition, vol. iv., § 374), and is no doubt to be attributed to the induction of the currents upon themselves.

This question of self-induction is indeed a very important one in respect of certain methods for determining the ohm; but it certainly cannot be said to have been neglected, as Mr. W. Smith seems to suggest. Both in the original experiments of the British Association Committee with a coil revolving about a vertical axis, and in my own recent repetition of them, the self-induction of the coil is a most important feature, and may cause a displacement of the position of maximum current from the plane of the magnetic meridian through as much as 20°. In my paper (*Phil. Trans.*, 1882, p. 661) I thought I had discussed the question at almost tedious length.

It is possible that Mr. W. Smith had in his mind rather determinations by the method of Lorenz, in which Faraday's disk is used. The arrangement here, however, differs in one very important respect from that of Mr. W. Smith's experiments in that the lines of force are symmetrically arranged in relation to the axis of rotation. The consequence is that, however great the speed of rotation, there are no currents circulating in the disk, and therefore no question arises as to the self-induction of such currents. What is observed is simply the difference of electrical potential between the centre and the circumference. It is impossible to discuss the matter fully here, but the reader will find all that is necessary by way of explanation in the paper published in the *Phil. Trans.* ("Experiments by the Method of Lorenz for the further Determination of the Absolute Value of the British Association Unit of Resistance," &c.). My object in writing is to correct the inference, suggested by W. Smith's remarks, that the question of self-induction has been neglected by workers upon this subject.

RAYLEIGH

THE INVENTIONS EXHIBITION

IN the presence of a crowded and distinguished assembly the Inventions Exhibition was opened by the Prince of Wales on Monday. The Exhibition is, as usual on first days, still in a somewhat chaotic condition, and we can do no more this week than refer to the leading incidents of the opening ceremony. Sir Frederick Bramwell, Chairman of the Executive Council, in his address to the Prince of Wales, gave a sketch of the progress and objects of the Exhibition, which, he pointed out, is intended to illustrate the progress of inventions since the year 1862, and that of musical instruments and appliances since the commencement of the present century. The labours of the different committees were, he stated, rendered extremely onerous by the vast number of applications received—a number far greater then we had space to accommodate. Influential Commissions have been nominated by Austria-Hungary, France, China, Greece, Italy, Japan, Russia, Siam, and Switzerland, from which countries interesting and valuable exhibits have been received or are promised. Arrangements have been made with the Council of the Royal Albert Hall by which that building forms an integral portion of the Exhibition, with the National Fish Culture Association for the maintenance of the Aquarium, and with the Council of the Royal Horticultural Society for the holding of the usual periodical flower and fruit shows. The Old London Street, which was so popular a feature in last year's Exhibition, has been maintained. Many small annexes have been swept away, and in their places spacious galleries have been erected. Not only has greater exhibiting space been thus obtained, but the gardens, which are so great a source of attraction to visitors, have actually been enlarged. Notwithstanding the fact that the gallery used last year for machinery has been greatly extended to meet the requirements of exhibitors, it proved to be inadequate for the many important inventions for which motive power was desired; indeed, it has been found necessary to furnish such power in no less than three other galleries. "The employment of electricity for the purposes of lighting," Sir Frederick said, "is undoubtedly one of the most striking instances of the application of science to the purposes of daily life; we have, therefore, not hesitated to give this subject special prominence. The method we have adopted will, it is believed, render any sudden failure of the lights impossible, and will favourably display the most recent and improved apparatus, and the advances that up to this date have been made in electric lighting. After most careful experiments we have ventured to employ, for the garden illumination, the incandescent electric lamp, and we have done so in a manner and on a scale which, we believe, has never before been attempted. As a division of the Exhibition is devoted to music, we have set apart an important portion of the buildings to the illustration of instruments and appliances appertaining to that art; and we have invited the formation of a historical loan collection of musical instruments, which we believe is of a deeply interesting character. In requesting your Royal Highness to declare this Exhibition open we desire to express the hope that it may, on the one hand, be the means of bringing valuable and meritorious inventions prominently before the general public, to the benefit and credit of the exhibitors, and that it may, on the other hand, be the means by which that public may, within the area of one exhibition, be enabled to appreciate the marvellous progress which during the past quarter of a century every industry has achieved."

The Prince of Wales, in reply said: It is with much pleasure that I have listened to the report of the Executive Council, and I fully appreciate the labours which you have bestowed upon this great undertaking. At the closing of the International Fisheries Exhibition I took the opportunity of expressing a hope that an International Inventions Exhibition might be held in these buildings during the present year; and I am sincerely gratified to find that this hope has been realised. The scope of this Exhibition is, indeed, vast, and I can readily comprehend the difficulties which must have beset you and the Committee of Advice in your endeavours to secure adequate representation for each branch of industry. I have observed with much pleasure that the classification originally adopted has been made the practical basis of the allotment of space in the Exhibition, and that the exhibits in each group have, as far as possible, been placed together. I am convinced that by following this plan you have materially increased the educational value of the Exhibition. I readily echo the sentiments of gratitude which you have expressed for the invaluable aid rendered by the guarantors; and I join with you in welcoming the representatives of those foreign countries who are present here to-day.

The Prince of Wales, after declaring the Exhibition open, made a tour of the galleries in company with the Princess of Wales and many others of the distinguished visitors who were present.

THE FLORA OF BANK-NOTES

"LA Flore des Billets de Banque" is the title of an article in *Science et Nature*, an article which, in spite of an amusing tendency inseparable from all things savouring of sensational science, may suggest thoughts more or less alarming in view of recent discoveries in bacteriology. It is no new fact that books, coins, and other articles of a durable nature which pass much from hand to hand may be the means of transmitting

FIG. 1

infectious diseases, and if these infectious diseases are caused by visible and tangible agents, it is not going far to expect that the agents should be discoverable on the transmitting media by means of the microscope, and by other methods employed by the specialists who devote themselves to tracing the awful bacterium to its home. Of course it is now matter of fact that "bacteria" (using the term in its widest sense) can be and are causal agents in disease, and the writer of the article referred to shows that bacteria and other minute organisms always occur on bank-notes; there is, perhaps, no more in this observation than that it demonstrates a fact in a particular case which scientific biologists have shown to be true much more generally. All objects exposed to the air and passed from hand to hand are apt to have minute organisms settling upon them, and we should expect such things as bank-notes, which pass through many hands, to be favoured by more than their usual share of "germs," knowing that simple abrasion is no satisfactory means for removing such minute bodies. Nevertheless it is interesting to see what really have been found on European bank-notes. M. Reinsch some time ago undertook to examine the money in circulation, with the result that two very small algæ, which were named as species of *Chroococcus* and *Pleurococcus* respectively, proved to be not uncommon on coins. M. Jules Schaarschmidt has since undertaken to examine the paper currency of various States, with the result that such living organisms and other objects as those in the annexed woodcut were discovered. According to the statements to hand, the notes examined were particularly those of Austro-Hungary and Russia, and new as well as old ones furnished "an abundant cryptogamic vegetation," as well as "microbes," and objects such as grains of starch, particles of hair, &c.

The entire list comprises *Bacterium termo*, the common bacterium of putrefaction; *Saccharomyces cerevisiæ*, the

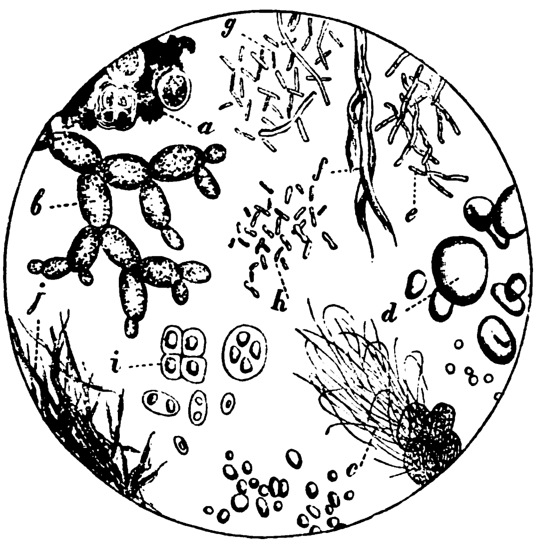


FIG. 2.—*a* and *i*, minute algæ; *b*, yeast cells; *c*, *Leptothrix*; *d*, starch-granules; *e*, *g*, *h*, various *Schizomycetes*; *f* and *j*, fibres.

yeast plant; various species of *Micrococcus*, *Leptothrix*, and *Bacillus*, as well as the two minute green algæ described by Reinsch.

We presume, in the absence of definite statements, that the groups of organisms sketched in Fig. 2 were obtained at different times, and on different notes; otherwise the "flora" is indeed a rich and abundant one, and may probably have been an isolated one, to allow the species of *Saccharomyces* to form such a fine growth.

There is obviously a very serious side to all this, however, if further researches prove that, as appears possible, our most minute and dreaded enemies are always in our midst on such apparently welcome visitants as coin and bank-notes: money will have earned a worse name even than it has heretofore! *En revanche*, there are two points which no doubt will be insisted on: in the first place, the observers named have not, so far, described any organism on the money investigated which is known to be inimical to us; and secondly, precautions have been taken from time immemorial against the transmission of currency passing from a plague-stricken community to a healthy one. Possibly the facts derived from these observations will be made use of to bring more forcibly before the minds of our less careful brethren the dangers of handling "filthy lucre" in times of disease.

STANDARD PITCH[1]

M. SORET raises the question of musical pitch, and advocates A 432, long ago proposed by M. Meerens, of Belgium. It is rather curious that in Belgium itself M. Meerens's proposal was considered and rejected by a Commission appointed in 1877, upon whose report the French pitch A 435 was adopted by Royal decree on March 19 of this year. There seems to be very little difference between the two; it amounts, in fact, to exactly 12 cents or hundredths of an equal semitone, of which 21½ make a comma. Hence there is no practical reason for making the change as affecting singers. But no instruments made for A 435 would be available for A 432, so that the advantage of uniformity would be lost, without any advantage to the voice or the quality of instruments. The arguments in its favour are almost entirely arithmetical. To begin with the inaudible 1 vibration and proceed by exact doubling to 64 is an arithmetical dream. It is true that König, by a most ingenious adaptation of a large tuning-fork acting in place of a pendulum to a clock going in a room at 20° C. (for about five days in a year), has succeeded in making a fork of that precise number of vibrations at that precise temperature. But at 15° C., the temperature adopted for the French *diapason normal* (standard fork), the pitch of this would not be 64, but, to take König's numbers, 64·036. The charm of the arithmetic vanishes, therefore, with a slight alteration of temperature, and the pitch has become fully 1 cent (hundredth of a semitone) sharper. Granted that this is an imperceptible amount, yet it is enough to alter the whole of the arithmetic. Then the arithmetic is itself founded on just intonation, which is not adopted anywhere. If we take the equal temperament, now generally accepted, we should get for A 432 the values C 256·9, C♯ 272·2, D 288·3, D♯ 305·5, E 323·6, F 342·9, F♯ 363·3, G 384·9, G♯ 407·8, A 432, A♯ 457·7, B 473·9, C 513·8. There is nothing charming here. M. Soret, in his table, quietly ignores the chromatic notes and the equal temperament. If, however, we took C 256 as the starting-point, the A of C major in just intonation would not be 432, but, as he owns, a comma flatter, 426·67. He bases everything physically on the violin, which is tuned in D and not in C, or the viola and violoncello, which are both tuned in G, not in C, and hence even for these instruments, with the great assumption of just intonation, his use of the major scale of C is incorrect.[2] The reasons that are to guide us in the choice of a pitch must certainly not be arithmetical. For more than two centuries up to 1813, when the Philharmonic Society was founded, all Europe used a pitch within a comma either way of Handel's fork A 422·5. Then, owing to the presentation of new instruments by the Emperor of Russia to a Vienna regiment at the Congress of Vienna, pitch rose gradually but slowly. In 1826 our Philharmonic Society, under Sir G. Smart, adopted A 433, between M. Soret's and French pitch, and this was known for many years in London as the Philharmonic pitch. France adopted A 435 in 1859. Under Costa our pitch rose to its present height, A 454·7. But our army pitch, used at Kneller Hall, and adopted for the forthcoming Exhibition, is A 452. Now, the trouble is that our classical composers wrote their music for Handel's pitch, while since 1860 Continental composers

[1] J.-L. Soret, "Sur le Diapason" (*Archives des Sciences physiques et naturelles*. January, 1885. Geneva).

[2] Savart, whom M. Soret quotes, was in error with regard to the pitch of the resonance of Cremona violins. It was not 256 vibrations. A series of instruments examined by Mr. A. J. Ellis in 1880 gave about 270 as the primary maximum, and 252 as the secondary. But the main character was the great uniformity of reinforcement for different pitches.—See his "History of Musical Pitch."

have used French pitch, and English composers our high pitch. The first and last may compromise with the second, but are incompatible with each other. To sing Handel in modern English pitch is to unduly strain voices and spoil the effect originally intended. But we submit to it even in Handel festivals. There is a greater difficulty in altering pitch in England than on the Continent. We have no subsidised Conservatoires or theatres to which we can say: "Use this standard of pitch, or go without subsidy." Even regimental bands are not supplied at the expense of the State. A new set of instruments is very costly, and more than that, it is long before makers learn how to manufacture correctly to a new pitch. The question is therefore beset with difficulties. But the solution is certainly not to be found in the arithmetic of M. Soret.

THE SCIENCE AND ART MUSEUM, EDINBURGH

We understand that Col. Murdoch Smith has been appointed by the Lords of the Committee of Council on Education to the Directorship of this Museum, in succession to the late Prof. Archer. As Lieut. Smith he was associated with Prof. Newton in the discoveries at Helicarnassus, and, subsequently, with Commander Pacher, R.N., undertook the explorations in the Cyrenaica which resulted in the acquisition by the nation of the valuable collection of sculptures now in the British Museum. Latterly, Col. Smith, while employed at Teheran, has acquired for the South Kensington Museum the large and valuable collection of Persian art and manufactures which is so well known there. We believe Col. Smith obtained his first Commission in the Royal Engineers direct from a Scottish University, and is one of the very few officers in that Corps who did not pass through the Royal Military Academy at Woolwich or Addiscombe.

NOTES

We take the following from the *Times*:—The following is the list of selected candidates recommended by the Council of the Royal Society for the election to the Fellowship:—A. W. Baird, Major R.E., P. Herbert Carpenter, D.Sc., Sir Andrew Clark, M.D., Mr. A. A. Common, F.R.A.S., E. W. Creak, Staff-Commander, R.N., Prof. E. Divers, H. Hicks, M.D., W. M. Hicks, M.A., F. R. Japp, Ph.D., A. M. Marshall, M.D., Prof. H. N. Martin, D.Sc., C. O'Sullivan, Prof. J. Perry, Prof. Sydney Ringer, and Sidney H. Vines, D.Sc.

Of the fifteen candidates who have thus been selected no less than five are Cambridge men. Mr. W. M. Hicks was bracketed seventh wrangler in the Mathematical Tripos of 1873. Prof. H. N. Martin, Prof. Milnes Marshall, and Dr. Vines were the seniors in the Natural Science Triposes of 1873, 1874, and 1875 respectively, while Dr. Herbert Carpenter obtained a First Class in the Tripos of 1874, together with Mr. J. N. Langley, who was elected to the Royal Society in 1883. The name of the late Prof. F. M. Balfour follows that of Dr. Martin in the Tripos list of 1873; while the late Prof. A. B. Garrod was senior in 1871, and the Tripos list of 1870 contains the names of Francis Darwin and E. J. Romanes. The Natural Science Triposes from 1870 to 1875, inclusive, have thus furnished no less than nine Fellows of the Royal Society, either actual or elect. The names of seven more occur in the Mathematical Tripos lists from 1871 to 1880 inclusive, viz.: J. Hopkinson (1871), J. W. L. Glaisher (1871), H. Lamb (1872), A. B. Kempe (1872), W. M. Hicks (1873), Rr. T. Glazebrook (1876), and J. J. Thomson (1880). To these may be added the name of Dr. W. H. Gaskell, who obtained mathematical honours in 1869, but has since devoted himself to physiology. All who know Cambridge will recognise how largely these results are due to the influence and example of the late Prof. Clerk Maxwell and of Prof. Michael Foster respectively.

We are informed that Dr. Frankland, F.R.S., has intimated his intention to resign the Professorship in Chemistry in the Normal School of Science and Royal School of Mines at the end of the current session. Applications for the post should be addressed to the Secretary, Science and Art Department.

The Fifty-fifth Annual Meeting of the British Association will commence on Wednesday, September 9, 1885, at Aberdeen. The President-Elect is the Right Hon. Sir Lyon Playfair, K.C.B., M.P., Ph.D., LL.D., F.R.S. L. & E., F.C.S., who will take the place of Lord Rayleigh. The Vice-Presidents are His Grace the Duke of Richmond and Gordon, K.G., Chancellor of the University of Aberdeen, the Right Hon. the Earl of Aberdeen, LL.D., Lord-Lieutenant of Aberdeenshire, the Right Hon. the Earl of Crawford and Balcarres, F.R.S., James Matthews, Lord Provost of the City of Aberdeen, Prof. Sir William Thomson, F.R.S., Alexander Bain, M.A., LL.D., Rector of the University of Aberdeen, the Very Rev. Principal Pirie, D.D., Vice-Chancellor of the University of Aberdeen, Prof. W. H. Flower, F.R.S., Pres.Z.S., Director of the Natural History Museum. General Treasurer: Prof. A. W. Williamson, F.R.S., University College, London, W.C. General Secretaries: Capt. Douglas Galton, C.B., F.R.S., A. G. Vernon Harcourt, F.R.S. Secretary: Prof. T. G. Bonney, F.R.S. Local Secretaries for the meeting at Aberdeen: J. W. Crombie, M.A., Angus Fraser, M.A., M.D., Prof. G. Pirie, M.A. Local Treasurers for the Meeting at Aberdeen: John Findlater, Robert Lumsden. The Sectional Officers are as follows:—A. Mathematical and Physical Science. President: Prof. G. Chrystal, M.A., F.R.S.E. Vice-Presidents: Prof. C. Niven, F.R.S., Prof. A. Schuster, F.R.S. Secretaries: R. E. Baynes, M.A., R. T. Glazebrook, F.R.S., Prof. W. M. Hicks, M.A. (Recorder), Prof. W. Ingram, M.A. B. Chemical Science. President: Prof. H. E. Armstrong, F.R.S. Vice-Presidents: Prof. A. Crum Brown, F.R.S., Prof. H. McLeod, F.R.S. Secretaries: Prof. P. Phillips Bedson, D.Sc., F.C.S. (Recorder), H. B. Dixon, M.A., F.C.S., H. Forster Morley, D.Sc., F.C.S., W. J. Simpson, M.D. C. Geology. President: Prof. J. W. Judd, F.R.S., Sec.G.S. Vice-Presidents: John Evans, Treas.R.S., Prof. W. C. Williamson, F.R.S. Secretaries: C. E. De Rance, F.G.S., J. Horne, F.R.S.E., J. J. H. Teall, M.A., F.G.S., W. Topley, F.G.S. (Recorder). D. Biology. President: Prof. W. C. McIntosh, F.R.S. Vice-Presidents: Prof. I. Bayley Balfour, F.R.S., Prof. J. S. Burdon Sanderson, F.R.S. Secretaries: W. Heape, J. Duncan Matthews, F.R.S.E., Howard Saunders, F.L.S., F.Z.S. (Recorder), H. Marshall Ward, M.A. E. Geography. President: Lieut.-General J. T. Walker, C.B., R.E. F.R.S., F.R.G.S. Vice Presidents: Prof. James Donaldson, F.R.S.E., John Rae, M.D., F.R.S. Secretaries: J. S. Keltie, F.R.G.S., J. S. O'Halloran, F.R.G.S., E. G. Ravenstein, F.R.G.S. (Recorder), Rev. G. A. Smith. F. Economic Science and Statistics. President: Prof. Henry Sidgwick, M.A., Litt.D. Vice-Presidents: Prof. R. Adamson, M.A., LL.D., Sir Rawson W. Rawson, K.C.M.G., C.B., Pres.S.S. Secretaries: Rev. W. Cunningham, D.Sc., F.S.S., Prof. H. S. Foxwell, F.S.S. (Recorder), C. McCombie, M.A., J. F. Moss, F.R.G.S. G. Mechanical Science. President: Benjamin Baker, M.Inst.C.E. Vice-Presidents: Prof. W. C. Unwin, M.Inst.C.E., Prof. H. C. Fleeming Jenkin, F.R.S., M.Inst.C.E. Secretaries: A. T. Atchison, M.A., M.Inst.C.E. (Recorder), F. G. Ogilvie, M.A., E. Rigg, M.A., H. T. Wood, M.A. H. Anthropology. President: Francis Galton, F.R.S., President of the Anthropological Institute. Vice-Presidents

W. Pengelly, F.R.S., Prof. W. Turner, F.R.S. Secretaries: G. W. Bloxam, F.L.S. (Recorder), J. G. Garson, M.D., Walter Hurst, B.Sc., A. MacGregor, M.B. The First General Meeting will be held on Wednesday, September 9, at 8 p.m. precisely, when the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., F.R.A.S., F.R.G.S., will resign the chair, and the Right Hon. Sir Lyon Playfair, K.C.B., M.P., Ph.D., LL.D., F.R.S. L. & E., F.C.S., President-Elect, will assume the Presidency, and deliver an address. On Thursday evening, September 10, at 8 p.m., there will be a Soirée; on Friday evening, September 11, at 8.30 p.m., a discourse by Prof. W. Grylls Adams, M.A., F.R.S., F.G.S.; on Monday evening, September 14, at 8.30 p.m., a discourse on "The Great Ocean Basins," by John Murray, F.R.S.E., Director of the *Challenger* Expedition Commission; on Tuesday evening, September 15, at 8 p.m., a Soirée; on Wednesday, September 16, the concluding General Meeting will be held at 2.30 p.m. The lecture to working men will be on the "Nature of Explosions," by Mr. H. B. Dixon, M.A., F.C.S., Fellow of Trinity College, Oxford.

WE understand that the Marquis of Lorne is likely to succeed Lord Aberdare as President of the Royal Geographical Society.

SIR JOHN LUBBOCK responded to the toast of "Science" at the Royal Academy dinner on Saturday evening, and in doing so adduced one more argument on behalf of science as a training and discipline even from the standpoint of art. He claimed for the workers in science that the careful habit of observation and study in which they are necessarily trained enable them to derive peculiar enjoyment from the creations of artistic genius; and he might have suggested in this connection the great advantage to the artist himself of a preliminary training in practical scientific work.

SIR FREDERICK BRAMWELL has evidently a very high ideal of the training necessary to qualify a civil engineer for the performance of the duties of his calling. At the anniversary dinner last week he told his audience that the ideal engineer—"I am glad to say in many cases the real engineer—of the present day is one who has a scientific knowledge as the foundation for his technical training, and frequently that scientific knowledge is of a very extended character. Mechanics, it need hardly be said, are essential, but, in addition, many branches of physical science, such as heat, light, sound, hydraulics, pneumatics, magnetism, electricity, are all now within the knowledge of the accomplished engineer. Moreover, although I do not suggest that every engineer should be a chemist, it is quite certain that he should not be without some chemical instruction, even if it be confined to that which is needed to warn him that the time has arrived when he should seek sound chemical advice."

DR. NOETLING, of the University of Königsberg, has been despatched by the Prussian Academy of Sciences to Lebanon, to study the geology of the Greater Hermon.

THE Italians have lost no time in erecting a meteorological station at Massowah, which they have occupied quite recently.

EARLY in the afternoon of the 2nd a loud detonation was heard from Mount Vesuvius, and two new craters, from which lava issued abundantly, were opened on the southern side at a height of about 200 metres above the upper station of the funicular railway. The lava flowed in the direction of Pompeii and Torre del Greco. The stream descends in a straight line for about half a kilometre, and then, turning sideways, is directed towards the crater of 1872. The new craters present the appearance of a great cleft. The lava has not spread beyond the side of the mountain, and according to the latest telegram the eruption is not increasing.

AT half-past 1 o'clock on the morning of the 1st inst. two or three rather violent shocks of earthquake were felt at Vienna, accompanied by a rolling noise, and causing a great clattering of furniture. Shocks of far greater violence were experienced in Styria, where many houses were damaged and some persons were killed. In the western districts the shocks were of a slight character. The phenomenon appears to have extended southward as far as Grätz and westward to Bavaria. A shock was also felt at Monte Carlo at 10 minutes to 3 on the morning of the 2nd. The shock was strongest in the districts of Condamone and the Cap d'Aile.

THE Annual General Meeting of the members of the Iron and Steel Institute commenced yesterday. The Bessemer medal for the year was presented to Prof. Richard Åkermann by Dr. Percy, F.R.S., the newly-elected President, who gave his inaugural address. The meeting will be continued to-day and to-morrow. The following is a list of some of the principal papers:—On the blast furnace value of coke from which the products of distillation have been collected, by Mr. I. Lowthian Bell, F.R.S.; on the manufacture of steel, by Sir Henry Bessemer, F.R.S.; on the mechanical properties of steel, by Dr. H. Wedding; on the microscopic structure of steel, by Dr. Sorby; on the causes of failures in steel plates, by Mr. W. Parker, of Lloyd's; on a new description of wrought-iron castings, by Mr. T. Nordenfelt; on natural gas, and its utilisation for manufacturing purposes in the United States, by Mr. A. Carnegie; on a modified type of the Siemens gas-producer, whereby the gases are enriched and the bye-products recovered, by Mr. J. Head. We propose to draw attention to the scientific points in some of these papers next week.

PROF. W. ODLING will give the first of two lectures on Organic Septics and Antiseptics, at the Royal Institution, on Saturday, May 16.

THERE is an excellent programme for May at the Royal Victoria Hall and Coffee Tavern, Waterloo Bridge Road, S.E. The science lectures on Tuesdays will be given by Dr. Dallinger, on wonderful things we do not personally see, on the 12th; and by Prof. Perry on the spinning tops of Japan and other countries, on the 19th. Owing to the depression in trade and wishing to put enjoyable entertainments within every one's means, the management have decided to lower the prices of admission during May.

THE Russian Geographical Society has awarded, this year, its great Constantine medal to M. A. S. Woeikoff for his important work, "The Climates of the Globe, and especially of Russia." Analysing this work in the "Annual Report for 1884" of the Society, Dr. Robert E. Lenz shows how original it is in its fundamental idea. Instead of representing the climates as they result from the averages of climatological elements, as is usually done in meteorological works, M. Woeikoff, like Dr. Hann in his "Handbuch der Klimatologie," but with much more fullness and details, tries to explain the local alterations which the general meteorological laws are submitted to in various countries in consequence of the topographical features of these last; and he verifies his conclusions with regard to each country by comparing them with those arrived at as to the climates of neighbouring countries, and establishes thus the elements of a comparative meteorology. The extensive travels of the author in Asia and America have enabled him to recognise the leading meteorological features of the climates he describes and to become acquainted, by personal knowledge, with the topographical features of each separate region. The first twenty-two chapters of this volume, 640 pages, are devoted to a detailed analysis of the chief meteorological elements: the heat received from the sun; the dynamical and thermical consequences of the rising and falling of masses of air; the hydrometeors and their influence on the climates of separate regions—many quite new and original remarks and observations being embodied in these five chapters; the influence of snow and ice-coverings—two chapters again where the meteorologist and geologist will find a series of most interesting suggestions; the temperature of lakes, seas, and oceans; the influence of wind; the variations of temperature with the height—very carefully discussed; the diurnal changes and the unperiodical ones; and finally, the influence of climate on vegetation, and *vice versâ*—again two chapters full of new appreciations. The climates of eight separate regions—Atlantic, North and Middle America, Tropical America, Middle and South Africa, Mediterranean basin, North-West and Middle Europe, South-Eastern Asia, and finally Russia and Northern Asia, are discussed with great detail and with a richness of quite new data in ten separate chapters. Needless to add that the author, well acquainted with so many foreign languages, has embodied in his work all that is worthy of notice in meteorological literature. The work is illustrated by ten maps and fourteen drawings, and contains very numerous tables.

DURING the opposition of Neptune, just passed, we learn from *Science*, Prof. Pickering continued the observation of the planet's magnitude with the meridian photometer of the Harvard College Observatory in the same method as previously employed. Nine series of observations extend from December 16, 1884, to January 21, 1885, the final result from which, when corrected for atmospheric absorption, instrumental error, and reduction to mean opposition, becomes 7·63. The residual difference for only one series is as great as two-tenths of a magnitude. The corresponding results for two previous seasons are 7·71 and 7·77. Contrary to the experience of Mr. Maxwell Hall, of Jamaica, who found evidence for a rotation-period of Neptune in small variations of the planet's light according to his own observations, Prof. Pickering regards it as improbable that there is any variation in the light of Neptune of a strictly periodic character, and further calls attention to the influence, much neglected by observers, upon the observed brightness of objects when seen east and west of the meridian on the same night. This has to be taken account of in the observations of maxima and minima of many variable stars, and may to some extent account for the variations of Neptune's light detected by Mr. Hall.

THE report of the. Post Office, Telegraph, and Observatory Departments of South Australia for the past year contains a detailed account *inter alia* of the work of the Observatory Department in that colony since its foundation in 1867. It would be impossible to do more than refer generally here to numerous details given in the ten closely-printed foolscap pages devoted to the subject. Since its establishment the department appears to have kept pace with the strides of the colony to which it belongs. The astronomical observatory at Adelaide is now well supplied with meteorological appliances, having self-recording and other instruments necessary to constitute it a first-class station as defined by the Meteorological Congress at Vienna. There are also fourteen well-equipped stations of the second order, scattered all over the colony, from Port Darwin, in the extreme north of the continent, to Cape Northumberland in the extreme south. Rain-gauges are kept at every telegraph office in the colony; in 1870 there were reports from forty-six stations; in 1883 from 254, and there are still large gaps to be filled up. A system of weather-telegraphy has been arranged between the Australasian colonies, these being divided into districts or aspects to facilitate the transmission of the messages, and to afford the necessary data for laying down the isobars. The important operations undertaken to determine Australian longitudes are also described in detail. Mr. Todd, the head of the combined departments—post, telegraph, and observatory—anticipates great assistance in the inter-colonial meteorological part of his work from Mr. Clement E. Wragge's high-level meteorological station on Mount Lofty, "as he brings to his work great practical experience and almost unbounded enthusiasm."

THE last number (vol. v. No. 4, 1885) of the *Proceedings* of the Bath Natural History and Antiquarian Field Club contains papers on the group of stones at Stanton Drew, in Somersetshire, by Mr. J. Allen Tucker, in which he favours the theory that these huge monuments are the remnants of a temple, either erected by the Druids or by some primeval or prehistoric race, and only used by the Druids, and were not intended to commemorate a battle, which was too common an event in early times; by Rev. L. Blomefield, on a second specimen of the rare Longicorn beetle found in Bath; by Mr. Williams, on the natural history of British owls; and by Mr. Morgan, on water-supply, principally as applied to domestic purposes. There are also several minor contributions noticed in the summary of proceedings at the meetings.

WE have received the prospectus of a Field Club for Hampshire, the Honorary Secretary to which is Mr. E. Westlake, Fordingbridge, Salisbury. The first meeting is to be held at Winchester on May 28. The marvel is that a county as varied as any in England in this respect should have been so long without its Naturalists' Field Club. White of Selborne on the east, and Kingsley on the north, have made the county a classic one for students of nature. With these examples to live up to, and such a field as Hampshire (including the Isle of Wight) the Proceedings of the new club should be interesting and successful.

THE Report of the Committee of the Kelvingrove Museum of Glasgow for the past year illustrates the truth of a remark of Mr. Higgins in his pamphlet on museums recently noticed in these columns, viz. that the number of museums in which a sum of money could be best spent in making additions is very small; that is, as a rule, arrangement is more needed than acquisition. The Committee of the Kelvingrove Museum report that the establishment has been overcrowded for years, that the enormous amount of specimens of all kinds stored away out of sight is constantly increasing, and that the labour and unremitting watchfulness required to keep such stored specimens from deteriorating grows in proportion, and withdraws from essential and more useful museum work much of the time of the small staff, and it has thus become from year to year increasingly difficult to undertake any considerable project for improving the order, classification, or labelling of any section of the museum. This is certainly a grave evil, for it threatens to destroy the main object of such a museum, viz. public instruction. It is to be hoped that a wealthy and public-spirited town such as Glasgow will not permit this state of things to continue; for, as the Report points out, from the stores already within the museum, supplemented in some departments by inexpensive and easily acquired objects, a natural history museum could be equipped which would satisfactorily illustrate all the range of the animal kingdom, and prove at once of great value to the student of zoology, and a popular attraction to the public. For the rest, there has been "a large, steady, and well-maintained flow of visitors, which does not show any indication of waning."

THE Lyceum of Natural History of Williams College, Williamstown, Mass., the oldest natural history society but one connected with any college in the United States, will celebrate its fiftieth anniversary on the 24th of this month, at which a former member, Dr. W. K. Brooks, of the class of 1870, now Associate of Johns Hopkins University, will deliver an address. The Lyceum proposed to take advantage of the occasion to raise funds to enable it to undertake expeditions to some spot, similar to those which it has undertaken in former years to Labrador, Florida, &c.

WE learn from *Science* that the Leander McCormick Observatory of the University of Virginia was inaugurated on April 13, the ceremonies taking place in the public hall of the institution, and Prof. Asaph Hall, of the Naval Observatory, Washington, delivering the address. The principal instrument is the great Clark refractor of 26 inches' aperture. The Observatory has a house adjoining for the director, Prof. Stone, and is possessed of a considerable endowment fund, the gift of Mr. W. H. Vanderbilt, of New York.

CAPT. L. U. HERENDEEN, of San Francisco, communicates the following notes on prehistoric structures in Micronesia to *Science*:—A few years ago I visited Ponapé Island in the Pacific, in E. longitude 158° 22′, and N. latitude 6° 50′. The island is surrounded by a reef, with a broad ship-channel between it and the island. At places in the reef there were natural breaks, that served as entrances to the harbours. In these ship-channels there were a number of islands, many of which were surrounded by a wall of stone five or six feet high; and on these islands there stood a great many low houses, built of the same kind of stone as the walls about them. These structures seem to have been used as temples and forts. The singular feature of these islands is that the walls are a foot or more below the water. When they were built, they were evidently above the water, and connected with the mainland; but they have gradually sunk until the sea has risen a foot or more around them. The natives on the islands do not know when these works were built: it is so far back in the past, that they have even no tradition of the structures. Yet the works show signs of great skill, and certainly prove that whoever built them knew thoroughly how to transport and lift heavy blocks of stone. Up in the mountains of the island there is a quarry of the same kind of stone that was used in building the wall about the islands; and in that quarry to-day there are great blocks of stone that have been hewn out, ready for transportation. The natives have no tradition touching the quarry—who hewed the stone, when it was done, or why the work ceased. They are in greater ignorance of the great phenomena that are going on about them than the white man who touches on their island for a few hours for water. There is no doubt in my mind that the island was once inhabited by an intelligent race of people, who built the temples and forts of heavy masonry on the high bluffs of the shore of the island, and that, as the land gradually subsided, these bluffs became islands.

A CORRESPONDENT recently referred to the use of artificial teeth by the ancient Romans, as shown by a passage from Cicero, where one of the laws of the Twelve Tables is quoted. The law in question belongs to the Tenth Table (*de jure sacro*), which deals mainly with funerals, with the object of limiting the display and ceremonies attending them. Thus the body must not be burnt in more than three robes, or be attended to the grave by more than ten musicians; women must not tear their faces in time of mourning, nor must the bones be collected to make a new funeral with them, the bodies of slaves could not be embalmed, and the like. Section IX. of Table X., which is the one relating to teeth, reads as follows in Ortolan's text ("Histoire de la Législation Romaine," p. 121): "*Neve aurum addito. Quoi auro dentes vincti escunt, ast im cum illo sepelire urereve se fraude esto*—Add no gold; but if the teeth are bound with gold, then that gold may be buried or burnt with the corpse." The date of the Twelve Tables is put about 450 B.C., and it is thought possible by some writers that some of the provisions relating to funerals were taken from the laws of Solon. It would therefore appear that dentistry was known and practised to some extent in the earliest period of their history by the Romans—to an extent, at any rate, that they used gold for binding the teeth. How the artificial teeth were made, or whether they had artificial teeth at all, is not apparent. In the case of the Etruscan skull mentioned recently in NATURE, the artificial teeth are made from the teeth of animals.

M. SOROLOFF, who continues his regular analyses of the water of the Neva, has come to the conclusion that the differences between the average monthly content of solid mixture in the water and the yearly average may be expressed by a curve whose characteristics are the opposite to those of the curve for the average monthly temperatures. The solid inorganic deposit remaining after the evaporation of a given amount of water is also inversely proportionate to the amount of organic matter contained by the water of the Neva. When comparing these curves for the Neva with that showing the amount of solid matter contained by the Thames (as given in the *Journal* of the London Chemical Society for 1880), it appears that both rivers give the same curves, notwithstanding the wide difference of their origins, which coincidence may lead to the supposition that the above might be considered as a law for the rivers.

THE additions to the Zoological Society's Gardens during the past week include a Yellow Baboon (*Cynocephalus babouin* ♀) from West Africa, presented by Mrs. Wilson; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♀) from West Africa, presented by Mr. James S. Jameson; a Crested Pigeon (*Ocyphaps lophotes*) from Australia, presented by Mr. J. Harrison; a Glaucous Gull (*Larus glaucus*), European, presented by Mr. G. Edison; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; four Common Lizards (*Lacerta vivipara*), British, presented by Mr. H. Hanauer; a Common Squirrel (*Sciurus vulgaris*), British, three Wigeons (*Mareca penelope* ♀ ♀ ♀), three Pintails (*Dafila acuta* ♀ ♀ ♀), two Shovellers (*Spatula clypeata* ♀ ♀), five Common Teal (*Querquedula crecca* ♂ ♂ ♂ ♀ ♀), European, purchased; a Yak (*Poephagus grunniens*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

TUTTLE'S COMET.—This comet returns to perihelion in the present year under circumstances which are not favourable for its re-observation, without an ephemeris deserving of some degree of reliance. For the last return in 1871 the perturbations during the previous revolution were very accurately determined by Tischler, of Königsberg, who lost his life before Metz in the Franco-German war; and the comet was detected at Marseilles about seven weeks before the perihelion passage, and was followed at the Cape of Good Hope for a still longer period after it. So far it does not appear that the observations of 1871-72 have been brought to bear upon the predicted elements, nor has it been notified that any one is occupied in ascertaining the effect of planetary attraction since the comet was last observed. Tischler's mean motion for 1871, neglecting perturbation, would bring the comet to perihelion again about 1885, September 23·5 G.M.T., and under this condition the comet's position will by readily commanded during the absence of moonlight in August, but unfortunately the theoretical intensity of light will be below the least value with which it has been thus far observed. Assuming the perihelion passage to fall on September 23, the following would be the rough places of the comet:—

At Greenwich Midnight

	R.A.	Decl.	Distance from Earth	Distance from Sun	Intensity of Light
	°	°			
August 10	106·5	+33·8	1·89	1·22	0·19
14	110·1	31·6	1·85	1·19	
18	113·6	29·3	1·82	1·17	0·22
22	117·0	26·7	1·78	1·14	
26	120·4	+24·0	1·75	1·12	0·26

In 1871, when the comet was detected by Borrelly at Marseilles with the aid of Tischler's ephemeris, the intensity of light was 0·54, and at the last Cape observation, 0·33. On August 10 the effect of an acceleration of eight days in the time of perihelion passage would be to increase the comet's right ascension rather more than 3°, and to diminish the declination about 4°·4.

In the middle of September it will have attained the value at which observations have been already made.

This comet was first observed by Méchain on January 9, 1790. It was rediscovered by Mr. Tuttle at Cambridge, U.S., on September 5, 1858: from the observations made in this year its period was ascertained to be about 13·8 years, so that the comet had completed five revolutions since it was found by Méchain, without having been perceived. According to Clausen's calculations it was in perihelion on the following dates:—1803, November 7; 1817, May 18; 1830, December 6; and 1844, June 28. It approaches nearest to the orbit of Jupiter in heliocentric longitude 264°, or at a true anomaly of about 144°, when its distance from the planet's orbit is 0·8. At the comet's last passage through this point in July, 1873, the distance from Jupiter was as great as 8·9.

Subjoined are the elements of the orbit for 1871, expressed as usual in the catalogues, and with a slight correction to the predicted time of perihelion passage, which the observations showed to be required:—

Perihelion passage, 1871, December 1·7974 G.M.T.

Longitude of perihelion	116° 4′ 36″	Mean
" ascending node ...	269 17 12	Equinox,
Inclination	54 17 0	1870
Eccentricity	0·8210540	
Log. perihelion distance	0·0128823	
" semi-axis major	0·7601603	

The corresponding period of revolution is 5044·7 days, or 13·812 years.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MAY* 10-16

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 10

Sun rises, 4h. 18m.; souths, 11h. 56m. 12·1s.; sets, 19h. 35m.; decl. on meridian, 17° 44′ N.: Sidereal Time at Sunset, 10h. 50m.

Moon (New on May 14) rises, 2h. 28m.; souths, 8h. 24m.; sets, 14h. 31m.; decl. on meridian, 1° 30′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	3 55 ...	10 51 ...	17 47 ...	10 7 N.
Venus ...	4 25 ...	12 3 ..	19 41 ...	17 38 N.
Mars ...	3 42 ...	10 44 ...	17 46 ...	11 23 N.
Jupiter ...	11 25 ...	18 41 ...	1 57* ...	13 49 N.
Saturn ...	6 7 ...	14 15 ...	22 23 ...	22 15 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
11 ...	44 Piscium	... 6 ...	3 27	near approach ...	160 —
16 ...	130 Tauri	... 6 ...	18 31 ..	19 27 ...	137 298

Phenomena of Jupiter's Satellites

May	h. m.		May	h. m.	
10 ...	20 46	II. occ. disap.	14 ...	19 46	I. tr. ing.
13 ...	1 17	I. tr. ing.		22 6	I. tr. egr.
	21 58	IV. occ. disap.	15 ...	20 27	I. ecl. reap.
	22 25	I. occ. disap.			
	22 35	III. ecl. reap.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

May	h.	
10 ...	10 ..	Mercury stationary.
11 ...	9 ..	Mercury at greatest distance from the Sun.
13 ...	4 ...	Mercury in conjunction with and 0° 21′ south of the Moon.
13 ...	4 ..	Mars in conjunction with and 2° 4′ north of the Moon.
13 ...	9 ...	Mercury in conjunction with and 2° 27′ south of Mars.
14 ...	18 ...	Venus in conjunction with and 3° 47′ north of the Moon.
16 ...	15 ...	Saturn in conjunction with and 4° 2′ north of the Moon.

GEOGRAPHICAL NOTES

We regret to learn that the well-known African explorer, Dr. Gustav Nachtigal, died on April 24, on board the German gunboat *Möwe*, off the west coast of Africa. Dr. Nachtigal was born at Eichstadt in 1834, and was trained to the medical profession. In 1862 he went to Algiers on account of his health, and in 1868 he started on his memorable journey into the heart of Africa, visiting the territories of Bornu, Baghirmi, Wadai, Darfur, Kordofan, emerging at Khartoum in 1874. This work placed Dr. Nachtigal in the front rank of African explorers. At the time of his death, it is well known, he was looking after the interests of Germany in connection with its recent annexations in West Africa.

The death is announced from Königsberg of Dr. Karl Zöppritz, Professor of Geography in the University there, and well known as the author of the reports on the progress of geophysics and of African exploration in Behm-Wagner's Geographical Year-Book.

On Monday last a lecture was delivered at the Alexandra Palace by Prof. A. H. Keane, on "The Lapps: their Origin, Type, Affinities, Social Usages," in connection with the company of Lapps who have recently arrived in London and pitched their tents on the slopes of Muswell Hill for the summer months. The group consists of seven persons, mostly members of one family, from the Karasjok district in Finmark, Norway, and belongs to the "mountain" or nomad division of the race. As these "Mountain Finns," as the Norwegians call them, are of much purer descent than the "River" and "Sea" Lapps, who have given up their nomad life and now reside in settled communities either along the riverain tracts or on the sea coast, they afford ethnologists a favourable opportunity of studying the type of these primitive inhabitants of the Arctic regions of North-West Europe. They are accompanied by six reindeer, and two native dogs used for tending the herds, and have also brought with them specimens of the three kinds of sledges still in use, and some of the famous snow-shoes with which they travel with such surprising velocity over the frozen surface of the ground. The average height appears to be about five feet (extremes, 4·10 to 5·4 in.); but in some other respects the type seems to have deviated considerably from the Mongolic, to which it fundamentally belongs, and has been assimilated, especially in the colour of the hair and eyes, in the complexion and shape of the nose, to the surrounding Norse populations. But the lecturer seemed disposed to attribute this assimilation rather to like climatic influences than to actual intermixture, of which there is no direct evidence.

At the last meeting of the Geographical Society of Paris, M. Thouar described in detail the observations made by him during his recent journey in search of the remains of the unfortunate Crévaux expedition in the Northern Chaco. These were divided into notes on the flora and fauna, with specimens of the dialects of the Tobas, Matacos, and Chiriguanos, a description of the dress, ornaments, implements, utensils, &c., of the Tobas and Chiriguanos, anthropological details of the same tribes, an itinerary from Tarija to Asuncion, with numerous meteorological observations, and two documents belonging to the Crévaux mission. He added a study on the Peruvian and Bolivian affluents of the Amazon. With reference to the statement (recently quoted in Nature) that certain members of the mission were still alive amongst the Indians, M. Thouar stated that this information should be received with the greatest reserve, because the date to which it referred was prior to his own sojourn on the frontier, which he traversed from north to south when no one gave him any such information. Since his return to France he has received directly from Bolivia numerous communications from Dr. Gianneccini, who lives on the frontier; in these nothing is said on the subject. A monument to Dr. Crévaux is to be unveiled at Nancy on June 13.

The Geographical Society of Paris has awarded a gold medal (La Rouquette's prize) to the well-known Danish Government publication on Greenland, "Meddelelser om Grönland," in which are from time to time published the results of the Danish scientific expedition exploring that continent. The same honour has befallen Danish subjects twice before, viz. Lieut. Graak, for his explorations of the east coast of Greenland; and Messrs. Bredsdorff and Olsen, for their map, "Esquisse d'une Carte orographique de l'Europe."

GEOGRAPHICAL education in Sweden has for years left much to be desired, but of late steps have been taken for its improvement. In the so-called "Elementär-lärovarken" (classical schools) geography has hitherto been classed as an appendix to history, and at the "Lektor" (candidate) examinations in history and geography questions are only asked about the former study. And while the hours and parts of history-teaching in the schools are detailed, no such arrangement has been made as regards geography; the hours of teaching are, in some cases, even not fixed. However, at the congress of teachers held in Stockholm last year, a resolution was adopted to the effect that geography ought to form a separate study of the school education. The University of Lund is the only institution which possesses an eminent geographer for this Board of Science, viz. Baron von Schverin, who, last year, represented Sweden at the Geographical Congress in Toulouse.

THE last Annual Report of the Russian Geographical Society contains extracts from letters addressed by M. Prjevalsky to the Grand Duke Alexander Alexandrovitch, which contains some further interesting details about his Hoang-ho journey. About the end of May he reached, as known, the foot of the Burkhan-budda Mountains, which inclose the high Thibet plateau separating it from Tsaidam. Leaving there his baggage, he went with only thirteen men to the sources of the Yellow River. The climbing on the 15,700 feet high passage of the Burkhan-budda ridge took three days. The descent, on the contrary, was very short, the plateau of Thibet being there 14,000 to 15,000 feet high. Further 60 miles across the desert plateau brought the traveller to the sources of the Yellow River. They are 13,600 feet above the sea-level, and consist of two rivers coming from the south and west and rising in the hills scattered on the plateau. A wide marshy valley, Odon-tala, 40 miles long and 20 miles wide, feeds numerous springs. The Hoang-ho itself is only a rivulet dividing into two or three branches, each of them but 80 to 100 feet wide, and only 2 feet deep at low water. Some 13 miles below this place the Hoang-ho enters a broad lake, colouring its southern part with its muddy water, and, after leaving it on the east, it enters again another lake, whence it flows out as a large river; further down it makes a great curve to avoid the snow-covered Amis-matchin range, and breaks through, in a wild course, the parallel ridges of the Xuen-lun. On the Thibet plateau the expedition experienced dreadful cold. In the second half of May snow-storms were as strong as in winter, and the night frosts reached $-23°$ Celsius. Still the thin grass covering did not perish and a few flowers reappeared every day under the sun-rays. Even in June and July the thermometer fell during bright nights as low down as $-5°$. As to rain, it poured every day, sometimes several days without interruption. The amount of vapour brought by the south-west monsoon and deposited there is so great that, during the summer, Northern Thibet becomes an immense marsh. Needless to say that the advance was difficult for camels. Though uninhabited by man, these deserts were full of herds of yakes, khoulans, antelopes, and mountain sheep; even bears were seen in groups, sometimes of more than ten at once; some thirty pairs were shot down; they are altogether very cowardly, and fly even when wounded. After having spent a few days at the source of the Hoang-ho, M. Prjevalsky went south to the Blue River, called there Dy-tchou by the Tangoutes. The plateau remained hilly, mostly covered with marshes, where the Thibet rush, hard as iron wire, grows freely. The water-divide between the two rivers has an altitude of 14,500 feet. Further south the region takes the characters of an Alpine country, still devoid of forests, but with a richer and more varied grass vegetation. Tangoutes, of the Kam branch, were met with, and received the travellers, though not friendlily, yet not as enemies. Some 70 miles across a mountain region brought M. Prjevalsky to the Dy-tchou River, at an altitude of 12,700 feet. The river, deep and very rapid, is 350 to 420 feet wide. To ford it with camels was quite impossible, so that a further advance to the south had to be renounced. So it was decided to stay there a week and then return to explore the great lakes of the Hoang-ho. During this stay the Tangoutes fired once from the opposite bank of the Dy-tchou. Returning to the Hoang-ho, M. Prjevalsky took another route to reach the lakes of this river, finding his way without guides. The Tangoutes closely followed the party, and on July 13 suddenly attacked them. This attack, as also another one, were repulsed, and the only further difficulties were in the rains and snow-storms (end of July). On the southern foot of the Burkhan-budda Mountains a party of gold-washers was met with. They did not dig the soil deeper than one or two feet, and their washing was most primitive. Still they showed handfuls of gold, mostly in corns as large as a pea, or twice and thrice the size. After having thus laid over more than 670 miles the party returned to Tsaidam, which appeared to them, as desert as it is, a real Eldorado in comparison with the Thibet plateau.

BESIDES the special medals awarded to M. Woeikoff and M. N. J. Zinger, the other medals of the Russian Geographical Society have been awarded as follows:—Small gold medals to the members of the last Pamir expedition, Col. Putyata; M. Ivanoff, geologist; and M. Bendersky, topographer, as also to M. Gavriloff for a manuscript on the religious beliefs of the Votyaks, and to Prof. Zomakion for magnetic measurements at Kazan. The great gold medals were awarded this year by the Sections of Ethnography and Statistics to M. Shein for his "Materials for the Study of the Customs and Language of the Russian Population in the North-West Provinces of Russia," and to M. Yanjul on the manufactures of the Government of Moscow. Sixteen silver medals have been awarded for several papers published in the publications of the Society, for observations extended over more than ten years on thunderstorms and rainfall, to those students who helped Prof. Zomakion in his magnetic measurements, and so on.

THE eccentricities of the European nomenclature of distant regions is well exemplified in the case of the eastern portion of the Indo-Chinese peninsula to which so much attention is attracted just now by the political events in progress there. On some English maps we find four separate divisions: starting from the north, Tonquin placed next to China; then Annam; then Cochin-China, and finally French Cochin-China. In the map accompanying Mr. Colquhoun's recent work, "Amongst the Shans," territory inhabited by independent tribes is inserted between Tonquin and China, which gives five divisions. This latter, however, is wholly incorrect, as the Tonquin frontier proper marches with that of China. In other maps (chiefly in those published in France) Annam and Cochin-China are thrown in together and called indifferently Annam or Cochin-China; while in others, mainly those of from ten to twenty years old, the whole coast from the Chinese frontier to the French colony of Saigon is called sometimes Cochin-China, sometimes Annam. We derive the name Cochin-China from the early navigators, who applied it to the whole coast round from Siam to China; and various generations, in search of trade rather than of geographical accuracy, have added to the confusion. Since the beginning of the present century, when the rulers of Annam imposed their yoke on Tonquin, there has been only one political power on this coast, viz. Annam. As the territories of this State stood twenty-five years ago, it was bounded by China, the Shan States, Siam, Cambodia, and the ocean, and, with the exception that France obtained three small States at the extreme south in 1861, so it stands at present. Tonquin was a feudatory State of Annam when the present war broke out. In a history of Annam recently published by Abbé Launay, a missionary in these regions, we find his title-page runs thus: "Histoire Ancienne et Moderne de l'Annam—Tong-King et Cochin-Chine—depuis, &c., &c.;" and in some interesting preliminary observations on these names, he explains that the titles Tonquin and Cochin-China are relatively recent, and are employed only by Europeans, and never by the Annamites. Tonquin comes to us from *Dong-kinh*, formerly the name of the capital, now called Hanoi; while Cochin-China comes from *Chen-chin*, the name given to the ancient State of Ciampa, situated to the extreme south of the peninsula. *Chen-chin* was probably preceded at one time by *Cao*, an abbreviation of Cao-tchi (*Giao-chi*), and from *Cao-chen-chin* Europeans have made Cochin-China. The name Annam was first given by the Chinese in the third century of our era. It was never used in the official documents between the two countries, but it is that by which the Annamites now call their country. It was at first applied to Tonquin only, but it was extended by conquest to Cochin-China, the ancient Ciampa. It should not, says Abbé Launay, be used for Cochin-China as distinct from Tonquin, but to the two united. The term *Giao-chi*, above alluded to, was that employed in the earliest epochs for the people inhabiting Annam, and was extended to the country. Their historians record that when the Emperor of China, Hoang-ti, formed the Chinese Empire in the twenty-sixth century before our era, he took Giao-chi as his boundary in the south-west. An ancient sacred book of the Chinese, the "Chou-king," which was collected in the sixth century before our era by Confucius from the remnants of still earlier works, refers to a tribe south of the Chinese frontier as the Giao-chi, which means "toes spread out," or "far apart," a term which points to a wide separation between the great toe and the others. This curious distinctive racial mark exists to-day, notwithstanding the lapse of time and the social revolutions of twenty-five or thirty centuries amongst the Annamites. We might therefore adopt the native distinctions as stated by Abbé Launay *en bloc*, and call the whole region Annam, with sub-divisions Tonquin and Cochin-China; or, making a sacrifice of strict accuracy to long habit, we might call the whole Cochin-China, with sub-divisions Tonquin and Annam. But it is probably as hopeless at present to expect strict uniformity in these names as it is to expect it in the orthography of Tonquin, although uniformity even in doing wrong would be better here than the present confusion.

AT the meeting of the Dutch Geographical Society on April 18, Mr. Robidée Van der Aa delivered a lecture on "Papuans and Melanesians, and their Relation to the Malay-Polynesian Race." Succinctly stated, the opinions expressed in the lecture were these:—The opinion once prevailed that the Papuans were the autocthones of the Malayan Archipelago, but that they were conquered by the Malays. There is, however, no support for this supposition, since in the interior of none of the Sunda Islands has a tribe been found bearing any resemblance to the Papuans. Since the researches and discoveries of Miklucho-Maclay we may not consider their hair or their dark skin as a decisive distinction with regard to other tribes. Moreover, it is now stated that their language is related to the Malayan tongue; there are still many customs and usages found amongst them similar to those met with among Malays. From all this Mr. Van der Aa concludes that the Papuans are one of five families, all of which have descended from one "insular race," and were separated from each other at an early date.

THOUGH nothing was said at the Dutch Geographical Society on April 18 about the expedition undertaken to the West Indies by Prof. Martin and Prof. Suringar, we now learn that they left Curaçoa in March. The former, accompanied by Mr. Van de Poel, arrived at Paramaribo and intended to make an excursion to the "Boven Suriname" on March 30; the latter intends to go to Venezuela, and after that to some of the Windward Islands, viz. St. Martin's, St. Eustathius, and Saba.

WE take from the Annual Report of the Russian Geographical Society the following figures giving the average temperatures for twenty-two months at the Sagastyr Polar Station at the mouth of the Lena. The following figures are on the Centigrade scale, and the first of them gives the average of the corresponding month for the year 1882–1883, while the second is the average of the same month for the year 1883–1884:—September, 0°·1 and 0°·6; October, −15°·1 and 14°·1; November, −27°·9 and −25°·7; December, −33°·5 and −33°·3; January, −37°·2 and −35°·8; February, −41°·3 and −34°·0; March, −31°·5 and −35°·2; April, 20°·7 and −21°·8; May, −8°·1 and −9°·7; June, 0°·9 and −0°·2; July, 5°·1; August, 3°·8. Average of the first year. −17°·1; of the second (incomplete), −16°·7. As seen, both years are closely similar; the exceedingly low temperatures of February, 1883, are most remarkable, the average of the month being only −41°·3, and the lowest temperature observed having been −52°·3 for the first year and −48°·0 during the second. The auroras were also less frequent, and the magnetic perturbances feebler. The number of hours during which auroras were observed is seen from the following figures:—September, 13 hours in 1882–1883, and 23 hours in 1883–1884; October, 87 and 69; November, 179 and 83; December, 191 and 178; January, 194 and 151; February, 197 and 126; March, 137 and 118; April, 10 and 8; none in May to August. Total for the first year, 1008; for the second, 756.

IT results from the same report that the delta of the Lena extends, by nearly one-half a degree, further north than on our best maps. The northern cape of the Danube (Dounay) Island is under 73° 55′ north latitude. This determination does not correspond with the Vega map, where Sagastyr, being under 73° 21′, the northern extremity of the island is under 73° 27′, and the course of the Vega in this longitude is under 74° 8′. At any rate, M. Yurgens has been compelled to go for twenty miles north of Sagastyr before reaching the extremity of the Dounay Island.

SOME EXPERIMENTS ON THE VISCOSITY OF ICE

THAT ice will change its form under the influence of pressure is exemplified at large in glaciers, and may be illustrated by experiments in the laboratory. How far this is due to a true viscosity, and how far to a rearrangement of the particles by melting and regelation, is a question the discussion of which among physicists has been of long continuance, though there there may now perhaps be some signs of permanent yielding under the influence of continuous pressure.

In the first volume of NATURE (p. 534) Mr. Wm. Matthews describes experiments (1870) in which planks of ice, supported at each end, but free in the middle, become permanently bent. In the first of these experiments the plank was 6 inches wide, 2⅜ inches thick, and supported by bearers 6 feet apart. The temperature of the air was above the freezing-point of water. The plank bent rapidly, so that the total deflection was 7 inches in about as many hours. "At its lowest point it appeared bent at a sharp angle, and was rigid in its altered form." Its lower surface showed minute fissures. In a second experiment a plank of somewhat similar dimensions (1⅞ inch thick, 6¼ to 6½ inches wide, 6 feet between the supports) became permanently bent. The amount of deflection was 3⅜ for the upper surface and 3¼ for the lower surface. The time was 64½ hours. The temperature "never rose above the freezing-point"; but the fact that the thermometer registered 29°·5 F. one morning at 9·30 a.m., and 30° F. the next morning at the same time, would lead us to suppose that the midday temperature was not far from the freezing-point. Similar experiments were subsequently carried out (1871) by Prof. Tyndall, in Switzerland, and are mentioned in NATURE (vol. iv. p. 447).

In NATURE, vol. vi. p. 396, Mr. John Aitken describes experiments in which weighted shillings were caused to sink into blocks of ice. But when the block of ice was previously cooled to about 1° below the freezing-point, a shilling weighted with 90 lbs. and left for three and a half hours, "was found not to have entered in the slightest degree into the ice." Subsequently, in 1873 (NATURE, vol. vii. p. 287), Mr. Aitken described experiments which showed that ice bends the more readily the more air-bubbles it contains. "Temperature," he says, "seemed to have some influence on the rate of bending of these beams, but this point was difficult to determine on account of the different beams bending at different rates at the same temperature; but, so far as could be ascertained from the experiments, the beams bent slower the lower the temperature. The lowest temperature used in these experiments was rather more than 3° F. below freezing."

In 1875 Prof. Pfaff described in *Poggendorff's Annalen* (civ. p. 169, reported in NATURE, vol. xii. p. 317) a carefully conducted experiment in which a paralellopiped of ice 52 cm. long, 2·5 cm. wide, and 1·3 cm. thick, was supported in such a way that 5 mm. at each end rested on the bearers. This was left for seven days, from February 8 to February 15, the temperature varying between −12° and −3·5° C. The total bend was 11·5 mm. That is to say, to translate these measurements into inches for the sake of comparison with the other results, in a bar 20 inches in length between the supports, 1 inch in width, and ½ inch in thickness; the total bending was a little over ·45 of an inch. When the temperature rose to slightly under 0° C. the bending increased, and amounted to 9 mm. (·34 inches) in 24 hours. Other experiments are described by Prof. Pfaff in the same paper, and the general conclusion to which he is led is, "that even the smallest pressure is sufficient to dislocate ice-particles if it act continuously, and if the temperature of the ice and its surroundings be near the melting point."

In the current volume of NATURE (p. 329) there is a report of a paper recently read before the Royal Society by Mr. Coutts Trotter (to whom I am indebted for references on this subject) "On some physical properties of ice, &c.," in which were described some experiments on the shearing of ice, carried out in a glacier grotto at a nearly uniform temperature of about 0° C. In that report we learn that in the paper itself "reasons are given for supposing that the range of temperature through which ice is sensibly viscous is small."

So far as I know no experiments on the viscosity of ice at very low temperatures have been recorded. It is the object of the present communication to describe some such experiments which I have recently conducted, through the kindness and courtesy of Messrs. J. S. Fry and Sons, of Bristol, in the snow chamber of the refrigerator, at their well-known Cocoa Works.

In this chamber the air, which has been previously condensed and cooled, is allowed to deposit, in the form of snow, the moisture which it can no longer retain owing to the great diminution of temperature due to expansion. George Punter, whose business it is to look after this snow chamber, rendered the most intelligent assistance in preparing the bars of ice, and in conducting the experiments. In this mode of experimentation the great variation of temperature, namely, between $-30°$ C., when the engines are stopped in the evening, and $-12°$ C., as a maximum when they begin work in the morning is an unavoidable drawback. Still, I think that the experiments, although they give uniformly negative results, are worth putting on record.

Experiment 1.—A cylinder of ice was cast with a diameter of 3 inches. Over it was hung, as in the well-known Bottomley experiment (NATURE, vol. v. p. 185), a wire loaded with a total weight of 5 lbs. It was left in the freezing-chamber $6\frac{1}{2}$ hours. No dent was traceable on the surface of the cylinder.

Experiment 2.—With a similar cylinder and wire the load was increased to 10 lbs. and the time to 8 hours, with like negative results.

Experiment 3.—With a similar cylinder and wire the load was further increased to 14 lbs. and the time to $17\frac{1}{2}$ hours, with the same result or absence of result. This experiment would seem to show that the ice refused to yield to a pressure of 20 to 30 atmospheres, or probably more, applied in this way and for this time.

Experiment 4.—A bar of ice $1\frac{1}{2}$ inches thick, $2\frac{1}{2}$ inches wide, and supported on bearers $13\frac{1}{2}$ inches apart, was left in the chamber from 12 noon on Monday until 12 noon on Saturday. It showed no sign of bending under its own weight.

Experiment 5.—A similar bar similarly supported was weighted in the middle with 7 lbs., and left for the same time. No sign of bending.

Experiment 6.—A similar bar similarly supported was weighted with 18 lbs., and left for the same time. There was no bending perceptible to the eye; but, on removing the apparatus, the bar broke with the jar occasioned by setting it down somewhat carelessly, so that no exact measurement was taken.

Experiment 7.—A bar of the same length and width, but thinner, tapering somewhat from $\frac{7}{8}$ to $\frac{5}{8}$ of an inch in thickness, was weighted with 7 lbs., to which, during the last two days, seven additional pounds were added, and left for the same time. No bending by measurement.

Such negative results are just what one would expect on theoretical grounds, and as an inference from previous experiments conducted at temperatures nearer the melting-point. But it is well not to rely on theory or on inference where direct experiment is practicable.

The matter, then, would appear to stand at present somewhat thus. The viscosity of ice, due to whatever cause, is—

(1) At temperatures at and above the melting-point...considerable.
(2) ,, ,, below but near ,, ,, ...much less.
(3) ,, ,, between $-3°.5$ C. and $-12°$ C....very slight.
(4) ,, ,, below $-12°$ C. ... ...*nil*.

What seems now to be wanted is an experimental determination of the lower temperature-limit of viscosity, which would appear to lie somewhere between $-12°$C. and $-3°.5$ C., but probably nearer the latter temperature.

University College, Bristol — C. LLOYD MORGAN

BEN NEVIS

AT the meeting of the Royal Society of Edinburgh held on Monday last, Mr. John Murray, Vice-President, in the chair, Mr. R. T. Omond, Superintendent of the Meteorological Observatory on Ben Nevis, delivered, at the request of the Council, an address on two years' residence and work there. Mr. Omond, at the outset, recalled the advantages which Ben Nevis presented as a high-level meteorological station, the services of Mr. Clement S. Wragge, and the chief steps that led up to the erection and equipment of the existing permanent observatory. Glancing at some of their daily experiences during last summer and autumn, he mentioned that some 3000 or 4000 tourists climbed the mountain—sometimes at least 100 in a single afternoon. Since the middle of October, however, not more than half a dozen strangers had ventured up. Some came for information; others were disappointed at finding they could not be fed as well as sheltered; others came to spend the night, but were disappointed at finding they could not do so. Most of the visitors, however, were satisfied, though a little astonished, by the explanation that the building on Ben Nevis was primarily a scientific observatory, and not a hotel. Storms of exceptional and terrific violence were described. Beautiful optical phenomena that had been witnessed, and the comparative scarcity of animal life on the mountain, were next alluded to. Rainbows are seldom seen. Thunderstorms are very rare. The temperatures during winter are not so low as many people think—10° F. is about the lowest recorded as yet, and the ordinary winter temperatures ran from 15° to 25°. Observing that much must yet be done in the work of the discussion and interpretation of the observations made on Ben Nevis, before the observations could be safely used, he proceeded to state some of the more interesting points which Mr. Buchan had already succeeded in approximately establishing: (1) The normal or average temperature and barometric pressure for each month, and the normal differences between these averages and those at sea-level. (2) The daily variation of temperature and pressure during each month. (3) The daily variation in the average velocity of the wind—this being shown to be greater at night than during the day, exactly the reverse of what holds good at sea-level. (4) Variations in the direction of the winds as compared with those prevalent over Scotland at any given time. A comparison of the Ben Nevis winds with those at low-level stations sometimes shows that both are part of one system, whether cyclonic or anti-cyclonic; but the direction is almost always different, and in the case of cyclonic storms, coming from the west. The observed differences in direction seem to give an indication as to whether the storm centre is to pass to the north or south of Ben Nevis. If this point can be definitely made out, it will obviously be of immense value in forecasting weather. (5) The hygrometric observations indicate that the atmosphere on the Ben shows that during ordinary weather a state of persistent saturation, usually accompanied by fog or mist, prevails; but occasionally a sudden and extraordinary drought sets in, the temperature rises, and the sky clears, not merely of fog, but often of every vestige of cloud, and at the same time the valleys and lower hills are often shrouded in mist, showing that this dryness coming from above is not able to penetrate right down to the sea-level. The thorough investigation of these phenomena is one of the most important pieces of work connected with the Observatory, and may be expected to throw great light on the question of atmospheric circulation. (7) The rainfall of Ben Nevis is greatly in excess of what several theories of the distribution of rain led them to expect—a result possibly due to the great vertical movements of the atmosphere indicated by the hygrometric indications referred to above. Though there are many high-level stations in different parts of the world, none, perhaps, are so favourably situated as Ben Nevis for the investigation of what he had explained is the present great problem in meteorology, namely, the vertical movements of the atmosphere. If the Scottish Meteorological Society were possessed of sufficient funds to establish a completely-equipped observatory at the foot of Ben Nevis as well as on the summit, he was convinced that the science of meteorology would advance far more in a few years than it would by a generation of ordinary work with low-level stations alone.

SUNLIGHT AND THE EARTH'S ATMOSPHERE[1]

THERE is, we may remember, a passage in which Plato inquires what would be the thoughts of a man who, having lived from infancy under the roof of a cavern, where the light outside was inferred only by its shadows, was brought for the first time into the full splendors of the sun.

We may have enjoyed the metaphor without thinking that it has any physical application to ourselves who appear to have no roof over our heads, and to see the sun's face daily; while the fact is that if we do not see that we have a roof over our heads in our atmosphere, and do not think of it as one, it is because it seems so transparent and colourless.

Now, I wish to ask your attention to-night to considerations in some degree novel, which appear to me to show that it is not transparent as it appears, and that this seeming colourlessness is a sort of delusion of our senses, owing to which we have never

[1] Lecture delivered at the Royal Institution, April 17, 1885, by S. P. Langley. Communicated by the author.

in all our lives seen the true colour of the sun, which is in reality blue rather than white, as it looks, so that this air all about and above us is acting like a coloured glass roof over our heads, or a sort of optical sieve, holding back the excess of blue in the original sunlight, and letting only the white sift down to us.

I will first ask you, then, to consider that this seeming colourlessness of the air may be a delusion of our senses, due to habit, which has never given us anything else to compare it with.

If that cave had been lit by sunshine coming through a reddish glass in its roof, would the perpetual dweller in it ever have had an idea but that the sun was red? How is he to know that the glass is "coloured" if he has never in his life anything to compare it with? How can he have any idea but that this is the sum of all the sun's radiations (corresponding to our idea of white or colourless light); will not the habit of his life confirm him in the idea that the sun is red; and will he not think that there is no colour in the glass so long as he cannot go outside to see? Has this any suggestion for us, who have none of us ever been outside our crystal roof to see?

We must all acknowledge in the abstract, that habit is equally strong in us whether we dwell in a cave or under the sky, that what we have thought from infancy will probably appear the sole possible explanation, and that, if we want to break its chain, we should put ourselves, at least in imagination, under conditions where it no longer binds us.

The *Challenger* has dredged from the bottom of the ocean fishes which live habitually at great depths, and whose enormous eyes tell of the correspondingly faint light which must have descended to them through the seemingly transparent water. It will not be as futile a speculation as it may at first seem, to put ourselves in imagination in the condition of creatures under the sea, and ask what the sun may appear to be to them; for if the fish who had never risen above the ocean floor were an intelligent being, might *he* not plausibly reason that the dim greenish light of his heaven—which is all he has ever known—was the full splendour of the sun, shining through a medium which all his experience shows is transparent?

We ourselves are, in very fact, living at the floor of a great aërial sea, whose billows roll hundreds of miles above our heads. Is it not at any rate conceivable that we may have been led into a like fallacy from judging only by what we see at the bottom? May we not, that is, have been led into the fallacy of assuming that the intervening medium above us is colourless because the light which comes through it is so?

I freely admit that all men, educated or ignorant, appear to have the evidence of their senses that the air is colourless, and that pure sunlight is white, so that if I venture to ask you to listen to considerations which have lately been brought forward to show that it is the sun which is blue, and the air really acts like an orange veil or like a sieve which picks out the blue and leaves the white, I do so in the confidence that I may appeal to you on other grounds than those I could submit to the primitive man who has his senses alone to trust to; for the educated intelligence possesses those senses equally, and in addition the ability to interpret them by the light of reason, and before this audience it is to that interpretation that I address myself.

Permit me a material illustration. You see through this glass, which may typify the intervening medium of air or water, a circle of white light, which may represent the enfeebled disk of the sun when so viewed. Is this intervening glass coloured or not? It seems nearly colourless; but have we any right to conclude that it is so because it seems so? Are we not *taking it for granted* that the original light which we see through it is white, and that the glass is colourless, because the light seems unaltered, and is not an appeal to be made here from sense to reason, which, in the educated observer, recalls that white light is made of various colours, and that whether the original light is really white and the glass transparent, or the glass really coloured and so *making* the white, is to be decided only by experiment, by taking away the possibly deceptive medium? I can take away this glass, which was not colourless, but of a deep orange, and you see that the original light was not white, but intensely blue. If we could take the atmosphere away between us and the sun, how can we say that the same result might not follow? To make the meaning of our illustration clearer, observe that this blueness is not a pure spectral blue. It has in it red, yellow, blue, and all the colours which make up white, but blue in superabundance; so that, though the white is, so to say, latent there, the dominant effect is blue. The glass coloured veil does not put anything *in*, but acts I repeat like a sieve straining *out* the blue, and letting through to us the white light which was there in the bluishness, and so may not our air do so too?

I think we already begin to see that it is at any rate conceivable that we *may* have been hitherto under a delusion about the true colour of the sun, though of course this is not proving that we have been so, and it will at any rate, I hope, be evident that here is a question raised which ought to be settled, for the blueness of the sun, if proven, evidently affects our present knowledge in many ways, and will modify our present views in optics, in meteorology, and in numerous other things. In optics, because we should find that white light is *not* the sum of the sun's radiations, but only of those dregs of them which have filtered down to us; in meteorology because it is suggested that the temperature of the globe and the condition of man on it, depend in part on a curious selective action of our air, which picks out parts of the solar heat (for instance, that connected with its blue light), and holds them back, letting other selected portions come to us, and so altering the conditions on which this heat by which we live, depends; in other ways, innumerable, because, as we know, the sun's heat and light are facts of such central importance, that they affect almost every part of scientific knowledge.

It may be asked what suggested the idea that the sun may be blue rather than any other colour.

My own attention was first directed this way many years ago when measuring the heat and light from different parts of the sun's disk. It is known that the sun has an atmosphere of its own which tempers its heat, and, by cutting off certain radiations and not others, produces the spectral lines we are all familiar with. These lines we customarily study in connection with the absorbing vapours of sodium, iron, and so forth, which produce them; but my own attention was particularly given to the regions of absorption, or to the colour it caused, and I found that the sun's body must be deeply bluish, and that it would shed blue light except for this apparently colourless solar atmosphere, which really plays the part of a reddish veil, letting a little of the blue appear on the centre of the sun's disk where it is thinnest, and staining the edge red, so that to delicate tests the centre of the sun is a pale aqua-marine, and its edge a garnet. The effect I found to be so important, that if this all but invisible solar atmosphere were diminished by but a third part, the temperature of the British islands would rise above that of the torrid zone, and this directed my attention to the great practical importance of studying the action of our own terrestrial atmosphere on the sun, and the antecedent probability that our own air was also and independently making the really blue sun into an apparently white one. We actually know then, beyond conjecture, by a comparison of the sun's atmosphere, where it is thickest, and where it is thinnest, that an apparently colourless atmosphere *can* have such an effect, and analogous observations which I have carried on for many years, but do not now detail, show that the atmosphere of our own planet, this seemingly clear air in which we exist like creatures at the bottom of the sea, does do so.

We look up through our own air as through something so limpid in its purity that it appears scarcely matter at all, and we are apt to forget the enormous mass of what seems of such lightness, but which really presses with nearly a ton to each square foot, so that the weight of all the buildings in this great city, for instance, is less than that of the air above them.

I hope to shortly describe the method of proof that it too has been acting like an optical sieve, holding back the blue; but it may naturally be asked, "Can our senses have so entirely deceived us that they give no hint of this truth, if it be one? is the appeal wholly to recondite scientific methods, and are there no indications, at least, which we may gather for ourselves?" I think there are, even to our unaided eyes, indications that the seemingly transparent air really acts as an orange medium, and keeps the blue light back in the upper sky.

If I hold this piece of glass before my eyes, it seems colourless and transparent, but it is proved not to be so by looking through it edgewise, when the light, by traversing a greater extent, brings out its true colour, which is yellow. Every one knows this in every-day experience. We shall not get the colour of the ocean by looking at it in a wine-glass, but by gazing through a great depth of it; and so it is with the air. If we look directly up, we look through where it is thinnest; but if we look horizontally through it towards the horizon, through great thicknesses, as at sunrise or sunset, is it not true that this air, where we see its real colour most plainly, makes the sun look very plainly yellow or orange?

We not only see here, in humid English skies, the "orange sunset waning slow," but most of us in these days of travel can perfectly testify that the clearest heavens the earth affords, the rosy tint on the snows of Mont Blanc, forerunning the dawn, or the warm glow of the sun as he sets in Egyptian skies, show this most clearly—show that the atmosphere holds back the blue rays by preference, and lets the orange through.

If, next, we ask, "What has become of the blue that it has stopped?" does not that very blue of the midday sky relate the rest of the story—that blue which Prof. Tyndall has told us is due to the presence of innumerable fine particles in the air, which act selectively on the solar waves, diffusing the blue light towards us? I hope it will be understood that Prof. Tyndall is in no way responsible for my own inferences; but I think it is safe at least to say that the sky is not self-luminous, and that, since it can only be shini g blue at the expense of the sun, all the light this sky sends us has been taken by our atmosphere away from the direct solar beam, which would grow both brighter and bluer if this were restored to it.

If all that has been said so far renders it possible that the sun may be blue, you will still have a right to say that "possibilities" and "maybes" are not evidence, and that no chain of mere hypotheses will draw truth out of her well. We are all of one mind here, and I desire next to call your attention to what I think is evidence.

Remembering that the case of our supposed dweller in the cave who could not get outside, or that of the inhabitants of the ocean-floor who cannot rise to the surface, is really like our own, over whose heads is a crystalline roof which no man from the beginning of time has ever got outside of, an upper sea to whose surface we have never risen; we recognise that if we could rise to the surface, leaving the medium whose effect is in dispute wholly beneath us, we should see the sun as it is, and get proof of an incontrovertible kind; and that, if we cannot entirely do this, we shall get nearest to proof under our real circumstances by going as high as we can in a balloon, or by ascending a very high mountain. The balloon will not do, because we have to use heavy apparatus requiring a solid foundation. The proof to which I ask your kind attention, then, is that derived from the actual ascent of a remarkable mountain by an expedition undertaken for that purpose, which carried a whole physical laboratory up to a point where nearly one-half the whole atmosphere lay below us. I wish to describe the difference we found in the sun's energy at the bottom of the mountain and at the top, and then the means we took to allow for the effect of that part of the earth's atmosphere still over our heads even here, so that we may be said to have virtually got outside it altogether.

Before we begin our ascent, let me explain more clearly what we are going to seek. We need not expect to find that the original sunlight is a pure monochromatic blue by any means, but that though its rays contain red, orange, blue, and all the other spectral colours, the blue, the violet and the allied tints were originally there in disproportionate amounts, so that, though all which make white were present from the first, the refrangible end of the spectrum had such an excess of colour that the dominant effect was that of a blueish sun. In the same way, when I say briefly that our atmosphere has absorbed this excess of blue and let the white reach us, I mean, more strictly speaking, that this atmosphere has absorbed *all* the colours, but, selectively, taking out more orange than red, more green than orange, more blue than green; so that its action is wholly a taking *out*—an action like that which you now see going on with this sieve, sifting a mixture of blue and white beads, and holding back the blue while letting the white fall down.

This experiment only rudely typifies the action of the atmosphere, which is di criminating and selective in an amazing degree, and as there are really an infinite number of shades of colour in the spectrum, it would take for ever to describe the action in detail. It is merely for brevity, then, that we now unite the more refrangible colours under the general word "blue," and the others under the corresponding terms "orange" or "red."

All that I have the honour to lay before you, is less an announcement of absolute novelty than an appeal to your already acquired knowledge and to your reason as superior to the delusions of sense. I have, then, no novel experiment to offer, but to ask you to look at some familiar ones in a new light.

We are most of us familiar, for instance, with that devised by Sir Isaac Newton to show that white light is compounded of blue, red, and other colours, where, by turning a coloured wheel rapidly, all blend into a grayish white. Here you see the "seven colours" on the screen; but, though all are here, I have intentionally arranged them, so that there is too much blue, and the combined result is a very bluish white which may roughly stand for that of the original sun-ray. I now alter the proportion of the colours so as to virtually take out the excess of blue, and the result is colourless or white light. White, then, is not necessarily made by combining the "seven colours," or any number of them, unless they are there in just proportion (which is in effect what Newton himself says); and white, then, may be made out of such a bluish light as we have described, not by putting anything to it, but by taking away the excess which is there already.

Here, again, are two sectors—one blue, one orange-yellow with the blue in excess, making a bluish disk where they are revolved. I take out the excess of blue, and now what remains is white.

Here is the spectrum itself on the screen, but a spectrum which has been artificially modified so that the blue end is relatively too strong. I recombine the colours (by Prof. Rood's ingenious device of an elastic mirror), and they do not make a pure white, but one tinted with blue. I take out the original excess of blue, and what remains combines into a pure white. Please bear in mind that when we "put in" blue here, we have to do so by straining out other light through some obscuring medium, which makes the spectrum darker; but that, in the case of the actual sunlight, introducing more blue, introduces more light, and makes the spectrum brighter.

The spectrum on the screen ought to be made still brighter in the blue than it is—far, far brighter—and then it might represent to us the original solar spectrum before it has suffered any absorption either in the sun's atmosphere or our own. The Frauenhofer lines do not appear in it, for these, when found in the solar spectrum, show that certain individual rays have been stopped, or selected for absorption by the intervening atmospheres; and though even the few yards of atmosphere between the lamp and the screen absorb, it is not enough to show.

Our spectrum, as it appears before absorption, might be compared to an army divided into numerous brigades, each wearing a distinct uniform, one red, one green, one blue, so that all the colours are represented each by its own body. If, to represent the light absorbed as it progresses, we supposed that the army advances under a fire which thins its numbers, we should have to consider that (to give the case of nature) this destructive fire was directed chiefly against those divisions which were dressed in blue, or allied colours, so that the army was thinned out unequally, many men in blue being killed off for one in red, and that by the time it has advanced a certain distance under fire the proportion of the men in each brigade has been altered, the red being comparatively unhurt. Almost all absorption is thus selective in its action, and often in an astonishing degree, killing off, so to speak, certain rays in preference to others, as though by an intelligent choice, and destroying most, not only of certain divisions (to continue our illustration), but even picking out certain files in each company. Every ray, then, has its own individuality, and on this I cannot too strongly insist; for just as two men retain their personalities under the same red uniform, and one may fall and the other survive, though they touch shoulders in the ranks, so in the spectrum certain parts will be blotted out by absorption, while others next to them may escape.

To illustrate this selective absorption, I put a piece of didymium glass in the path of the ray. It will, of course, absorb some of the light, but instead of dimming the whole spectrum, we might almost say it has arbitrarily chosen to select one narrow part for action, in this particular case choosing a narrow file near the orange, and letting all the rest go unharmed. In this arbitrary way our atmosphere operates, but in a far more complex manner, taking out a narrow file here and another there, in hundreds of places, all through the spectrum, but on the whole much the most in the blue, the Frauenhofer lines being merely part of the evidence of this wonderful quasi-intelligent action which bears the name of selective absorption.

Before we leave this spectrum, let us recall one most important matter. We know that here beyond the red is solar energy in the form of heat which we cannot see, but not on that account any less important. More than half the whole power of the sun is here invisible, and if we are to study completely the action of our atmosphere, we shall have to pay great attention to this part, and find out some way of determining the loss in it, which will be difficult, for the ultra-red end is not only invisible, but compressed, the red end being shut up like the closed pages of a book, as you may notice by comparing the narrowness of the red with the width of the blue.

Now refraction by a prism is not the only way of forming a spectrum. Nature furnishes us colour not only from the rainbow, but from non-transparent substances like mother-of-pearl, where the iridescent hues are due to microscopically fine lines. Art has lately surpassed nature in these wonderful "gratings," consisting of pieces of polished metal, in which we see at first nothing to account for the splendid play of colour apparently pouring out from them like light from an opal, but which, on examination with a powerful microscope, show lines so narrow that there are from 50 to 100 in the thickness of a fine human hair, and all spaced with wonderful precision.

This grating is equal in defining power to many such prisms as we have just been looking at, but its light does not show well upon the screen. You will see, however, that its spectrum differs from that of the prism, in that in this case the red end is expanded, as compared with the violet, and the invisible ultra-red is expanded still more, so that this will be the best means for us to use in exploring that "dark continent" of invisible heat found not only in the spectrum of the sun, but of the electric light, and of all incandescent bodies, and of whose existence we already know from Herschel and Tyndall.

Now we cannot reproduce the actual solar spectrum on the screen without the sun itself, but here are photographs of it, which show parts of the losses the different colours have suffered on their way to us. We have before us the well-known Frauenhofer lines, due, you remember, not only to absorption in the sun's atmosphere, but also to absorption in our own. We have been used to think of them in connection with their cause, one being due to the absorption of iron-vapour in the sun, another to that of water-vapour in our own air, and so forth; but now I ask you to think of them only in connection with the fact that each is due to the absorption of some part of the original *light*, and that collectively they tell much of the story of what has happened to that light on its way down to us. Observe, for instance, how much thicker they lie in the blue end than in the red—another evidence of the great proportionate loss in the blue.

If we could restore all the lost light in these lines, we should get back partly to the original condition of things at the very fount, and, so far as our own air is concerned, that is what we are to ascend the mountain for—to see, by going up through nearly half of the atmosphere, what the rate of loss is in each ray by actual trial; then, knowing this rate, to be able to allow for the loss in the other part still above the mountain-top, and, finally, by recombining these rays to get the loss as a whole. Remember, however, always, that the most important part of the solar energy is in the dark spectrum which we do not see, but which, if we could see, we should probably find to have numerous absorption-spaces in it corresponding to the Frauenhofer lines, but where heat has been stopped out rather than light. To make our research thorough, then, we ought not to trust to the eye only, or even chiefly, but have some way of investigating the whole spectrum; the invisible in which the sun's power chiefly lies, as well as the visible, and both with an instrument that would discriminate the energy in these very narrow spaces, like an eye to see in the dark; and if science possesses no such instrument, then it may be necessary to invent one.

The linear thermopile is nearest to it of any, and we all here know what good work it has done, but even that is not sensitive enough to measure in the grating spectrum, in some parts of which the heat is 400 times weaker than in that of a prism, and we want to observe this invisible heat in very narrow spaces. Something like this has been provided since by Capt. Abney's most valuable researches, but these did not at the time go low enough for my purpose, and I spent nearly a year before ascending the mountain in inventing and perfecting the new instrument for measuring these, which I have called the "bolometer" or "ray-measurer." The principle on which it is founded is the same as that employed by my late lamented friend, Sir Wm. Siemens, for measuring temperatures at the bottom of the sea, which is that a smaller electric current flows through a warm wire than through a cold one.

One great difficulty was to make the conducting wire very thin, and yet continuous, and for this purpose almost endless experiments were made, among other substances pure gold having been obtained by chemical means in a plate so thin that it transmitted a sea-green light through the solid substance of the metal. This proving unsuitable, I learned that iron had been rolled of extraordinary thinness in a contest of skill between some English and American iron-masters, and, procuring some, I found that 15,000 of the iron plates they had rolled, laid one on the other, would make but one English inch. Here is some of it, rolled between the same rolls which turn out plates for an iron-clad, but so thin that, as I let it drop, the iron plate flutters down like a dead leaf. Out of this the first bolometers were made, and I may mention that the cost of these earlier experiments was met from a legacy by the founder of the Royal Institution, Count Rumford. The iron is now replaced by platinum, in wires or rasher tapes, from 1-2000 to 1-20,000th of an inch thick, one of which is within this button, where it is all but invisible, being far finer than a human hair. I will project it on the screen, placing a common small pin beside it as a standard of comparison. This button is placed in this ebonite case, and the thread is moved by this micrometer screw, by which it can be set like the spider line of a reticule; but by means of this cable, connecting it to the galvanometer, this thread acts as though sensitive, like a nerve laid bare to every indication of heat and cold. It is then a sort of sentient thing: what the eye sees as light it feels as heat, and what the eye sees as a narrow band of darkness (the Frauenhofer line) this feels as a narrow belt of cold, so that when moved parallel to itself and the Frauenhofer lines down the spectrum it registers their presence.

It is true we can see these in the visible spectrum, but you remember we propose to explore the invisible also, and since to this the dark is the same as the light, it will feel absorption lines in the infra-red which might remain otherwise unknown.

I have spent a long time in these preliminary researches; in indirect methods for determining the absorption of our atmosphere, and in experiments and calculations which I do not detail, but it is so often supposed that scientific investigation is a sort of happy guessing, and so little is realised of the labour of preparation and proof, that I have been somewhat particular in describing the essential parts of the apparatus finally employed, and now we must pass to the scene of their use.

(*To be continued.*)

THE INSTITUTION OF MECHANICAL ENGINEERS

A VERY interesting discussion on the merits of the Maxim automatic machine-gun, which was described in NATURE, vol. xxxi. p. 414, took place at the special meeting of the Institution held on the 30th ult. In reply to Mr. Carbutt, M.P., the inventor explained that the recoil of the gun, which is utilised for loading and firing, did not interfere with the accuracy of aim, and instanced the circumstance that as good target-practice was made in firing from the shoulder as with fixed rifles; whilst the energy of recoil was sufficient to carry on the automatic action, whether the muzzle of the gun was elevated or depressed. As regarded keeping the barrel cool, he found that the water-jacket around the body of the gun acted most efficiently, as gunpowder in exploding produced very little heat-energy, or, as he put it, "he should not buy gunpowder to raise steam." During all his experiments he had used only Government cartridges, and had never found one to fail; he thought it would be an advantage if cartridges were packed in cases containing calcium chloride or other hydroscopic material, so that they might not be injured by moisture.

The gun was frequently fired during the meeting, and its automatic action was thoroughly shown, as well as its freedom from danger should a cartridge hang fire. Mr. Maxim had a most enthusiastic reception, the general feeling of the speakers and of the meeting being in favour of the gun being taken up by the British Government, the President and Mr. Adamson giving it as their opinion that, if the necessity should occur, 1000 of these guns could be produced weekly at a month's notice, when their use might have as material an effect on a campaign as the needle-gun had at Sadowa. Mr. Maxim is now experimenting with a more recent form of gun of his invention, which fires a projectile 3 lbs. weight at the rate of 120 shots a minute; in this the cartridges are fed from above, which much simplifies the mechanical arrangement, as no apparatus has to be arranged for lifting the cartridges into the magazine of the gun; in this new form the total length of firing apparatus is 22 inches. This arrangement was not described, as the various patents for which the inventor had made application, amounting to over a hundred in all, were not yet complete.

On the 1st inst. was read Prof. Kennedy's abstract of the work of the Research Committee of the Institution on Riveted Joints. There can be no question of the value of a series of experiments of this character, covering in all 290,—64 on perforated (punched and drilled) plates, 97 on actual joints, 44 on the tenacity of the plates used in the joints, 33 on the tenacity and shearing resistance of the rivet steel used in the joints, and the rest on various other matters connected with them. The whole of the experiments were made upon soft steel supplied from the Landore Siemens-Steel Works, which was found to have a tenacity of from 28 to 30 tons per square inch, with an extension of 23 to 25 per cent. in a length of 10 inches. The limit of elasticity of the metal was generally about 60 per cent. of its ultimate resistance, the percentage of carbon in the plates was given as about 0·18.

The main conclusions drawn from these experiments are the following:—The metal between the rivet holes has a considerably greater tensile resistance per square inch than the same metal unperforated, the excess tenacity varying from 20 to about 8 per cent. The shearing resistance of rivet steel is a much more variable quantity than the tenacity of steel plate or of the rivet steel itself—a result due, Prof. Kennedy thinks, in some manner to the want of attention directed to this point, or of experiments specially upon it. The size of the rivet heads and ends plays a most important part in the strength of the joints, at any rate in the case of single riveted joints; an increase of about one-third of weight of metal in the heads and ends increased the resistance of the joint $8\frac{1}{2}$ per cent., the additional strength being no doubt due to the prevention of so great tensile stress in the rivets through distortion of the plates. The strength of a joint made across a plate is equal to that of one made in the usual direction. The intensity of bearing pressure on the rivets exercises, with joints proportioned in the ordinary way, a very important influence on their strength. The value of hydraulic as compared with hand riveting, in the case when sound hand-riveting is possible, lies in the increased security and stiffness it gives at ordinary working loads rather than in any actual raising of the breaking load.

The experiments point to very simple rules for proportioning joints of maximum strength. Assuming a bearing pressure on the rivet of 43 tons per square inch, and an excess tenacity of the plate of 10 per cent. of its original strength, the diameter of the rivet-hole should be $2\frac{1}{4}$ times the thickness of the plate, and the pitch of the rivets $2\frac{5}{8}$ times the diameter of the holes for single riveted joints, while for double-riveted lap-joints with the same ratio of diameter to thickness the ratio of pitch to diameter should be from 3·64 to 3·82. If a smaller rivet be used than that here specified, the joint will not be of uniform, and therefore not of maximum, strength; but with any other size of rivet the best result will be obtained by using a pitch calculated from the following formula, viz.:—

$$p = a\frac{d^2}{t} + d,$$

where p is the pitch, d the diameter of the hole, and t the thickness of the plate, whilst the mean value of the constant a is 0·56. By use of this formula for double-riveted lap-joints it is likely that the prescribed size of rivet may be inconveniently large in practice. In this case the diameter of the rivet should be taken as large as possible, and the above formula will give the pitch, by making the constant $a = 1·15$ in the mean. For double-riveted butt-joints of maximum strength the diameter of the rivet hole should be 1·8 times the thickness of the plate, and the pitch should be 4·1 times the diameter of the hole.

In a boiler the plate is much more affected by time than the rivets, and it is therefore not unreasonable to estimate the percentage by which the plates might be weakened by corrosion before the boiler would be unfit for use at its proper steam-pressure, and to add correspondingly to the plate area. In this case the joint should be proportioned not for the actual thickness of the plate, but for a nominal thickness less than the actual by the assumed percentage. The joint will thus be approximately one of uniform strength by the time it has reached its final workable condition, up to which time the joint as a whole will not really have been weakened, the corrosion only gradually bringing the strength of the plates down to that of the rivets.

There is an interesting point to which we propose reference on a future occasion, viz. the probable causes to which an increase of tensile strength in the remaining material of perforated plates may be due.

The President, at the conclusion of an interesting discussion, referred to the circumstances that the paper was an abstract of three years' work, the experiments having been carried on by Prof. Kennedy free of charge to the Institution, whilst the material supplied and the work of preparing the various joints tested had been performed at prime cost.

The main feature in connection with the Blooming Mill designed by Mr. C. B. Holland, of Ebbw Vale, a paper describing which was read, was the application of hydraulic power to all the work performed, except that of actually driving the rolls.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—On Tuesday last an effort was made to relieve Honour men in the non-classical final schools from the drudgery entailed by the present Pass Classical Moderations. Council brought forward a scheme substituting a Preliminary Honour Examination in each Honour School in lieu of "Pass Mods." Under this scheme the study of the classical languages would not be required of any candidate for honours in Natural Science or Mathematics after he had passed the present Responsions or "Smalls;" thus an extra year would be given to the study of the subjects chosen for the final schools. Unfortunately for the measure, the preamble—mainly of general character—contained one clause relating to Mathematics which would have exempted mathematical class-men from any literary work, and the preamble was therefore opposed by many who approved of its general policy bnt desired an opportunity of discussing or amending the Preliminary Examinations to be introduced into each Faculty. The preamble, after a long debate, was lost on a division by one vote only—71 voting for it and 72 against. No doubt a similar measure will be brought forward again.

SCIENTIFIC SERIALS

To the number of the *Journal of Botany* for March Mr. F. Townsend contributes an illustrated paper on the floral envelopes of Cyperaceæ and Gramineæ, in which he claims a closer homology between the corresponding parts in the two orders than has generally been allowed.—Mr. G. Murray has another and apparently a final word on the so-called "sclerotiets" found by Mr. A. S. Wilson and Mr. Worthington Smith in the leaves of diseased potatoes, and which he demonstrates not to have the organic structure attributed to them and to be unconnected with the potato disease.—In the number for April Mr. T. Hick gives a further observation on the continuity of protoplasm, which he finds to prevail throughout the frond of a seaweed belonging to a different group from those in which it had hitherto been obeerved, the common *Ascophyllum nodosum* (*Fucus noaosus*).—In addition to these papers there are in these two numbers others which are descriptive or refer to local botany.

THE most interesting article in the *Nuovo Giornale Botanico Italiano* for January, 1855, is by Signor Cugini on the anatomy of the inflorescence and of the flowers of *Dïöon edule*. The intermediate position occupied by the Gymnosperms, and especially by the Cycadeæ, between Cryptogams and the more highly developed flowering plants, renders especially valuable any fresh contribution towards the knowledge of the structure of their reproductive organs. The present paper deals especially with the anatomy of the ovule and of the ovuliferous leaves.—The greater part of the same journal for April is occupied by a very elaborate paper by Signor J. Danielli, illustrated by a number of plates, on the structure, distribution, and uses of the American aloe, *Agave americana*.—A shorter article of interest in the same number is by Signor A. Piccone, on the part played by herbivorous (phytophagous) fishes in the distribution of marine algæ. An examination of the intestines of several species of fish showed that, in addition to *Zostera* and other flowering plants, they contained the remains of a number of seaweeds, some of them in a fruiting condition, the spores of which are in all probability voided in the excrements, and are then in a favourable state for germination.—The remaining papers in these numbers are descriptive or contributions to local floras.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, April 25.—Prof. Guthrie, President, in the chair.—The following papers were read:—On the theory of illumination in a fog, by Lord Rayleigh. The paper dealt with certain theoretical results based upon the assumption that the medium in which the fog was formed and the substance composing the fog itself were perfectly transparent. The effect of such a fog surrounding a source of radiation would be to diminish the radiation, and in the case of a supply of energy from without, as with the carbon filament of an incandescent lamp, the temperature of the source would be increased by the fog. A spherical envelope of such a fog surrounding the lamp, and sufficiently thick to be impervious, would act as a perfectly reflecting surface. A problem closely related to the above, and which is easily worked out, is that of light incident normally upon a pile of glass plates. If m be the number of such plates, and ρ the fraction of incident light reflected by one plate, $\phi(m)$ the light reflected, and $\psi(m)$ that transmitted by a pile of m plates, we have—

$$\frac{\phi(m)}{2m\rho} = \frac{1}{1+(2m-1)\rho} = \frac{\psi(m)}{1-\rho}.$$

If the transmitted light be allowed to fall upon another pile consisting of n plates, we have an infinite amount of reflection between the plates, and as the final result if A denotes the radiation in the original direction, and B that in the opposite,

$$A = \frac{2n\rho+1-\rho}{2(m+n)\rho} \quad B = \frac{2n\rho}{2(m+n)\rho+1}.$$

If m and n are large, we have—

$$A = B = \frac{n}{m+n},$$

which shows that by increasing n we can make the radiation between the plates as much as if the first pile did not exist whatever the number of plates in it.—On a monochromatic telescope, by Lord Rayleigh. This is a modification of Maxwell's colour-box. In this instrument, as is well known, light passes through a slit in the focus of a collimating lens; it traverses in succession this lens, a prism, and another lens by which it is brought to a focus upon a plane surface in which is a movable slit, the eye being placed behind which receives light approximately monochromatic. If, in addition, a lens be placed just behind the first slit, so as to bring some distant object into focus at a convenient distance from the eye, this object will be seen by the light that would enter the eye in the simple colour-box. The author suggested the use of this instrument to compare lights of different colours, and hinted at the possibility of choosing some colour towards the middle of the spectrum at which light might be compared for practical purposes.—On the self-regulation of the compound dynamo, by Prof. A. W. Rücker. If ϕ represents the current or electromotive force in the external circuit of either form of compound dynamo, it is given by means of an equation of the form

$$\phi = \frac{P}{A+x} - \frac{Q}{B+x},$$

where A, B, P, and Q are quantities which are different in different cases, but are always independent of the external resistance, and x is the conductivity or the resistance of the external circuit, according as ϕ represents the E.M.F., or current. The constant A in all cases depends only on the resistance of the various parts of the machine. If μ and m are respectively the largest and smallest values of x between which self-regulation is aimed at, then $\mu - m$ may be called the *range of x*. That value of x which corresponds to the resistance most frequently used may be called the *usual value* of x and indicated by ξ. The maximum efficiency η of the machine is connected with A and ξ by the relations

$$A = \xi\,(1+\eta)/(1-\eta) \text{ if } \phi \text{ be the external E.M.F.}$$
$$A = \xi\,(1+\eta)/(1+\eta) \text{ if } \phi \text{ be the external current.}$$

It can easily be shown that the function ϕ has two critical values, and that the value of x, corresponding to one of these, is necessarily negative, unless one of the inducing spirals is wound so as to diminish the magnetisation Various cases are considered, corresponding to different relations among the magnitudes of the constants A, B, P, and Q. The following indications of the method of treatment may suffice. If $A/B < 1 < \sqrt{P}/\sqrt{Q}$, ϕ is positive for all positive values of x, and the critical value of ϕ occurs for a negative value of x, so that ϕ diminishes as x increases. Hence, if we write

$$\frac{P}{A+m} - \frac{Q}{B+m} = \phi,$$

we must have

$$\frac{P}{A+\mu} - \frac{Q}{B+\mu} = \frac{\phi_1}{1+q},$$

where q is a positive quantity which will be less as the self-regulation is more perfect. These equations give

$$P = \frac{\phi_1}{1+q} \cdot \frac{\mu - m - q(B+m)}{(A-B)(\mu - m)}(A+\mu)\,(A+m)$$

$$Q = \frac{\phi_1}{1+q}\,\frac{\mu - m - q(A+m)}{(A-B)\,\mu - m)}(B+\mu)\,B+m).$$

Now since $A - B$ is negative, we must, if P and Q are positive, have

$$q < (\mu - m)/(A+m),$$

and *a fortiori*.

$$q < (\mu - m)/(B+m).$$

By similar methods inferior limits to q are found in other cases, and it is thus shown that for given values of μ and m, the limit is lower as A is larger. It has, however, been proved above that if the maximum efficiency of the machine is high, A will be large or small, according as it is taken from an expression that gives the external E.M.F. or the external current. Hence it is more difficult to combine high efficiency with good self-regulation if an approximately constant external current is desired than if an approximately constant external E.M.F. is aimed at. The equations do not lead to any simple rules for the relations which should hold between the various parts of compound dynamos; but if some of the constants are taken as given, the values which must be assigned to the others can be calculated if a given efficiency for the usual value of x and a given deviation from perfect self-regulation between given values of x are to be attained.—On the determination of the heat-capacity of a thermometer, by Mr. J. W. Clark. The method consists in the estimation of the masses of the mercury and glass of the thermometer by weighing the instrument in air and in water, and again in water when immersed to the extent usual in the thermal experiment. The specific gravity of the glass and mercury being known, the absolute masses immersed can be readily calculated, and consequently their thermal capacity.—A photometer which enabled a comparison to be made between the light of a lamp emitted at any angle and a standard was exhibited by Mr. Dibdin, and the action explained by Mr. Livingstone, who stated that the maximum amount of illumination took place at an angle of 45°.

Geological Society, April 15.—Prof. T. G. Bonney, F.R.S., President, in the chair.—John Rudd Leeson, M.D., was elected a Fellow of the Society.—The following communications were read:—A general section of the Bagshot strata from Aldershot to Wokingham, by the Rev. A. Irving, F.G.S. The author referred to earlier papers in the *Geological Magazine*, in which the green colouring-matter so common in the Middle and Lower Bagshot strata of the London Basin had been attributed to the presence of vegetable *débris* and the materials resulting from decomposition of vegetable matter. The marked difference in this respect between these strata and the higher members of the series furnishes a clue to the conditions under which they were respectively deposited, the former being delta- and lagoon-deposits, the latter the deposits of a marine estuary. This implies a transgressive overlap of the upper portions of the Bagshot series upon the London clay; and the present paper was devoted to a consideration of the stratigraphical evidence of this overlap. Sections were described in detail at Aldershot, Farnborough, Yateley, Camberley, Wellington College and the neighbourhood, and from the last-named place to Wokingham. From these a general section was constructed to exact scale, both as to thickness of strata and altitudes, showing a relation of the Bagshot formation to the London clay which was inconsistent with the generally received idea of their conformability and at variance with the mapping of the district as executed by the Geological Survey. The importance of the Bagshot pebble-bed as a basement-line of the upper division of the Bagshot strata was shown, as was suggested by the author so long ago as 1880. The synclinal arrangement of the London clay was shown to have been produced *before* the deposition of the Bagshot series, though a certain amount of movement (with a resultant amount of 150 feet of tilting in thirteen miles from south to north) has since taken place.—Notes on the Polyzoa and Foraminifera of the Cambridge greensand, by G. R. Vine. Communicated by Thomas Jesson, F.G.S.

Royal Meteorological Society, April 15.—Mr. R. H. Scott, F.R.S., President, in the chair.—The following papers were read:—Report of Committee on Decrease of Water-Supply. This Committee was appointed to take into consideration the question of the decrease of water in springs, streams, and rivers, and also the simultaneous rise of the flood-level in cultivated countries. As far as any inference can be drawn from the records collected by the Committee, it appears that the years 1820, 1821, 1824, 1835, 1838, 1845, 1847, 1850, 1854, 1855, 1858, 1859, 1864, 1865, 1871, 1874, 1875, and 1884 have been periods of marked low water. On the other hand, the years 1817, 1825, 1830, 1836, 1841, 1842, 1853, 1860, 1861, 1866, 1873, 1877, 1879, 1881, and 1883 have been periods when there has been exceptionally high water. In 1852 the water was very low in the early part of the year, while at the end of the year it was very high. In the intervening periods the water has been of moderate altitude. It does not appear from existing records that there is any diminution in the water-supply of this country, and the large quantity of water which has been stored or has flowed off the ground between 1876 and 1884 is confirmatory of this view. There appear, however, to be periods when there is exceptionally low water, and these are almost immediately followed by periods of exceptionally high water. With reference to the increase of floods, it does not appear from the records that there is any great increase in the height to which the floods rise in this country. Whether or not the height to which floods have risen in recent years has been affected by river improvements and the greater facility with which floods can be got rid of, or whether there is a diminution in the quantity of water, are questions upon which the Committee have not at present sufficient information to speak positively.—Report of Committee on the occurrences of the Helm-Wind of Cross Fell, Cumberland, from 1871 to 1884. In response to a letter inserted in the Penrith newspapers, the Committee has received a number of communications bearing on the subject of the helm-wind. With the view of ascertaining as far as possible the meteorological conditions which exist when the helm-wind is blowing, all the recorded occurrences that have been received have been chronologically arranged. The first systematic record commences in 1871, and in this report the Committee deals with all occurrences from that date to the end of 1884. Since that time more detailed records have been commenced at numerous stations in the locality at the instigation of the Royal Meteorological Society. Ninety-three instances of the helm-wind were recorded from 1871 to 1884; the months with the greatest frequency being February, March, April, and November. On examining the Daily Weather Reports it was clearly seen that, whenever the helm-wind was blowing there was an easterly wind, not only in the locality, but generally over the entire country. As the helm-wind seemed to occur so regularly with the easterly wind, the Committee further extended the inquiry with regard to the east wind. The Daily Weather Charts were consequently examined for each day from January 1, 1871, to December 31, 1884, and every occurrence of east wind tabulated; the instances with general easterly conditions over the whole country being kept separate from those instances in which the easterly wind was only partial, though of sufficient intensity to occasion the helm-wind. This examination showed that, although the wind over the United Kingdom is generally easterly when the helm occurs, yet the helm by no means occurs whenever the wind is easterly. Indeed, this step in the inquiry has not at all tended to the elucidation of the phenomenon in question, for it frequently happens that the conditions are, to all appearances, precisely similar when the helm is on, and yet no such occurrence has been recorded. This may in part be due to the occasional omission to record the helm, although it cannot possibly be, in the main, attributable to such an omission; but it points to other conditions being necessary besides absolute agreement of wind direction and isobaric lines. Possibly the different hygrometric qualities of the air with the existing easterly winds may be an important factor in deciding whether or no the helm will be formed, but it is not readily conceived why, even in this case, the helm-wind should not blow. It must, however, be borne in mind that the surface-winds can only be examined, whilst those at a comparatively small elevation may be intimetely connected with the phenomenon. From the observations made prior to those started at the beginning of 1885, no idea can be formed of the behaviour of the upper currents, even at the time of the occurrence of the helm-winds, far less with the occurrence of each east wind experienced. The Society has, however, provided for the extension of the inquiry in this direction in the records which are now being collected, the observers supplying observations of the upper currents by means of the clouds, as well as the direction of the winds at the surface of the earth. As soon as a sufficient number of these observations have been received, the Committee hopes to present a further report, which will tend to explain the phenomenon of the helm-wind.—Results of meteorological observations made at Asuncion, Paraguay, by R. Strachan, F.R.Met.Soc.

PARIS

Academy of Sciences, April 27.—M. Bouley, President, in the chair.—Experimental researches regarding (1) Attacks of an epileptic character excited by the electrisation of the excito-motor regions of the brain properly so-called; (2) the duration after death of the excitability so produced in the brain, by M. Vulpian. The main object of these experiments, made chiefly on dogs, is to confirm the conclusion already arrived at and communicated by the author in a previous paper, that the grey cortical substance of the cerebral regions known as motor centres does not play the indispensable part hitherto supposed in the production of epileptic attacks caused by the faradisation of those regions. The inference is also confirmed that amongst the higher mammals under normal conditions the cerebral substance proper loses its excitability as soon as the circulation has completely ceased in the nerve-centres.—Nebula discovered, observed, and tabulated at the Observatory of Marseilles, by M. E. Stephan.—Results of the boring recently carried out at Ricard, in the Grand'-Combe Valley, Gard, in search for coal, by M. Grand'-Eury. These borings tend to confirm the conclusion, already arrived at on other grounds, that no parallelism exists between the St. Barbe and Grand'-Combe geological systems, and as the former are unquestionably the older, they must, in the normal state, necessarily underlie the latter.—Report on the relation between the phenomena presented by the recent earthquakes in Andalusia, and the geological constitution of the region comprised within the area of disturbance, by M. Fouqué.—Remarks on an instrument analogous to the sextant, by means of which angles projected on the horizon may be directly measured, by M. E. H. Amagat.—Note on the calculations made to determine the solar parallax from the daguerrotypes taken by the French Commission during the transit of Venus in 1874, by M. Obrecht. The calculations have been carefully checked, and the definite result is represented by

$$\pi = 8''\cdot81 - 0''\cdot004\, dL \pm 0''\cdot06,$$

where π is the solar parallax, and dL the correction to be made for the longitude of Pekin.—Elements and ephemerides of the planet 246, deduced from the observations made on March 9 at Marseilles, Vienna, and Düsseldorf, on March 18 at Marseilles and Vienna, on March 31 at Berlin, and on April 9 at Marseilles, by M. Andoyer.—On a general law in the theory of the partition of numbers, by MM. Bougaieff.—A short and simple demonstration of M. de Sperre's theorem regarding Poinsot's "herpolhodie" curve, by M. A. de Saint-Germain.—Note on a method of regulating the velocity of electric motors, by M. M. Deprez.—*Régime* of combustion of explosive mixtures formed with illuminating gas, by M. A. Witz.—Description of the solar corona, the so-called "Bishop's ring," observed subsequently to the Krakatoa eruption in 1883, 1884, and 1885, by M. F. A. Forel.—Researches on the phosphates: a method of reproducing at pleasure a large number of crystallised phosphates and oxides, by M. H. Debray.—On the oxidation of iodine during the process of natural nitrification, by M. A. Müntz. The object of this paper is to determine the natural conditions under which were produced the extensive deposits of nitrates in certain tropical regions.—On the ammoniacal sulphate of copper, and on a basic sulphate of copper, by M. G. André.—On the dimorphism of telluric anhydride and on some of its combinations, by MM. D. Klein and J. Morel.—On the chemical constitution of cocaine, by MM. G. Calmels and E. Gossin.—Studies on the inhalation of bichloruretted formene (chloride of methylene) and of tetrachloruretted formene (perchloride of carbon), by MM. J. Regnauld and Villejean.—On the effects produced on man and animals by the stomachic ingestion and hypodermic injection of the microbes associated with the diarrhœic liquid of cholera, and cultivated in peptonised gelatine, by M. Bochefontaine. Experiments made by the author on himself and on the guinea-pig tend to show that these preparations, when swallowed or injected in small doses, produce no morbid symptom, although large doses may give rise to more or less serious local inflammation. He infers that the physiological disorders observed in cholera patients are due, not to the development of the microbe germs, but to the presence of a special substance not yet determined; further, that in its normal state the blood of man and other animals is destructive to the choleraic microbes artificially prepared in gelatine.

BERLIN

Physiological Society, March 27.—Prof. Ewald spoke on the occurrence of lactic acid in human gastric juices, which was now universally regarded as a pathological formation, *i.e.* a product of fermenting processes which did not obtain under normal conditions. In conformity with this opinion he had, in a former investigation, clearly demonstrated the absence of lactic acid, even after milk had been partaken. On the other hand, he had regularly found hydrochloric acid in the gastric juice. Two cases of hysteric vomiting, which had come under his observation in the infirmary, induced him to resume this investigation, one of the cases especially inviting such inquiry. The female patient was able to retain on her stomach and normally digest solid food, but whenever she swallowed anything fluid the whole contents of the stomach were at once vomited. Opportunity was, therefore, here offered at any time to examine the contents of the stomach after food had been received. Prof. Ewald mentioned the different chemical reactions by means of which the presence of lactic acid might be easily detected in the gastric juice, and among them he deemed carbolic acid and chloride of iron the most trustworthy. He then described the experiments he had carried out on the female patient above referred to, which had yielded the following results:—After a mixed meal (of bread, vegetables, and meat), lactic acid was found 26 times out of 31 in the contents of the stomach in the space of 10 to 100 minutes after the reception of the food; in 5 cases, however, not till 120 minutes or more after that point of time. Hydrochloric acid was found in the contents of the stomach only in the second hour and later, after the lactic acid had disappeared. Out of 26 cases in which white bread was alone eaten, lactic acid was demonstrated in 17 cases, occurring in 10 to 100 minutes from the time of eating. Out of 15 cases in which cooked albumen was administered, lactic acid was found only in one case, within one-and-a-half hours from the time of its being taken; while, on "schabefleisch" (scraped raw meat) being administered, lactic acid became again demonstrable; in the majority of cases in 10 to 100 minutes' time. From these experiments it was to be inferred that lactic acid occurred normally in the contents of the stomach, namely, in the first period of digestion. It was, however, in the opinion of Prof. Ewald, no normal constituent of the gastric juice, but in the case of a mixed and meat diet originated in the carno-lactic acid obtained from the meat and, in the case of white bread being taken, from the fermentation of the starch. On albumen being taken, lactic acid was, therefore, not found, because it occurred in the stomach only when it was introduced with the food—in the case of meat, for example—or when it arose from a fermentive aliment. With reference to the ulterior issues of the lactic acid, the speaker adopted the view of Prof. Maly, that it was employed towards the formation of the free hydrochloric acid afterwards appearing in the gastric juice.—Dr. Blaschko reported some observations he had made on sensations of pressure. In the course of investigations into the development of the skin, he had found that the hair-roots were provided with a rich nerve plexus in the same manner as the touch corpuscles in the touch balls of the hands and feet, and this induced him to examine the hairs in respect of their sensibility to pressure. When he took a stiff hair a little curved at the tip, and stroked the skin with it, he had only then a sensation when he touched a lanugo hair. By this and other means he became convinced that the hair papillæ possessed such a high degree of sensibility as entitled them to be placed in a series with the touch papillæ. While, however, the touch corpuscles had to be drawn hither and thither over the object to be touched, in the case of the touch hairs the body to be felt had, on the contrary, to be waved over it. Dr. Blaschko was therefore of opinion that a direct and an indirect, or a papillary and a ciliary feeling of the skin had to be distinguished. The first performed its functions at the unhaired cutaneous spots; the touch balls of the hand, and the foot, and at the lips; by means of the touch corpuscles. The indirect or ciliary sensations, on the other hand, were performed by the lanugo hairs covering the whole body, which were properly, therefore, touch hairs. If at a limited spot of the skin, such as the forehead, the lanugo hairs were shaved away, then would the fine sensations of pressure likewise disappear, and on waving that part of the skin with the stiff hair above referred to, a correspondingly large hiatus would become perceptible, at which nothing would be felt. In the course of this investigation the speaker had failed to convince himself of the existence of special points of pressure, and controverted the doctrine set up by Dr. Goldscheider in the former sitting of the Society respecting the specific energies of the nerves of feeling, and their punctiform distribution over the surface. In the discussion which followed, Dr. Goldscheider maintained the accuracy of his former statements, and invited Dr. Blaschko to convince himself of their correctness according to the method prosecuted by him.

VIENNA

Imperial Academy of Sciences, February 5.—Contributions to general nerve and muscle physiology (seventeenth communication): on the electric stimulation of the sphincter of Anodonta, by W. Biedermann.—Experiments on the oxidation of albumen by potassium permanganate, by R. Maly.—On *Clemmys sarmatica*, nov. spec., from the Hernalstegel, near Vienna, by C. A. Purschke.—Remarks on the velocity of light in quartz, by K. Exner.—Histological and embryological researches on the uro-genital apparatus, by T. Tanosik.—On a new vegetable parasite of the human body, by R. von Wettstein.

February 12.—On the bloodless-vessels in the tail of Batrachian larvæ, by S. Mayer.—On the constitution of isutivinic acid, by T. Schreder.—On the isogyric plane of double-refracting crystals, by H. Pitsch.—On the geographical distribution of the Jurassic formation, by M. Neumeyr.

CONTENTS

THURSDAY, MAY 14, 1885

SIR WILLIAM THOMSON'S "MATHEMATICAL AND PHYSICAL PAPERS"

Mathematical and Physical Papers. By Sir William Thomson. Vols. I. and II. (Cambridge University Press. 1882, 1884.)

EVERY one interested in the study of physics of the more profound kind will welcome this collection of essays by the celebrated natural philosopher, so many of which, hitherto scattered throughout various periodicals, difficult to gather together, or even wholly inaccessible to readers out of the reach of large public libraries, are yet of decisive importance for those chapters of the science to which they refer. With the two volumes now before us, in conjunction with the late publication, "Reprint of Papers on Electrostatics and Magnetism," the collection is now completed down to the date of February, 1856. Vol. II. contains, besides, all that the author has written on the Transatlantic Telegraphs, which, according to the strict order of time, might have been looked for in later volumes. The first volume begins with a series of essays, for the most part of a mathematical nature, ranging from the year 1841 to 1850. So far as these essays relate to physical problems, their chief interest turns on the difficulties connected with the analytic method. These difficulties were, however, even at that early period, treated by the youthful author with great skill, and under comprehensive points of view. The problems are, in part, geometrical and mechanical, referring to lines of curvature, systems of orthogonal surfaces, principal axes of a rigid body, &c. Most of them, however, deal with the integration of the differential equations, on which is based the doctrine of thermal conductivity and potential functions. The latter, as is well known, form the mathematical foundation of a large number of chapters in physics—the doctrine of gravitation, of electrostatical distribution, of magnetic induction, of stationary currents of heat, of electricity and of ponderable fluids. By treating all these problems collaterally and rendering concretely in some what in others appears in the highest degree abstract, the author has succeeded in overcoming the greatest difficulties, and we can only recommend every student of mathematical physics to follow his example. A field particularly favourable for the exercise of his powers was opened up to Sir W. Thomson by the phenomena, newly discovered by Faraday, in diamagnetic and weakly magnetic bodies, crystalline as well as uncrystalline. These our author rapidly and easily succeeded in arranging under comprehensive points of view. One great merit in the scientific method of Sir William Thomson consists in the fact that, following the example set by Faraday, he avoids as far as possible hypotheses on unknown subjects, and by his mathematical treatment of problems endeavours to express the law simply of observable processes. By this circumscription of his field the analogy between the different processes of nature is brought out much more distinctly than would be the case were it complicated by widely-diverging ideas respecting the unknown interior mechanism of the phenomena.

From the year 1848 and onwards there follows a long series of important investigations into the fundamental problems of thermo-dynamics. These start first with Saadi Carnot's conclusions respecting the mechanical functions of heat arrived at before J. P. Joule had experimentally demonstrated the equivalence of heat and mechanical energy. At the time when Carnot published his investigations heat was, by the majority of physical scientists, deemed an imponderable substance capable of flowing from one body to another, of entering occasionally into a more intimate kind of union with ponderable matter, and becoming, so to say, chemically united with it, under changes in the state of aggregation and under chemical processes. According to this older view temperature signified as much as the pressure under which the imponderable fluid stood in the warm bodies. In the case of a great number of thermal processes heat, in point of fact, acts entirely like a substance, showing the constancy of quantity, which is the most characteristic criterion of substances. In this way large sections of the doctrine of heat, embracing great bodies of facts, could very well be treated under the substantial conception of this agent—such, for example, as the exchange of heat between different bodies, the confinement and liberation of latent heat, the chemical production of heat. All that was necessary to render the substantial conception of heat apparently satisfactory was but to leave out of account all cases in which other forms of work are produced by heat or in which heat is produced by such. Cases of this kind then known were indeed very few, whereas the sections of the doctrine of heat already referred to were exactly those which till towards the middle of this century engaged the attention of natural philosophers. Carnot's highly acute investigation was an attempt to bring the phenomena likewise of the performance of work by means of heat into harmony with the assumption of the substantial theory of heat. The result of this endeavour was remarkable enough. He showed, namely, that heat was capable of performing mechanical work only when a quantity of it passed from a body of higher temperature into another body of lower temperature. A complete analogy thus seemed to be established between heat and those gases which through their pressure are capable of performing work, expanding, as they do, and abating their pressure in a measure corresponding with their expansion. The heat of a warm body corresponds n a manner with a compressed gas; it diffuses itself in space, passing into neighbouring bodies, to the lowering of the temperature of the body in which it was originally compacted.

Carnot's deductions, although based essentially on the erroneous assumption that the quantity of heat was constant like that of a substance, proved in reality correct so far as they respected transitions of heat within very narrow limits of temperature. They cease, however, to be strictly accurate when they are extended to wider intervals of temperature, for in that case finite parts of the transferred heat become transformed into work and no longer continue as heat. We now know through the experiments of Joule that heat does not possess the absolute constancy of a substance, but only the relative constancy of an equivalent of work which, to be sure, can neither be produced from nothing nor come to nothing but is yet capable of being transferred into other forms of equivalents of work which may be presented in a very diverse and hardly recognisable manner.

In his first Essays, Art. XXXIX., "On an Absolute Thermometric Scale," and Art. XLI., "An Account of Carnot's Theory of the Motive Power of Heat," dating from the years 1848 and 1849, our author still occupies essentially Carnot's standpoint, but he nevertheless calls attention to the fact that the argument adduced by Carnot in support of his theorem, apparently valid though it was in all points, was yet defective if the experiments by Joule, which were just then made known, should be confirmed, according to which heat might be generated anew by work (vol. i. p. 116). That which more immediately directed Sir William Thomson's studies to this subject was the possibility of attaining, in accordance with Carnot's theorem, to an absolute scale of temperature, and he endeavoured to utilise the observations which Regnault had shortly before carried out with special care in reference to the pressure and latent heat of steam for he purpose of calculating such a scale. But in doing so, he was obliged to apply the hypothesis, not perfectly exact in this case, that the density of steam was to be calculated from pressure and temperature according to the laws of gases.

The theory of Carnot next obtained highly surprising confirmation from the theoretical deductions drawn by Prof. James Thomson, the elder brother of Sir William, touching the alteration of the freezing-point of water in consequence of differences of pressure. The accuracy in point of fact of this deduction was experimentally demonstrated by Sir W. Thomson. This was a discovery which perhaps more than any other served to draw the attention of physical scientists to the accuracy and the importance of Carnot's theorem.

Meanwhile our author, no longer able to doubt the correctness of Robert Mayer and Joule's thesis respecting the equivalence of heat and work, devoted himself to the problem of how Joule's and Carnot's laws might be combined. This question he answered in his treatise of March, 1851, "On the Dynamical Theory of Heat," Art. XLVIII. Prof. Clausius, in Germany, had, however, been busied with the same problem, and had published the results at which he arrived before Sir W. Thomson, in May, 1850. The essential results of the two investigations coincided exactly; only in their numerical values for the absolute scale of temperature, the two authors had started with two different hypotheses, and had therefore reached different conclusions. Sir William Thomson had, as above mentioned, calculated the density of steam from pressure and temperature, as if for complete gases, whereas Prof. Clausius had accepted the hypothesis set up by Robert Mayer, according to which the work of a gas expanding itself was exactly equivalent to its loss of heat. Later on, when his opponents set forth the unsatisfactory basis of this hypothesis, Robert Mayer pointed to an old and very little-known experiment of Gay-Lussac, according to which a gas diffusing itself in empty space without encountering any resistance suffered no diminution of heat. The same experiment was afterwards carried out by Joule without his having any knowledge of the earlier observation of a similar nature. This form of the experiment was, however, as a whole, not fitted to yield very precise results, seeing that the mass of air available for it, whose consumption of heat was to be measured, was necessarily very small in comparison with the mass of water of the calorimeter. It was not till the investigations into the changes of temperature undergone by a mass of gas made to pass through a very dense porous substance—an investigation carried out in common by J. P. Joule and Sir W. Thomson, in 1852, and described in Art. XLIX., "On the Thermal Effects of Fluids in Motion"—that it was demonstrated how, in point of fact, R. Mayer's hypothesis was accurate to within a very close degree of approximation, although not with absolute precision, in respect of hydrogen and atmospheric air, whereas carbonic acid showed greater deviations.

To this have to be added extended investigations into thermo-electric currents, and the equivalent of their operations (Appendix to Art. XLVIII. and Art. LI. "Experimental Researches in Thermo-electricity," Vol. I., Art. XCI. Bakerian lecture, pp. i., ii., and iii., Vol. II.). In a thermo-electric chain which, from its conducting wire, sets magnets in motion, or generates heat in them, the heat conducted to the soldering seams is manifestly the source of the operations. We know that in such a case, according to the important observations of Peltier, heat disappears from the warmer soldering seam, and becomes developed in the colder. That is, in fact, the condition, according to Carnot's law, under which heat becomes transferable into other forms of work. This particular process was, however, of special interest for the universal validity of the theory, seeing that the work of heat is here produced under conditions altogether different from those of the steam-engine and hot-air engine. Our author was by this investigation led to the conclusion that, contrary to the opinion hitherto entertained, it was not in the soldering-seams of the metals, at all events not in those alone, but in the whole length of the wires, by a process which he calls "electric convection of heat," that the essential cause of the thermo-electric force was to be sought; and, in point of fact, he succeeded by a series of very laborious and subtle experiments in demonstrating that the conduction of heat in iron proceeded more rapidly in the direction of the current of negative electricity, and in copper in the direction of the positive current.

In the first volume of the book which is the subject of notice, the consecutive stages may thus be followed in the development of one of the most remarkable chapters in the history of discoveries, a chapter specially remarkable also as an example of how discoveries are arrived at in a manner not always rational. The course of this discovery reminds one in some measure of the invention of achromatic telescopes. Starting with the erroneous supposition that the eye of man was achromatic, Euler inferred that Newton's assumption of the proportionality between refraction and dispersion of light was false, and that his conclusion as to the impossibility of achromatic telescopes was without foundation. Thereupon Euler gave the receipt for the making of achromatic telescopes—a correct conclusion from a false premiss; similar to the case of Carnot with the doctrine of heat. After all the confirmations which have been obtained in the different branches of physics for the validity of the deductions of the corrected Carnot law there can hardly longer remain any doubt that we have here found one of the most comprehensive and important laws of nature of unlimited applicability. Down to the present moment we are, however, not yet in a position to derive a complete argument for its truth from the general principles of kinetics. Our analytic methods are inadequate even to the problem of completely determining the movement of three bodies reciprocally attracting one another. In the case, however, of motion which we perceive as heat, there are myriads of atoms engaged, all in the most irregular movement, and influenced by forces the nature of which is still almost wholly unknown to us. It is highly probable that the peculiar difficulty of reducing thermal motion into other forms of mechanical energy, which is expressed in Carnot's thesis, is due to the circumstance that thermal motion is a completely "unregulated" movement, that is, that there is no kind of similarity between the movements of atoms immediately neighbouring one another. Even in the case of the most rapid vibrations of light and sound, on the other hand, the movements and conditions of neighbouring atoms are so much the more similar to one another the nearer they are to one another. These, therefore, I am in the habit of calling "regulated" in antithesis to thermal motion. Sir W. Thomson has introduced for this conception the name of "dissipation of energy." Prof. Clausius denotes the quantitatively determined measure of the same magnitude by a more abstract name, "entropie." The dissipation of energy is capable, according to Carnot's law, by every known process of nature in the inorganic world, only of constant increase, never of decrease, and this leads to the much-talked-of conclusion that the universe is tending towards a final state of absolute unchangeableness with stable equipoise of all its forces under the establishment of complete equipoise of temperature, as our author expressed it in the year 1852 (Art. LIX., "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy").

On the other hand the ascertained laws of dynamics yield the deduction that if we were able suddenly to reverse the total movements of the total atoms of an isolated mechanical system the whole system would of necessity retraverse all the states which up to that point of time it had passed through. Therewith also would all the heat generated by friction, collision, conduction of electrical currents, &c., return into other forms of energy, and the energy which had been dissipated, would be all recovered. Such a reversion, however, is a postulate beyond the power of human means to fulfil. We have no agency at our disposal by which to regulate the movement of atoms. Whether, however, in the extraordinarily fine structure of organic tissues a mechanism capable of doing it exists or not is a question not yet to be answered, and I deem it very wise on the part of Sir W. Thomson that he has limited all his theses respecting the necessity of increasing dissipation by restricting their validity to "inanimate matter."

The recognition of this scientific law of so universal applicability and so rich in consequences is, be it repeated, due in the first place, through Carnot, to an erroneous assumption regarding the nature of heat. The universal demonstration given by him of the principle, a demonstration which in his day appeared completely satisfactory, is based purely on this assumption. And, what is still more noteworthy, it is hardly to be supposed that the principle in question could have been deduced from the more correct view—namely, that heat is motion, seeing that we are not yet in a position to establish that view on a completely scientific basis. The two natural philosophers, moreover, who brought Carnot's and Joule's principles into harmony with each other, and whom we have to thank for our present knowledge on this subject, are able to refer their conclusions only to an axiom generalising the experience that heat tends ever to expand, never to concentrate. Sir W. Thomson expresses this axiom in the following terms:—"It is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects."

The reviewer has, further, succeeded in demonstrating that the peculiar limitation affecting the transformation of heat into other forms of work likewise applies to other classes of motions revolving on themselves, so long as no external forces are brought into play directly opposing or accelerating the internal motion.[1]

When by J. P. Joule's experiment it was demonstrated that the basis of Carnot's proof was defective, it might have been apprehended that along with the element of error the element of truth in it would also be rejected. It must therefore be regarded as a special merit on the part of Prof. Clausius and Sir W. Thomson that, while removing the mistakes, they brought the truth into precise expression and into universal recognition, and that the recent theory of heat has become so fruitful in discoveries respecting the most secret connections between the different physical qualities of bodies in nature.

The second volume of these Reprints contains chiefly the researches having relation to the laying of the first submarine telegraph cable. The motion of electricity in these cables undergoes a peculiar retardation in consequence of the fact that the conducting-wire separated from the sea-water, which is likewise a tolerably good conductor, only by a thin isolating layer of gutta-percha, forms an enormous Leyden jar, which must first be charged with the electricity entering it before the current will pass with full force along the whole length of the wire to the other end. The physical laws of the processes which here come into play were generally known, but a far-searching mathematical investigation was still needed to determine the whole procedure of these currents and to ascertain the amount of influence exercised on them by the dimensions and conductivity of the wire, by the neighbourhood of other wires, and by the particular quality of the gutta-percha, as also to arrive at a knowledge of the conditions under which the most rapid series of signals might be transmitted and received at the opposite end.

All these questions our author disposed of thoroughly and exhaustively, having also to contend with opposition to his views based on observations made under restricted conditions on other cables. He was then a comparatively little-known young man, and did not enjoy that recognition and authority now everywhere freely accorded him.

To this were joined mechanical problems connected with the sinking or eventual raising and repairing of

[1] H. von Helmholtz, "Studien zur Statik monocyklischer Systeme." Sitzungsberichte der Berliner Akademie, 1884, März 6, 27, und Juli 10.

the cable; further, the construction of telegraphic signal apparatuses able to utilise the first weak beginnings of the current arriving at the other end of the cable. These ultimately led to the invention of the siphon-recorder—a writing apparatus in which the tube containing the ink does not come into immediate contact with the strips of paper on which it has to write, and is therefore not hindered by friction from moving even under the least electro-magnetic impulse. By electric charges it is brought about that the ink spurts over the paper in a series of fine points.

The conclusion of the second volume is formed by the Bakerian Lecture for 1856, which gathers up the results of the author's investigations into the qualities of metals as displayed under the conduction of electric currents, and under magnetisation, and the changes they undergo in consequence of mechanical, thermal, and magnetic influences.

Let us hope for an early continuation of this interesting collection. There are still nearly thirty years of scientific activity on the part of the author to be accounted for. When we think of that we cannot fail to be astonished at the fruitfulness and unweariedness of his intellect.

HERMANN L. F. HELMHOLTZ

OUR BOOK SHELF

Paradise Found. The Cradle of the Human Race at the North Pole. A Study of the Prehistoric World. By William F. Warren, S.T.D., LL.D., President of Boston University, &c. (London: Sampson Low and Co.)

IT has come to be an understood thing that when geologists or biologists propound theories as to past stages of life on the earth, and these theories attain to a certain popularity, some theologian shall twist the words of the Book of Genesis into a new interpretation, to show that this was what the inspired author meant all the time. A fresh musician has set Moses to dance to a new scientific tune. Since the publication of well-known modern views as to the diffusion of plants and animals from the Polar Region, it was to be expected that we should have a book proving that man was created in an Arctic Paradise with the Tree of Life at the North Pole; and here the book is. Other ancient cosmologies, such as the Greek and Indian, are made to bear their not always willing testimony. Those who take up the book should notice that the commendatory letters published from Professors Sayce, Tiele, and Whitney do not at all imply that these eminent scholars countenance the Polar Paradise doctrine. The President of Boston University seems to have sent them a paper some years ago on "Ancient Cosmology and Mythical Geography," their acknowledgments of which they are now perhaps hardly delighted to find figuring as certificates in a "Paradise Found."

Epping Forest. By Edward North Buxton, Verderer. (London: Stanford, 1885.)

THE public generally, and especially the people of London, and those who take some interest in natural history, are to be congratulated on the acquisition of so charmingly complete a little itinerary of Epping Forest as that now issued in a cheaper form by one of the Committee of Conservators, who is a resident on the borders, and an enthusiast as to the attractions of the Forest. It is, as the author observes in his preface, "hardly a desirable state of things" that so small a percentage of the summer visitors to the Forest "ever venture far from the point at which they are set down by train or vehicle;" and, with the choice of a score of beautiful walks, described in Mr. Buxton's book, and the guidance of his six carefully prepared maps, five of which are on the scale of three inches to the mile, there is no longer any reason for their not venturing into those depths of the Forest in which its chief beauties are to be seen. The chapter on the history of the Forest which the author has wisely prefixed to the itinerary, that visitors may be reminded of the events which secured this magnificent playground for their enjoyment, is most complete, though it is to be regretted that the late City Solicitor, Sir Thomas Nelson, is not mentioned *by name* on p. 22. The practical character of the book may be gauged from the inclusion of railway time-tables, the fact that the distinctive letters of each route have been cut on trees at some points, and from such suggestions as that an east wind is, in Epping Forest, the best for views, because not smoke-laden. Personal experience has convinced the present writer of the skill with which the routes have been selected; the "objects of interest within and around the Forest," and their historical associations, are fully described and illustrated by some excellent drawings, the latter by Mr. Heywood Sumner; but what must render the work peculiarly gratifying to all lovers of nature, is the ample space—more than half the volume—devoted to the fauna and flora of the Forest. The mammals, reptiles, birds; the chief moths and butterflies; the trees, flowering plants, ferns, fungi, and mosses, are all enumerated, with general, *i.e.* not too specific, localities; and the notes on the mammals and birds will be of interest to naturalists in other districts. Such lists can, fortunately, never be complete; insects marked as "rare" are notoriously liable at any time to prove common: even since the publication of this work evidence has been produced suggesting the addition of *Sparganium neglectum* to the list of flowers, and each year's cryptogamic meeting of the Essex Field Club has as yet added several species to the catalogues of the lower plants. There may yet be room for a more pretentious monograph of Epping Forest, and, of course, from the naturalist's stand-point, so rich a collecting-ground affords material for a library of expository literature—the freshwater algæ, for example, call for recognition;—but, for its purpose, the present work could hardly have been executed in a manner more creditable both to author and publisher.

G. S. BOULGER

Traité de Minéralogie appliquée aux Arts, à l'Industrie, au Commerce et à l'Agriculture, &c. Par Raoul Jagnaux. Avec 468 figures dans le texte. (Paris: Octave Doin, Éditeur, 1885.)

THIS work of 883 pages, as is stated in a title-page of corresponding length, is intended for the use of French students in their preparation for a degree in the subjects of engineering, chemistry, metallurgy, &c. We do not think that in its purely scientific contents it is likely to be of advantage to English students. The first part, devoted to the subject of crystallography, is rather incomplete and unsatisfactory, even if regard be had to the main purpose of the work. As usual, in the figure of Wollaston's goniometer the crystal is represented as adjusted in a way that every practical student is immediately taught to avoid. Nor will the chemical formulæ meet with the favour of English students: though the atomic weights of oxygen and silicon are given as 16 and 28 respectively, silica appears throughout as SiO_3, water is still HO, while to nitre is assigned the formula $KO . AzO_5$. Further, the ordinary symbols for the atoms are occasionally, as in the forty-nine formulæ of pp. 423-5, used to signify equivalent proportions of the oxides; olivine, for instance, being given as (Mg . fe)Si. The classification is likewise ancient; in the description of the species alum stone immediately follows the oriental chrysolite, a precious stone, merely because both substances contain alumina. In its explanation of the uses which have been discovered for the various subjects of the mineral kingdom, the work, however, supplies a want which has been long felt, and it will prove convenient for purpose of reference. The amount of detail will be better appreciated if we mention that in the description of the uses of carbonate of lime even the hammers used by stonemasons are specially figured.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Photographing the Aurora Borealis

I SHOULD be obliged if I might be permitted to state, with reference to the negative of the aurora borealis obtained by Mr. Tromholt in Christiania on March 15 (NATURE, vol. xxxi. p. 479)—the first ever obtained—that he now informs me that, although the plate was exposed for eight and a half minutes, the said impression is so faint and imperfect *that it cannot be reproduced as a positive*. My object in asking to be allowed to mention this important fact is to show that the opinion expressed by Mr. Tromholt in his work just published, "Under the Rays of the Aurora Borealis," that it is almost impossible to photograph the aurora borealis on account of the small strength of light and its limited chemical action, may be said still to hold good in the main.

CARL SIEWERS

Speed and Velocity

YOUR reviewer of Williamson and Tarleton's "Dynamics" (NATURE, February 26, p. 385) speaks of the confusion therein of *speed* and *velocity*. Does he mean that these words should now be used in distinct senses? If so, would he kindly specify the distinction, which is unknown to me and my friends.

B.

[Certainly. Velocity is a directed quantity, or Vector. Speed is its Tensor.—YOUR REVIEWER.]

Time.—Thunderbolts.—Vision.—Sunglows

ON my return from a magnetic tour along the Red Sea, I ask leave to refer to some back numbers of NATURE. In vol. xxxi. p. 125, Latimer Clark is quite right when he says that mean and sidereal time ought to be distinguished by names. I should prefer a step farther, and use for the latter the decimal angle, thus abolishing our frequent and tiresome conversion of time into space, and *vice versâ*. The resulting advantages would be obvious.

Answering Herr Von Danckelman's remarks in vol. xxxi. p. 127, I beg leave to quote my memoir, "Sur le Tonnerre en Ethiopie," published in 1858 by the French Institute, among its *Mémoires des Savants étrangers*. Facts mentioned there do not support the opinion that fatal thunderbolts are all but unheard of in Tropical Africa.

In your published remarks on vision, is it not Lord Rayleigh who says that the supposed superiority of eyesight among savages may be explained otherwise? Years ago, when reading Bergmann's travels among the Kalmouks, I noticed his remark that when examining camels *returning* to the fold, those natives distinguished sexes with their naked eyes just as well as he could through his excellent field-glass. In conclusion, Bergmann says that savage eyes are superior to civilised ones, or something to that effect. I must confess that I then accepted his opinion as being admirably warranted by the quoted facts. However, some time afterwards I was travelling on foot in the Pyrenees with a Basque illiterate peasant, and a splendid refractor by Cauchoix, which I proudly carried myself. My companion having tauntingly asked me why I had not left that lumber at home, I gave him, foolishly, a lecture on optics, and wound up by saying that the glass enabled me to distinguish a cow from an ox, even from that distant hill. He said he could do as much without my lumber. I then selected a cow grazing, and asked him what that was. "Wait till the brute walks," said the peasant; and at its first step he exclaimed: "it is a cow." I tried him, then, several times, and never found him in fault. He affirmed that cows and oxen do not lift their legs in the same way. May I request your rural readers to tell us whether that remark applies to English cattle? When on the Atlantic a sail was announced for the first time. I could perceive nothing, because I had not yet learnt what kind of a hazy thing I should distinguish. Having then sharp eyesight, I succeeded after a short practice, in discerning distant sails before any of my companions, and could turn tables on them by repeating their own saying, "*Ça crève les yeux.*"

To your lore on far-sightedness in vol. xxxi. p. 506, allow me to add two instances. Zach saw from Marseilles, Mount Canigou (2700 m.), at a distance of 158 English miles; he had calculated the true azimuth beforehand, and says that the peak bursts into view at sunset. Sir W. Jones informs us that the Himalayas have been seen at the great distance of 244 miles. I quote this from Carr's "Synopsis," a useful volume, which I regret to see behindhand in many cases since the death of its clever author.

May I intrude here a comment on our mysterious sunglows? My companion having a nice eye for discriminating colours, has confirmed my notion that on rising from the horizon the successive *nuances* of fiery red, faint red, rose, mallow, prussian blue, and green, are *not* the same on consecutive days, although thermometer, barometer, and wind have not changed. This suggests the hypothesis either that the lower strata of our atmosphere undergoes changes otherwise unperceived, or that there are maxima, minima, and perhaps regular epochs in the phenomenon. To those who, unlike myself, remain stationary under a rainless sky like that of Egypt, I would recommend a careful record of these changes, at least during a few months.

Cairo, April 22 ANTOINE D'ABBADIE

Plutarch on Petroleum

THERE is in "Plutarch's Lives," in the life of Alexander, an interesting notice of the petroleum of Media; I have not found any mention of this passage in "Plutarch" either in encyclopædia or chemical dictionary; I trust, therefore, that you will give me the opportunity of reproducing it in NATURE. I transcribe the passage from the translation of John and William Langhorne (9th edition, London, 1805):—

". . . and in the district of Ecbatana he (Alexander) was particularly struck with a gulph of fire, which streamed continually as from an inexhaustible source. He admired also a flood of naptha, not far from the gulf, which flowed in such abundance that it formed a lake. The naptha in many respects resembles the bitumen, but it is much more inflammable. Before any fire touches it, it catches light from a flame at some distance, and often kindles all the intermediate air. The barbarians, to show the king its force and the subtlety of its nature, scattered some drops of it in the street which led to his lodgings; and, standing at one end, they applied their torches to some of the first drops, for it was night. The flame communicated itself swifter than thought, and the street was instantaneously all on fire."

W. H. DEERING

Chemical Department, Royal Arsenal, Woolwich, May 6

Hut Circles

THE remains of the ancient British habitations on the downs on both sides of Dunstable are fairly well known to archæologists. I have often wished to expose the floor of one or more of these circles, as the task could be accomplished with a spade in an hour or two. It is, however, far better that the remains should be left alone, as it is not likely that anything would be found beyond a few flakes and the other simple forms, such as are abundant in the cultivated fields close to the huts.

On passing some of the circles on the east side of Dunstable, in the railway, about ten days ago, I noticed that the remains were covered with whitish soil instead of the normal green of the short pasture belonging to the downs. Thinking that some persons had been digging at these antiquities, I took an early opportunity of going to the spot. On reaching the circles I found they had been undermined in every direction by a large number of moles. A great deal of the material from the actual floors had been brought to the surface, and on examining this chalk rubble—for such it was—I had no difficulty in securing two or three handfuls of flint flakes. Mingled with them were a very few stones, which had been reddened and crackled by fire. No trace of burnt wood, ashes, or bone could be seen. It was remarkable that nearly all the stones found were flakes, as very few unworked pieces of flint could be lighted on. The flakes from the huts differ in condition materially from the flakes in the fields below, as all the flakes in the fields are marked with dark ferruginous strains, whilst those from the hut-floors are perfectly unstained, no iron having ever reached them.

In the immediate neighbourhood I have at different times found a large number of scapers, a lance-head, a few arrow-heads, and a few rudely-chipped celts, some broken. One small chipped celt has incurved sides, indicating, as Mr. John Evans has pointed out in his work on stone implements, that this particular form was possibly an imitation in flint of an early, flat bronze celt.

It is always well to examine the earth brought out of holes by rabbits, moles, foxes, rats, and other animals, in places where prehistoric relics exist on pasture-land. I have secured a considerable number of my antiquities from such places.

Last year I told a young niece of mine to keep a watch on such places at the spot where the five large tumuli are placed on Dunstable Downs, and where I had on previous occasions found flint flakes in the heaps made by moles, &c. It was not long before my niece lighted on two pieces belonging to the back part of a human skull. They had been scratched out of the base of the northernmost tumulus by some animal. Fortunately the two pieces fitted together; they are evidently of great antiquity, and probably represent part of the person who was buried in the tumulus, quite possibly one of the old chippers of Neolithic implements. WORTHINGTON G. SMITH

A Lady Curator

IN NATURE for November 27, 1884 (p. 90) you acknowledge the receipt of the "Catalogue of the Natural History Collections of the Albany Museum, Grahamstown, Cape of Good Hope," and allude to the "zealous curator." Are you aware that that individual is a young and accomplished lady? Here is another path opened for our daughters and "sweet girl graduates" to fame and fortune. Those who, like myself, have the pleasure and privilege of knowing and corresponding with Miss Glanville can appreciate the ardour and zeal with which she is following up her chosen vocation. May every success attend her. E. L. LAYARD

British Consulate, Noumea, February 25

Hoar Frost

A COMMUNICATION in NATURE of January 8 (p. 216), in regard to frost-formations, leads me to send a word from Maine. I have seen frost-work so like the description there given, that it would answer very well for an account of frosts in this climate. These frost-formations occur when the wind is chilly and blowing steadily, without the compass veering, for hours. I have compared these deposits to the most delicate designs of Oriental lace-work. At one time I witnessed an accretion on a wall, where the feathery forms were from two to four inches in length, with the points towards the wind. I think this is because each added particle adhered to the very tip of the previous one. Certainly no pen-description can do justice to the delicate beauty when the sun suddenly broke through the clouds and shone upon this forest of frost-ferns. CAROLINE W. D. RICH

Auburn, Me., April

Rainbow Phenomenon

ON Saturday night, about six o'clock, I observed, at Old Trafford, on the west side of Manchester, a rainbow with accompanying phenomena, which I had never observed before. Several very heavy showers had occurred during the day. The wind was within a point or two of west. At the hour above named a cloud was passing over, very dense and uniform in colour, and with that dark leaden hue so general in thunderstorms. There was, however, no thunder or lightning. Rain fell in torrents. As the cloud, which was of large area, passed off, the sun shone brightly in the north-west, and a magnificent rainbow painted itself on the dense black screen afforded by the cloud. The rainbow was double, the prismatic colours, of course, occurring in reverse order in the outer bow. The most remarkable feature of the display was the sharp contrast in the shadow of the cloud, evidently caused by the rainbow. Between the two bows it was of the densest leaden hue. Inside the inner bow it was exceedingly light coloured, with the faintest suggestion of luminosity. Outside the outer bow it was of an intermediate grey. The uniform mass of cloud was marked off by the two bows with geometrical accuracy into three regions, each perfectly homogeneous in itself, but distinctly contrasted with the two other tints. The effect was weird and startling, and was observed and commented upon by several spectators in whose company I was. There was another feature connected with the inner bow which I have never observed before. The green and violet colours were repeated inside the bow. Probably the whole tract from green to violet inclusive was repeated, but I could only make out those two colours distinctly.

Have these peculiarities, either or both, been observed before, and, if so, how are they accounted for? CHARLES CROFT

Prestwich, near Manchester, May 11

FIVE MATHEMATICAL RARITIES

A BRIEF reference to some recent reprints, &c., by Dr. Bierens de Haan, of Leyden, may not be unacceptable, though, unfortunately, ignorance of the language in which four of them are written prevents our giving more than the barest description of them.

The "Stelkonstige Reeckening van den Regenboog," or Algebraical Calculation of the Rainbow, is a rare tract, by no less distinguished an author than B. de Spinoza. It was for a long time supposed to be lost, if not burned; it is here printed in exact facsimile from a copy published at the Hague in 1687. Bound up with it is another rarity, similarly printed, entitled "Reeckening van Kanssen," or Calculation of Chances. No reference to this is made by Todhunter. There is a slight probability of this tract having proceeded from the same hand, as Dr. De Haan cites a reference to the forty-third letter in the collected works of Spinoza.

The third reprint is of a very rare book by A. Girard: "Invention nouvelle en l'Algèbre, tant pour la solution des équations, que pour recognoistre le nombre des solutions qu'elles reçoivent, avec plusieurs choses qui sont nécessaires à la perfection de ceste divine science" (Amsterdam, 1629). M. Marie writes: "Cet ouvrage est surtout remarquable par les idées justes que l'auteur émet au sujet des racines négatives des équations et de leur usage en géométrie."

The last two tracts have not been before printed: they are both the work of Simon Stevin, and are entitled "Van de Spiegeling der Singkonst" (*i.e.* Miroir de l'Art du Chant), and "Vande Molens." There is a full account prefixed to the former of these works, and we learn that the latter contains "le calcul de 19 moulins à vent, suivant la méthode usitée et suivant une nouvelle méthode de Simon Stevin lui-même, qui consiste à indiquer les roues, les dents et les pignons, afin de satisfaire à quelques conditions données."

Thanks are due to Dr. de Haan for the great care with which he has brought out these facsimiles, and we think he will certainly reap the reward he seeks. We quote his words in the last of these volumes: "J'ose espérer que la réproduction de ces ouvrages d'un homme si renommé pourra intéresser ceux qui s'occupent de l'histoire des sciences."

ON CERTAIN SPECTRAL IMAGES PRODUCED BY A ROTATING VACUUM-TUBE

THE beautiful effects produced by the rotation of a vacuum-tube when illuminated by a series of electrical discharges from an induction-coil are well known. The tube is generally attached to a horizontal axis, which is turned rapidly by means of a multiplying wheel; the images due to successive discharges which, if the tube were at rest, would be superposed, are thus caused to occupy different parts of the retina, and if the discharg follow one another at the rate of n per second, the number of images simultaneously visible will be about $n/8$, since the luminous image produced by each separate flash persists for about an eighth of a second after the flash itself has ceased. The result of these effects is the appearance of a gorgeous revolving star.

If the tube is made to rotate very slowly, there occurs a different and very curious phenomenon, which, so far as I know, has never hitherto been noticed. The tube used in my experiments was thirteen inches long, and contained various devices in uranium glass; the induction-coil had a resistance of 1400 ohms, and was worked by a single large bichromate cell. When the rotation is performed at about the rate of one turn in three seconds, the luminous images of the tube are almost superposed, forming a bunch which is slightly spread out at the ends. But about 40° behind the bunch, and separated from it by an interval of darkness, comes a *ghost*. This ghost is in shape an exact reproduction of the tube: it is very clearly defined, and distinctly shows every detail of the uranium glass devices. But the colour is entirely changed, the violet tint of the luminous bulb and the bright green fluorescence of the uranium glass being replaced by a uniform steel gray. If the rotation is stopped, the ghost still moves slowly on, and, after the lapse of about half a second, disappears in coalescing with the luminous tube. The phenomenon may be diagrammatically represented by the letter X, the thick stroke being the bunch of luminous images, and the thin stroke the spectral attendant. The direction of the motion is supposed to be opposite to that of the hands of a watch when seen from above. If the rate of rotation is too slow, the ghost approaches the luminous bunch so closely as to be obscured by its superior brilliancy; while, if it is too fast, the image becomes blurred and ill-defined. The strength of the inducing current should be regulated by trial. With too strong a current the effect is the same as when the rotation is too slow; with too weak a current the image is rendered feeble. Generally speaking, the best results are obtained with a somewhat weak current.

The experiment has been witnessed by a dozen persons, all of whom, with the exception of one adult, and the doubtful exception of a child, at once saw the spectral image. It is almost ludicrously difficult for those who are able to see it, to understand how any one else could possibly fail to do so.

This curious effect clearly belongs to the class of spectral images or "ocular spectra," which result from looking at a bright object, persistence of vision in the ordinary sense of the term having nothing to do with it. I proved this to be the case in a very simple manner. The vacuum tube being at rest in a feebly-lighted room, I concentrated my gaze upon a certain small portion of it while the discharge was passing. The current was then interrupted, and the luminous image was almost instantly replaced by a corresponding image which appeared to be intensely black upon a less dark background. After a period which I estimated at from a quarter to half a second (probably more nearly the latter), the black image again became luminous, assuming the characteristic steel gray colour: this luminous impression lasted but for a small fraction of a second, and the series of phenomena terminated with its disappearance. I found the effect to be most clearly marked when a narrow portion of the tube was observed; the definition of the spectral image was then exceedingly sharp, even the striæ being represented with perfect distinctness. It was also found desirable to make the preliminary illumination as short as possible, a single flash being generally sufficient to produce the phenomena. This is more easily effected by a judicious manipulation of the contact-breaker than by means of a key, or of the commutator attached to the coil. I may add that it is by no means certain that a person who is altogether new to the subiect will at first be able to see the appearances last described, even when he knows exactly what to expect. They belong to a class of phenomena which in ordinary life we habitually train ourselves to disregard, and our persistent neglect makes it difficult to perceive them when we desire to do so. With a little patient attention the difficulty will probably disappear.[1] It was probably owing to my constant habit of studying visual impressions that the appearance of the ghost attracted my notice in the first instance.

The series of phenomena seem to be due to an affection of the optic nerve which is of an oscillatory character. Abnormal darkness follows as a reaction after the luminosity, and again after abnormal darkness there is a rebound into a feebler luminosity. Following this idea I have endeavoured to detect the existence of a second ghost as the result of a further rebound, but hitherto without success.

It is an interesting fact, as proved by these experiments, that the formation of a spectral image does not occur until the expiration of a measurable interval of time after the exciting cause has ceased to operate.

SHELFORD BIDWELL

[1] The adult who failed to see the ghost is totally unable to perceive the subjective images in complementary colours, which generally result from gazing at brightly-coloured objects. Her general powers of vision are decidedly above the average, and she is in no degree colour-blind. The doubtful child is a daughter of this adult. A younger child can certainly see the phenomenon.

JUPITER

DURING the present opposition of this planet, the details of the belts and spots have continued to furnish materials of great interest. Some very obvious modifications have occurred since the previous year, and several curious new features have become conspicuous. The great red spot has surprised us by its extended duration. As early as 1882 it lost such a considerable depth of tone that its obliteration seemed imminent, but it has lingered on, until now its existence appears likely to be indefinitely prolonged, though under visible conditions far less imposing than at an earlier stage. All that at present remains of this remarkable formation is a dusky elliptic ring, darkest at the following end, and only well seen under good definition. Whether this ellipse is identical with similar appearances delineated by Dawes in 1857, Huggins in 1858, and Gledhill in 1869, 1870, and 1871 is involved in doubt, because of the lack of intermediate observations. We have no definite information as to what became of the various objects alluded to. It is very possible that they severally represent an object of considerable permanency. The changes such as observed may have been induced by atmospheric interference. There is every indication that the dense vaporous envelopes of this planet are rapidly variable, especially in the zone included by the two equatorial belts, and that the chief features undergo singular fluctuations, some of which may possibly be of periodical character.

The particular objects drawn by Dawes and others suggest a close relationship to the red spot as it now appears. There is far from being an actual coincidence either in the positions or forms of the features here sought to be connected, but small differences must actually occur in results based on estimation. A sufficient likeness is established between them to show that further investigation may have an interesting outcome as affirming the theory of recurrent markings of identical form. There is, however, an inability to trace the history of these singular objects, owing to the meagre number of observations available. This is a circumstance much to be regretted. Markings of specially interesting character deserve something more than mere record. They should be persistently watched during several oppositions, if possible, for it is only by this continuity of records that the really important questions affecting them admit of settlement. The red spot has now been followed since 1878, and though apparently on the verge of absolute extinction, it may yet linger on a considerable time in its present feeble aspect until possibly it is again enabled to obtrude upon general notice as an object of great prominence. It may not return under precisely the same outline as formerly, or exhibit the same depth of tone or degree of colouring, for, doubtless, some new development is to be anticipated on this disturbed region of the planet. In case of any distinct reappearance it will be important to determine that it occurred from the exact position so long tenanted by the old spot. The motion of this feature has been so thoroughly followed during the last seven years, that it will be feasible to compute its predicted place with great nicety in future months. In the mean time, and until the spot finally withdraws from reach, the same necessity exists as before of recording the times of its passages across the central meridian of Jupiter. And even assuming the total extinction of the spot, and that its place immediately south of the great equatorial south belt should resume the unbroken zonal arrangement existing in other longitudes, it will be necessary to re-examine this region occasionally for traces of any subsequent outbreak from the same focus.

During the last three years this object has given a rotation period of 9h. 55m. 39·1s., which has been steadily maintained throughout each opposition, subject to some minor disturbances partly due to errors of observation. The first few years of its existence it showed an increasing retardation of motion, which lengthened the period from 9h. 55m. 34s. to that already quoted, but, contemporarily with the decay of the spot in 1882, the velocity ceased to slacken, and the results accumulated during the past few oppositions prove it to have been equable in a marked degree.

With reference to the equatorial white spot some striking phenomena have been presented during the past winter. Between October 4, 1884, and January 13, 1885, its motion appears to have increased in an alarming ratio. The spot continued to rush on far in advance of its computed places, and all the while exhibited a more brilliant appearance than at any preceding epoch since the autumn of 1880, when it first came under systematic observation. The form and appearance of the spot have been so special as to prevent any confusion in mistaking it for other white spots in nearly the same latitude. Between October 4 and January 13, 1885, the rotation period was 9h. 49m. 51·95s., but the great increase in velocity evidently occurred towards the end of November. Between November 21, 1884, and January 13, 1885, the period was only 9h. 49m. 38·45s., or 34 seconds less than the mean period of 9h. 50m. 12·25s. shown by the same spot during the two preceding years.

When the first intimation of this great increase of speed forced itself upon my notice, I at once resolved to obtain as many observations as possible, in order to assure myself more certainly of the fact. Much cloudy, wet weather ensued, but I observed the spot on fourteen occasions between November 27 and January 13. A lengthened period of overcast skies then supervened, and I saw nothing more of Jupiter until January 27, when the place of the spot, computed on the basis of my prior observations, appeared absolutely vacant. About 15° E. there was, however, a remarkably brilliant spot, the exact counterpart of the one previously observed. Then arose the question of identity. Could the velocity have become so much retarded in the fortnight's interval from January 13 to 27 as to have occasioned so considerable a displacement in longitude? From my observation on January 13 and several preceding nights the spot had shown an increasing disposition to slacken, and, from records obtained in previous years, the motion was known to fluctuate in the most unaccountable manner. In the seventeen days from September 30 to October 17, 1881, I noted the spot underwent a sudden translation of 11°·6 in the direction of east longitude. The fact was independently confirmed by Prof. Hough at Chicago and Mr. Stanley Williams at Brighton. The most obvious departures from the mean rate of motion have been detected in other instances, and I am therefore led to conclude that the objects observed on January 13 and 27, 1885, were, notwithstanding their discordance of position, really identical objects. The consistent brilliancy of the marking alluded to, for several months before the cloudy period set in, is entirely opposed to the idea that it could have suddenly disappeared. And the real displacement is not so large as the limiting observations suggest. Deriving a mean from my results near January 13 and 27, I obtain the following figures:—

1885	Spot precedes 1st meridian m.	Long. (878°·34)
Jan. 7 to 13, mean of 7 obs.	64·0 ...	321·0
Jan. 27 to Feb. 6, mean of 6 obs. ...	46·4 ...	331·4

Adopting this mean, we practically eliminate errors in single observations, and in the present case it is fortunate I obtained so many transits just before and after the period of cloud. The real displacement is seen from this comparison to be only 10°·7, which is quite within the limits of previous experience. And if the fact of identity had not been rendered a very tenable hypothesis by past observation, I should have regarded the brilliant appearance of the spot and its comparative isolation as conclusive. Moreover, during the period that this object continued moving so rapidly, I often carefully examined the place where, had no change occurred, it must have been presented, but no object having a remote likeness to the old spot could be detected. Having observed this feature on the central meridian on more than 200 nights, I am familiar with its usual aspect, and could not possibly have overlooked it, on the many occasions when I looked for it in vain, had the spot retained the approximate place assigned to it from the observations of preceding years.

Let us now analyse the degree and period of the remarkable velocity alluded to. Arranging my observations into short intervals, the following are the rotation-periods severally derived from them:—

1884	Interval in Minutes	Spot gained on 1st. Mer. m.	Spot gained in Long. °	Number of Rotations.	Period. h. m. s.
Oct. 4 to Nov. 7 ...	48,985 ...	6·5 ...	4·0 ...	83 ...	9 50 7·55
Nov. 7 to Nov. 21 ...	20,064 ...	3·5 ...	2·1 ...	34 ...	9 50 6·07
Nov. 21 to Nov. 27 ...	8838 ...	15·1 ...	9·2 ...	15 ...	9 49 11·85
Nov. 27 to Dec. 9 ...	17,098 ...	17·4 ...	10·6 ...	29 ...	9 49 36·25
Dec. 9 to Dec. 18 ...	12,970 ...	13·8 ...	8·5 ...	22 ...	9 49 34·61
Dec. 18 to Dec. 24 ...	8843 ...	9·3 ...	5·6 ...	15 ...	9 49 35·05
Dec. 24 to Dec. 31 ...	10,023 ...	9·5 ...	5·8 ...	17 ...	9 49 38·72
Dec. 31 to Jan. 8 ...	11,208 ...	4·6 ...	2·8 ...	19 ...	9 49 57·73
1885					
Jan. 8 to Jan. 13 ...	7078 ...	3·5 ...	2·2 ...	12 ...	9 49 54·75
		Lost	Lost		
Jan. 13 to Jan. 27 ...	20,089 ...	24·9 ...	15·2 ...	34 ...	9 50 56·19
Jan. 27 to April 19 ...	118,042 ...	9·7 ...	5·7 ...	200 ...	9 50 15·16

The period of really great acceleration extended over forty days (November 21 to December 31), and it is remarkable that in the mean time the spot had completed exactly one revolution of Jupiter relatively to the red spot. In fact, the sudden increase and diminution of velocity occurred with the white spot following the red about 2h. 44m., so that there was a difference of 100° in the longitude. The maximum speed appears to have been shown between November 21 and 27, when the rotation-period was one minute less than the mean of the two preceding years. But my observation of November 21 was considered rather late, and the interval being a very short one of only six days, would originate a rather large error. But the four short intervals, from November 27 to December 31, exhibit a singular consistency in the resulting periods, the mean being 9h. 49m. 36·16s., which proves the real increase of speed to have been 36·09s. in each rotation; and, if we amalgamate the two preceding periods, from November 7 to November 27, we get a mean of 9h. 49m. 38·96s., which is closely accordant.

In the forty days, November 21 to December 31, the spot gained 65·1m. = 39·7° upon Mr. Marth's central meridian (*Monthly Notices*, vol. xliv. No. 9), based on the period of 9h. 50m. 12·25s. The spot must therefore have moved 28,700 miles to the westward at the rate of 717 miles per terrestrial day, and 294 miles per Jovian day. Then after January 13 it suddenly retrograded if we accept the

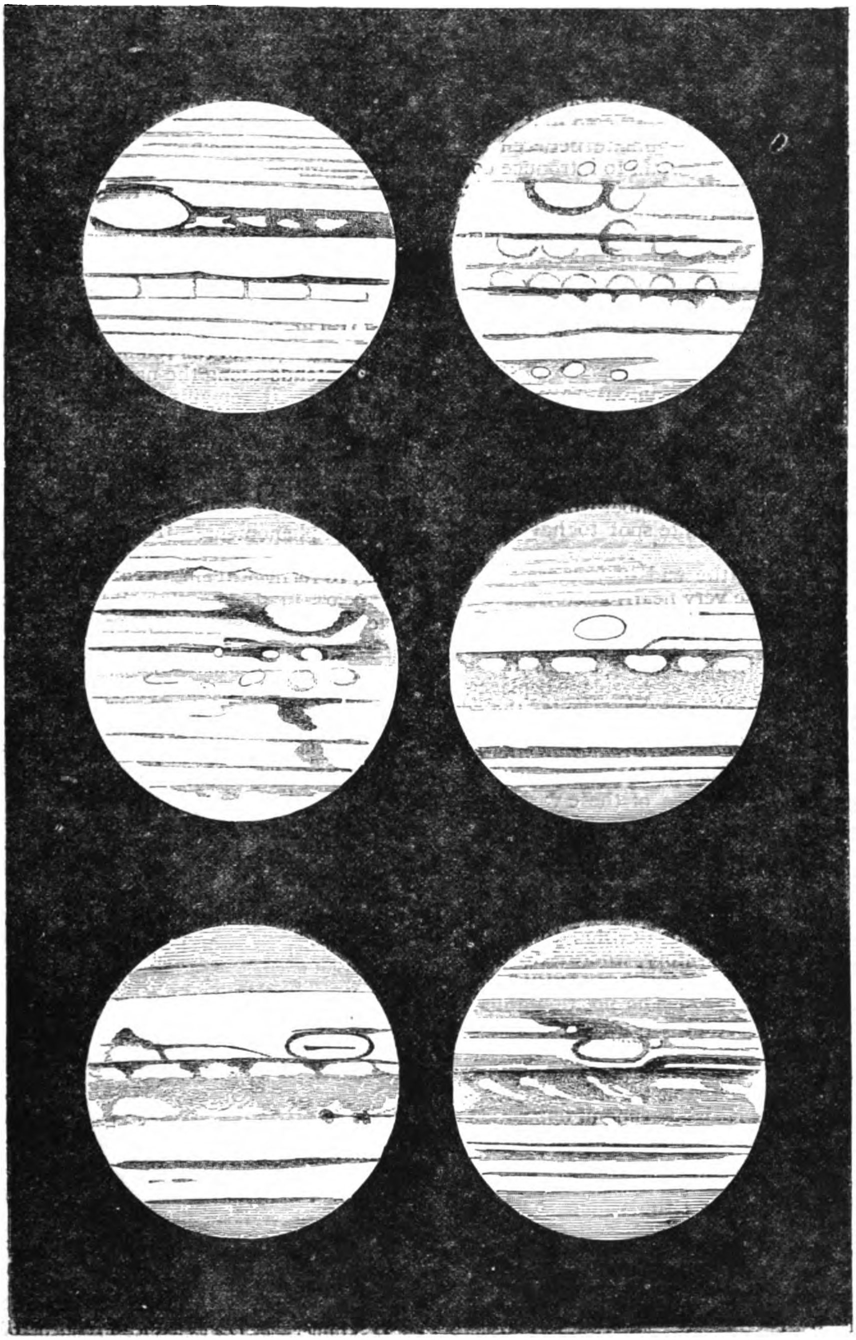


FIG. 1.—Probably recurrent markings on Jupiter. I. 1857, November 27 (Dawes). II. 1859, December 29, 10h. 50m. (Huggins). III. 1858, March 2, 9h. (Huggins). IV. 1870, January 23, 8h. 20m. (Gledhill). V. 1872, February 2, 10h. 30m. (Gledhill). VI. 1885, February 25, 12h. 50m. (Denning).

identity of the spots observed on January 13 and 27; so that in the fourteen days it lost nearly 11,000 miles, which is greater than the rate of its previous excess. But since the end of January the motion has steadied down to its normal degree, and thus we find the period closely agreeing with that adopted by Mr. Marth.

The motion of this brilliant white spot prior to January 13 is involved in no doubt whatever, so that the question of its identity with the one observed on January 27 is an entirely separate one, and cannot affect the remarkable phenomena, which the increased velocity exhibited, except as to the retrogressive motion which subsequently occurred. The question of identity may be definitely settled if any observations of the spot during the interval from January 13 to 27 are forthcoming from foreign observatories. In this part of England the sky was densely overcast at night during the whole of that time. If Prof. Hough at Chicago or some other systematic student of the planet can supply the missing links for the period referred to, it will be most important to ascertain how far they corroborate the assumed identity of the markings in question.

These white spots are liable to great variations in apparent brilliancy at short intervals; so that, unless an observer is very careful to discriminate between objects approximately situated, he is certain to introduce complications into his results. But, in regard to the conspicuous white spot which has been the subject of so much comment during the last few years, I have never found much difficulty in following it, because of its special character. Occasionally smaller spots slightly nearer the equator are seen on each side of it, but the leading spot of the trio is so bright and almost invariably shows a bright trail running from its north-east side towards the equator, that it may be readily identified. During the observations between October 4, 1884, and January 13, 1885, of the present opposition the extreme brilliancy of the spot was very noticeable, and the observations were pursued without any liability to error. I fear, however, that, morning observations being rendered necessary by the position of the planet in November and December will have enabled the singular vagaries of the white spot to have generally eluded notice.

It is curious that since the end of January this white spot has maintained a rate very nearly conformable to the first meridian of 9h. 50m. 12·25s., computed by Mr. Marth from the observations between 1882 and 1884; but there occurred a sudden deviation between March 14 and 18, amounting to some 8°. These singular displacements cannot be induced by changes in the form of the object, and they are far too considerable to be referred to errors of observation. Between February 9 and 16, 1882, Prof. Hough noticed an acceleration of 6¾°.

The verification and true cause of these variations can only be efficiently sought out by frequent and very accurate observation. Our own climate is very ill-adapted to an investigation of this kind where the most essential point consists in closely consecutive results. What we need is an almost unbroken series. It is to be earnestly hoped that some attention will be devoted to this important work at the Lick Observatory, where "the elevation is 4200 feet above the sea, and *for six or seven months of the year every night is clear!* The position thus commands natural advantages (in this work of far more importance than instrumental advantages) which would enable it to obtain some most valuable evidence bearing on the question of the remarkable variations affecting the white spots on Jupiter. Near the time of opposition they might be observed every night, and it is this consecutive, close treatment that is required before the phenomena will really admit of satisfactory discussion.

The question arises whether the whole southern belt partakes in these erratic and apparently frequent variations of speed, or whether they are confined to proper motions affecting the individual spots at different times. If several markings were made the subject of contemporary study it might soon be determined whether they exhibited uniform displacements, and, if so, it would have to be admitted that the whole equatorial atmospheric current is subject to the singular onrushes and alternating lulls which our recent observations have demonstrated.

Of the new features presented during the last few months the most striking are:—

(1) The appearance of large, bright spots indenting the north edge of the great northern equatorial belt. A peculiarity of these objects is that lines of light flowing from their west sides divide the dark belt and finally emerge near the equator, where they became indefinite. These spots show a rotation period only a few seconds less than the red spot.

(2) The outbreak of dark, reddish spots, elongated in longitude, upon the narrow belt which became visible in 1882, immediately outlying the great belt. The depression north of the red spot was formed by the ends of this belt suddenly dipping northwards before reaching the spot where they became blended with the old belt. The spots now visible here are very plain and will probably increase until finally their material is dispersed around the planet and the belt becomes much darker than before. The individual spots should be carefully watched to ascertain whether this is their ultimate development. The rotation period they have hitherto shown is precisely the same as that of the red spot. One of the most conspicuous of these new spots is about 10,000 miles long; it follows the red spot 1h. 48m., so that its longitude is 66° east.

(3) The fading away of the west shoulder of the depression north of the red spot. This is now very obvious, and extends along the narrow belt far to the west of the red spot. It remains to be seen whether this decadence will continue now that various other regions of the belt exhibit a confluent eruption of dark spots.

The several features referred to are of extreme interest, as suggestive of peculiar forms of atmospheric disturbance and as affording fresh materials for students of Jovian phenomena. It will be necessary to follow each of these special features during the two ensuing months, and to recover them, if still visible, when the planet reappears in the morning sky towards the end of October next.

W. F. DENNING

NOTES

AT the *conversazione* of the Royal Society on Wednesday evening last week, the Fellows, we are sure, were all glad to see their President back again, in renewed health, after his long absence. Prof. Huxley had to welcome a very large number of guests, and some of the objects exhibited were of much interest. Prof. H. N. Moseley exhibited a collection of Pueblo Indian pottery, charms, prayer-sticks, &c., from Zûni, New Mexico; Gen. Strachey, an instrument for drawing curves of sines adapted to graphical representation of the harmonic components of periodical phenomena; Mr. W. T. Thiselton Dyer lent some beautiful flowering specimens of Himalayan rhododendrons (the small, rosy-pink *R. glaucum* and the large, velvety-white *R. nuttalli*), a fruiting branch of coffee, and the various vessels and implements used in the collection and preparation of Para india-rubber; iridio-platinum weights, with a density of 21·5660, absolutely adjusted, and a piece of platinum wire ·00075 of an inch, prepared by drawing, &c., were exhibited by Mr. G. Matthey; the Linnean Society lent a remarkable set of drawings from the collection of Lady Impey, at Calcutta, painted by a native of Patna towards the end of the last century, and still in perfect preservation; the Anthropological Institute contributed ethnographic photographs of various races; and there were many highly interesting philosophical instruments shown.

THE Council of the British Association have nominated Prof. J. Struthers, M.D., as a Vice-President of the Association for the Aberdeen meeting, and have added the name of Prof. J. Stirling, M.D., D.Sc. (Aberdeen) to the list of those nominated for the Vice-Presidency of Section D.

AT the invitation of Prof. Flower, a meeting of the Essex Field Club will be held on Saturday afternoon, May 16, at 3.30, in the Lecture Room at the Zoological Gardens, when the Professor will speak of the principal objects of interest in the

Gardens, and will afterwards conduct the party to visit them in order, and give a demonstration of the most remarkable species.

A LETTER of Mr. Miklucho Maclay is inserted in the *Isvestija* of the Russian Geographical Society (1834, vi.), in which he expresses his regret that he cannot yet return to Russia, and explains the plan he has adopted for the publication of his reports. He wishes to have them published in two different parts, the first to contain (*a*) a statement of the reasons for any voyage or important excursion which he has undertaken, (*b*) a detailed narrative, and (*c*) scientific results of each of them; the second part to contain the scientific results concerning (*a*) anthropology, (*b*) ethnology, (*c*) zoology and comparative anatomy, (*d*) meteorology. In this manner Maclay hopes to suit both those who desire a general view of the outcome of his travels and those who wish to make themselves more particularly acquainted with the scientific results. By the way it may be mentioned that he has already described some new species, viz. (1) *Dorcopsis Chalmersii*, (2) *D. Macklayi*, (3) *Macropus Jukesii*, (4) *M. gracilis*, (5) *M. tibol*, (6) *Brachymelis garagassi*, (7) *Mus yelve*.

THE following, from *Science*, is a complete list of the papers read at the meeting of the National Academy of Sciences, April 21-24:—J. S. Billings and Dr. Matthews, U.S.A., methods of measuring the cubic capacity of crania; S. H. Scudder, winged insects from a palæontological point of view; A. S. Packard, the Syncarida, a hitherto undescribed group of extinct malocostracous Crustacea; the Gampsonychidæ, an undescribed family of fossil schizopod Crustacea; the Anthracaridæ, a family of carboniferous macrurous decapod Crustacea, allied to the Eryonidæ; Alexander Agassiz, the coral reefs of the Sandwich Islands; the origin of the fauna and flora of the Sandwich Islands; T. Sterry Hunt, the classification of natural silicates; Elias Loomis, the cause of the progressive movement of areas of low pressure; C. B. Comstock, the ratio of the metre to the yard; C. H. F. Peters, an account of certain stars observed by Flamsteed, supposed to have disappeared; J. E. Hilgard and A. Lindenkohl, the submarine geology of the approaches to New York; Theodore Gill, the orders of fishes; J. W. Powell, the organisation of the tribe; G. W. Hill, on certain lunar inequalities due to the action of Jupiter, and discovered by Mr. E. Neison; E. D. Cope, the pretertiary Vertebrata of Brazil; the phylogeny of the placental Mammalia; C. A. Young, some recent observations upon the rotation and surface-markings of Jupiter; H. A. Rowland, on the value of the ohm; F. A. Genth and Gerhard vom Rath, on the vanadium minerals—vanadinite, endlichite, and descloizite—and on iodyrite, from the Sierra Grande mine, Lake Valley, New Mexico; A. N. Skinner (by invitation), on the total solar eclipse of August 28, 1886; Theodore Gill and John A. Ryder, the evolution and homologies of the flukes of cetaceans and sirenians; Ira Remsen, chemical action in a magnetic field; A. Graham Bell, the measurement of hearing-power; A. Graham Bell and F. Della Torre, on the possibility of obtaining echoes from ships and icebergs in a fog. The following biographical notices of deceased members were also presented: of Dr. J. J. Woodward, U.S.A., by J. S. Billings; of Gen. A. A. Humphreys, U.S.A., by H. L. Abbot; and of William Stimpson, by Theodore Gill.

BOTANY, as well as geology, we are pleased to notice, is well represented upon the Afghan Boundary Commission. Mr. Condie Stephen, who has just arrived in London, speaking of the Penjdeh Valley or Koosh Valley, stated to a press representative that Dr. Aitchison, who has charge of the botany of the Expedition, is delighted with the country, and has made a very large and valuable collection.

THE *Times* Calcutta Correspondent telegraphs that the Indian Government has at last begun to fulfil a promise made years ago to the Asiatic Society, that a systematic zoological exploration of the depths of the Indian seas should be undertaken, in connection with a survey of the coasts. "A skilled naturalist, Dr. Giles, has been attached to the surveying steamer *Investigator*, which is supplied with proper appliances for deep-sea dredging. During a recent cruise in the Bay of Bengal some casts were made with very interesting results. Some of the animals found appear to be new, and have been sent home for examination. The dredgings also proved that the depression of the bottom, near the mouth of the Hooghly, known as the Swatch, regarding which much speculation had been indulged in, was merely a deep submarine valley, forming part of the original basin of the Bay of Bengal—as Sir Charles Lyall long ago suggested."

A PORTION of the work of Protestant missionaries in China, which has attracted little attention in this country, and which, nevertheless, is of great importance, is the preparation of school- and text-books in Chinese. For this purpose Protestant missionaries of all nationalities and denominations have united. At a general conference held in Shanghai in 1877, a committee of eight of the leading missionaries was appointed to superintend the preparation and publication of the series. The work has now been going on for eight years, and the Committee are able to report that over forty works have been issued, and that thirty more are in various stages of progress. In addition, four numbers have been issued of an "outline series" compiled with the object of supplying Chinese schools with small and simple treatises on scientific subjects at cheap rates, suitable either as elementary school-books or as popular tracts for general distribution. What "cheap rates" mean will appear from the fact that the outlines of astronomy costs rather less than a penny, that of political and physical geography and geology about twopence each. The larger works embrace anatomy, in five volumes; ancient religions and philosophies in three; arithmetic, charts of astronomy, birds and mammals, with accompanying handbooks (these charts, from the prices, are obviously intended for the walls of schools); chemistry, political economy, geology, universal history, international law (a translation of Bluntschli, it appears), zoology, and several on biblical topics. Those in preparation include treatises on various branches of elementary mathematics, botany, ethnology, hygiene, jurisprudence, logic, mathematical physics, meteorology, mineralogy, philology, and forty wall-charts with accompanying hand-books. These works, it must be remembered, have first to be compiled with a special view to the knowledge usually possessed by Chinese children, and then to be translated, representing in each case two distinct tasks. That the missionaries in China and elsewhere have schools where they teach the young is well known, but it will probably be a surprise to many to find that, in addition to their ordinary labours as preachers and teachers, the missionaries in China have had to undertake a task of such magnitude as the creation of school literature on all subjects of human knowledge, from arithmetic to jurisprudence, and from anatomy to logic. The statement on this subject is taken, it should be added, from the *Chinese Recorder* of Shanghai, a magazine which is itself a monument to the learning and enterprise of Protestant missionaries in China.

THERE will be an Exhibition of Plans, Maps, and Models in connection with the International Congress on Inland Navigation to be held in Brussels from May 24 to June 2. Those desiring to contribute are requested to send in their exhibits at once, addressed, carriage-free, to Mr. A. Gobert, 212, Rue de la Victoire, Brussels.

AN interesting scheme in connection with the Bedford School is that of higher education for adults by means of evening lectures on literary and scientific subjects, at nominal fees. The lecturers are drawn for the most part from the staff of Bedford School. Among the scientific subjects included in the course are mathematics, geology, physical geography, and botany. Bedford is fortunate in having amongst its residents men qualified and willing to organise and carry out an excellent plan of this nature for its benefit.

THE British Consul at Leghorn in his report for the past year makes some interesting observations on coral in the Mediterranean. Some centuries back the Mediterranean coral fisheries were carried on exclusively by the Spaniards, and the principal establishments engaged in the manufacture of coral ornaments were in the hands of Jews residing in Spain. Towards the close of the sixteenth century, to escape the persecutions to which they were exposed, a large number of these merchants removed to Leghorn, in order to enjoy the secure asylum afforded by the liberal enactments of Ferdinando di Medici. Crews were obtained from the Neapolitan coast, principally from Torre del Greco; hence this place at an early period became the chief seat of the coral fishery, and most of the boats engaged in it are still fitted out at that port, although the manufacture of coral ornaments and beads is carried on principally at Leghorn and Genoa. These ornaments are met with in almost every part of the world, and in many countries, even in Europe, coral is believed to be possessed of a peculiar charm. In Asia and Africa it is regarded with a sort of religious veneration, while in India it is largely used for the adornment of corpses when prepared for cremation. But the present situation of the coral trade is disastrous. In 1880, a coral bank several kilometres in length was discovered near the island of Sciacca, on the coast of Sicily, and consequently the yield of raw material has been far in excess of the demand, and the reef is still very far from being exhausted. A great depreciation in value has ensued, and as a consequence an extensive trade has sprung up in coral with Africa, where the natives now purchase coral ornaments in place of glass beads of Venetian and German manufacture. The raw coral comes from Naples, and is worked at Leghorn by women into beads, British India and Egypt being the chief customers for them.

ON April 24 Mr. Edward Berdoe, M.R.C.S., read a paper at University College, Gower Street, before the Browning Society, on "Browning as a Scientific Poet." The paper, as reported in the *Lancet*, opened with an exhaustive argument to prove that the progress of science need not, as some had said, tend to the destruction of the poetic art; that, in fact, some of the greatest poets had enriched their verse by the study of natural phenomena—Lucretius, Haller, Milton, and Goethe, and in our own times Tennyson and Browning, while students of natural and physical science had not found their exact acquaintance with natural laws impede the luxuriant growth of their poetic fancy. Many of Browning's most beautiful similes were the result of his intimate acquaintance with anatomy, physiology, and chemistry; and the use he constantly makes of figures drawn from the science of optics has enabled him to illustrate his favourite optimism by much beautiful imagery. The poet of the future will be denied his former "power of dealing capriciously with facts," but this restraint, Mr. Berdoe argued, would not repress the poetic spirit. Mr. Berdoe, in conclusion, claimed for Mr. Browning that he is essentially the poet for the scientific man: abreast of the highest culture of his time, and in close touch with the great aims of science.

HERR SCHWEIGER, writing from Widdin to the *Monatsschrift für den Orient*, refers to baldness amongst Orientals. In Europe the idea is general that baldness is the prerogative of scholars; in the East, on the other hand, it is the common characteristic of two races—the Spanish Jews and the Turks, whose nervous system has never been overwrought by any devotion to serious studies. In some measure to explain the origin of this phenomenon we must commence at the cradles of the two peoples living side by side. The indolence of Oriental women is well known and is manifested in sins of omission rather than of commission. The Oriental mother neglects the principal duties to her offspring. During the first eight days of its earthly career the infant is sprinkled with a little tepid water once a day by some old woman, then wrapped in coloured rags to save the trouble of frequent changes, the head being wrapped in a well-wadded cap tied under the chin. This process is repeated during the succeeding weeks once every two days, until finally it has become too toilsome even for this repetition, and is abandoned altogether, through fear, it is said, that the child would catch cold from frequent washings. Superstition has added its force to laziness, for the women believe that the head of an infant should never be washed, as the scab produced by the dirt is good for the eyes. This dirt, mixed with the secretions from the sebaceous and other glands, becomes the home of numerous animal and vegetable parasites, which prevent the development of hair and destroy that already grown. The open air, which might assist in destroying these parasites, is, however, carefully excluded by the custom which is imperative among Semitic peoples of never, by day or night, or upon any occasion whatsoever, taking off the head-covering. At night the fez is changed for a linen cap of similar shape. This perpetual covering naturally retards the growth of the hair, and transmission and propagation do their work. Herr Schweiger, who has lived in the East for many years, first noticed chronic baldness amongst the lower classes of the Turks, especially the so-called Spaniols of Salonica.

THE National Fish Culture Association's hatchery at South Kensington is now gradually becoming depleted of fry, which are being transmitted to public waters gratuitously, and to the fishery at Delaford belonging to the Association. The spawning and hatching season has been very prosperous and successful, there being but a very low minimum mortality amongst the fish produced.

THE Aquarium at the International Inventions Exhibition is assuming a more complete aspect, and has been an attractive feature with visitors from the first. An Aquarium Handbook is now in the press and will be shortly published by Messrs. Clowes and Sons, containing a natural history of the fish in captivity and a series of articles upon the culture of fish, the management of aquaria, &c.

ON April 22 a meteor was seen descending in a straight line from the zenith at Fogelsta railway station in Östergötland, Sweden, and fall some distance off. On the station-master proceeding to the spot he found a stone, about the size of a hand, and brown in colour, which smelt strongly of phosphorus when struck against a hard object. It was split into three pieces, each being forwarded to a museum.

THE *Calcutta Gazette* has published a resolution of the Government directing the institution of an inquiry, under a specially selected officer, into the castes and occupations of the people of Bengal. The results of this inquiry should be of great ethnographical value.

THE exceptionally heavy rainfall at Bergen on October 25, 1884, when 74 mm. were registered for the twenty-four hours, was commented on at the time by the Scandinavian press as affording confirmatory evidence of the truth of the popular opinion that this town is the rainiest place in Norway. This notion, however, like many other traditional beliefs, has been dissipated by the test of carefully-conducted scientific observations, for we learn from *Naturen* that the annual mean of its rainfall is exceeded by that of two among the other seventy Norwegian meteorological stations. Thus while at Bergen 1722 mm. are measured annually, the rainfall at Domsten and Florö amounts respectively to 1951 mm. and 1873 mm. It has further been shown that 105 mm. rain were registered at Holmedal on the Söndfjord, on the same day that the rainfall at Bergen reached 74 mm., the highest recorded since rain-measurements have been made there. There are in fact eighteen instances given by the meteorological reports in which the rainfall has elsewhere exceeded the latter measure. Among these the most remarkable have been supplied by Ullensvang and Flesje, at the former of which stations there fell in one day (December 8, 1884) 113 mm. rain, while at the latter 112 mm. were registered for the twenty-four hours on March 15, 1882. These downfalls, the highest recorded in Norway since the observations were begun in 1875, have been exceeded, according to Dr. Hamberg of Stockholm, at the Swedish station of Hernösand, where 118·5 mm. rain fell on August 19, 1878. Facts such as these effectually refute the opinion, alike strenuously maintained by natives and foreigners, that more rain falls at Bergen both in the year and in the course of one day than at any other place in Scandinavia. Such, however, is the character of the annual distribution of rain in this locality, that the chances are about equally in favour of a wet or a dry day.

In reporting to the Empress of China the occurrence of a violent earthquake at the town of Pu-erh on November 14 last year, the Viceroy of Yunnan observes with humility that this awful visitation is to be regarded as a penalty of Heaven for his own inefficiency and incompetency and that of his staff. They will, the memorialist promises, endeavour to take the lesson to heart and earnestly amend their ways. Pu-erh will be remembered by readers of Mr. Colquhoun's "Across Chrysê" as an important town on the borders of the Shan States, with a large trade in tea. The earthquake here referred to is also worth notice as showing that seismic activity during the past winter was manifested over a vast area, and indeed seems to have affected the greater part of the Old World. At Pu-erh the shock lasted an hour, causing the collapse of a large number of houses, temples, and public buildings, while many lives were lost, and much injury was caused to the inhabitants.

M. Léo Errera calls attention in the *Bulletin Scientifique du Département du Nord* to the value of Indian ink, on account of its harmlessness and its intense coloration, for the study of certain microscopic organisms. He has succeeded in keeping infusoria, &c., alive for several days in the liquid, the carbonic matter not appearing to affect them in the slightest degree. For making durable preparations ink diluted with water should be gradually replaced by that diluted with glycerine. Many organisms which are distinguished with difficulty in water, are easily observed in water charged with Indian ink; this is especially the case with many *Algæ*. M. Errera thinks that this new method could probably be applied with advantage to the study of the digestion of the infusoria, and to the movements of ciliated organisms.

The additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, presented by Mrs. Wall; a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Miss Margaret Ellis; a Getulen Gronnd-Squirrel (*Xerus getulus*) from North-West Africa, presented by Mr. W. Cook; a Grey Ichneumon (*Herpestes griseus* ♀) from India, presented by Mrs. Dundas; two Martinican Doves (*Zenaida martinicana*) from Bahamas, presented by Mrs. Blake; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. J. G. Witte; a Dorsal Squirrel (*Sciurus hypopyrrhus*) from Central America, an Indian Mynah (*Acridotheres ginginianus*), four White-backed Pigeons (*Columba leuconota*), a Black Hill-Squirrel (*Sciurus macrurus*) from India, two Chinese Jay-Thrushes (*Garrulax chinensis*) from China, a Sun Bittern (*Eurypyga helias*) from Brazil, two Greek Partridges (*Caccabis saxatilis*), South European, a Double-banded Sand-Grouse (*Pterocles bicinctus*) from Senegal, a Talapoin Monkey (*Cercopithecus talapoin*) from West Africa, a Negro Tamarin (*Midas ursulus*), a Humboldt's Lagothrix (*Lagothrix humboldti* ♂), a Rosy-billed Duck (*Metopiana peposaca* ♀) from South America, a Viscacha (*Lagostomus trichodactylus*), a Scorpion Mud-Terrapin (*Cinosternon scorpioides*) from Buenos Ayres, a Gadwell (*Chaulelasmus strepera* ♂), nine Spotted Salamanders (*Salamandra maculosa*), European, purchased; a Crossoptilon (*Crossoptilon mantchuricum* ♂) from Northern China, received in exchange; a Gayal (*Bibos frontalis*), two Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

The Harvard College Observatory, U.S.—The thirty-ninth Annual Report of this Institution has been issued, and with it Prof. Pickering's summary of observations of variable stars in 1884, made agreeably to the plan suggested by him in a communication to the American Academy of Arts and Sciences (vol. xix. p. 296). Thirteen observers, private and professional, have co-operated in these observations, amongst them Mr. Knott, of Cuckfield, and Mr. T. W. Backhouse, of Sunderland. In the summary referred to, the positions of the stars for 1875, the limits of variation and the periods, as far as reliably determined, are repeated from the circular of last year, and these particulars are followed by a statement of the number of observations of each star, made by the various observers in the course of 1884, so that it is easy to see which objects most require attention. It is certain that in this branch of observational astronomy there is ample work for a much larger number of co-operators, which it may be hoped that Prof. Pickering will succeed in enlisting amongst our amateurs, and eventually it may be possible to particularise the objects which each one may undertake to watch effectively, so as to secure observations of the whole or the majority of the list in each year.

With regard to the general proceedings of the Harvard Observatory, it is stated that photometric observations of the eclipses of Jupiter's satellites have been continued upon the system adopted in 1878, and 284 eclipses have now been thus observed, forty-seven since the end of October, 1883. The revision of the zone-observations of stars between 50′ and 60′ north of the equator has been completed during the year. Selections of stars for standards of stellar magnitude have been made for regions extending four minutes (time) in right ascension, and ten minutes in declination, and additional photometric methods of measurement are under consideration for determining such magnitudes with satisfactory precision. Observations of comets, of the spectra and colours of stars, and a tentative revision of the magnitudes of the *Durchmusterung*, have also formed a part of the year's work. We do not learn from the report that any attempt has been made to repeat the valuable series of observations on the rings of Saturn, made by the Bonds, &c., with the Harvard 15-inch refractor, when the planet was previously situated in the position it occupied in 1884; but the class of observations more especially attended to at present may have rendered this impracticable. Vol. xiv. parts 1 and 2 of the *Annals* have been published; the latter part has been circulated very recently.

Tempel's Comet (1867 II.).—Up to the 7th inst. it does not appear that the editor of the *Astronomische Nachrichten* had received any notice of the re-observation of this comet. Doubtless, of the last degree of faintness, it could only have been commanded last month by instruments of the highest order. In the next period of absence of moonlight the theoretical brightness will have diminished. The comet will be due in perihelion again in the spring of 1892, a more favourable condition for the observation of this body than has existed in the present year.

NEW NEBULÆ.—M. Stephan publishes positions and descriptions of 100 nebulæ discovered at Marseilles in the years 1883–85, in addition to the large number previously detected at that observatory. Not the least notable characteristic of M. Stephan's catalogues is the precision of the places given in them. He mentions that on October 1 and 2, 1882, neither the nebula Dreyer-Schultz 5085 nor *h* 12 were perceptible in the positions assigned to them by the discoverers.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MAY* 17–23

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 17

Sun rises, 4h. 7m.; souths, 11h. 56m. 10·8s.; sets, 19h. 46m.; decl. on meridian, 19° 26′ N.: Sidereal Time at Sunset, 11h. 29m.

Moon (at First Quarter May 21, 6h.) rises, 6h. 59m.; souths, 14h. 53m.; sets, 22h. 44m.; decl. on meridian, 18° 7′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	3 37	10 30	17 23	9 41 N.
Venus	4 18	12 10	20 3	19 55 N.
Mars	3 24	10 36	17 48	13 13 N.
Jupiter	11 0	18 15	1 30*	13 38 N.
Saturn	5 43	13 51	21 59	22 18 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
19	α Cancri	4	22 52	23 15	48 359
21	B.A.C. 3407	6	0 21	1 12†	125 276
21	35 Sextantis	6	20 48	21 18	26 340

† Is below horizon at Greenwich.

Phenomena of Jupiter's Satellites

May	h. m.		May	h. m.	
17	23 21	II. occ. disap.	21	0 21	I. occ. disap.
19	20 28	II. tr. egr.		21 41	I. tr. ing.
20	21 33	III. occ. reap.	22	0 1	I. tr. egr.
	23 10	III. ecl. disap.		22 22	I. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

May 21, 3h.—Jupiter in conjunction with and 4° 17′ north of the Moon.

THE IRON AND STEEL INSTITUTE

THE Iron and Steel Institute met on Wednesday, the 7th inst., when Dr. Percy gave the presidential address. After inviting the co-operation of the members in supplying him with materials for the new edition of his work on "Iron and Steel," and referring to Mr. Lowthian Bell's recent valuable work on the same subject, Dr. Percy drew attention to the existing universal depression, due, in his opinion, to over-production. "Darwinianism prevails in the manufacturing world as it does in the natural world, however painful and unwelcome may be that truth—only the fittest will survive. The struggle may be severe and to many persons disastrous, but so long as supply exceeds demand, it is inevitable, and the result is not doubtful."

In the matter of technical education he regretted that a few of its professed friends should have indiscreetly attempted to imbue all our artisans with the notion that the one thing which at present they urgently need is technical education, and that it will be certain to benefit them all alike, whereas in some trades, such as that of the file-cutter, the marvellous skill which is alike the surprise and admiration of all is to be obtained only by the practice of his art. He referred with pleasure to the judicious and enlightened way in which Sir Bernhard Samuelson, M.P., had advocated technical education in its widest sense, and rejoiced over the liberality of the founders of the Owens College (now the Victoria University) in Manchester, the Mason College in Birmingham, and the Firth College in Sheffield, and of the Whitworth Scholarships, through whose aid scientific instruction is placed within the reach of the artisan class.

The major portion of the address was devoted to the physical and chemical properties of iron and steel, and the learned President's remarks brought out in strong relief the prevailing want of knowledge. How comes it, he inquires, that the force of cohesion should be increased by mechanical treatment, which, *à priori*, might be supposed would tend in greater or less degree to produce disaggregation? Why is iron or steel wire increased in strength by wire-drawing? What is the cause of the physical changes which some metals and alloys have been observed to undergo spontaneously while at rest and under ordinary atmospheric conditions?

"It is not many years since that we had to grope about to discover an analysis of iron ore or of pig iron, whereas now we are actually overwhelmed with such analyses. We are deluged with percentages of carbon, graphitic or combined, of silicon and manganese, of sulphur and phosphorus. We are bewildered by this vast accumulation of material. What is now wanted is the man to reduce it to law and order, to evolve from it principles for our sure guidance. But the problem is so intricate and complex that no common brain can solve it. What are the physical properties of pure iron after fusion? What are the chemical and physical properties of compounds of pure iron and pure silicon in various proportions? What are the modes of existence of manganese, silicon, and phosphorus when present together in pig iron? What is the *modus operandi* of manganese in the manufacture of iron and steel? Why are animal matters or certain other substances rich in nitrogen, required in case-hardening iron? Is any nitrogen or any compound of it imparted to the case-hardened part of the iron? These and such like questions the metallurgist asks of the natural philosopher and chemist, and has failed hitherto to receive a reply."

Having concluded what may be called the technical part of his address, Dr. Percy treated the question of the extent to which the Government of a country should engage in manufacture, and stated "that, if it could be shown that the people as a whole would be benefited by the Government's engaging in manufacture, then the Government was bound to take that course." Treating the various cases of armour-plates, steel for guns, and steel for ship-plates, he showed that in each case, owing to competition, co-operative management, and other causes, private industry was always able to produce articles as good as and cheaper than the Government.

The address was listened to with the greatest attention throughout, both on account of the inherent interest of the matter and the great oratorical skill employed in its delivery. The closing paragraphs are of such universal interest that we quote them verbatim:—

"Everything in this world, nay, there is reason to believe everything in the universe itself, is changing from moment to moment. There is, as I have stated in print long ago, nothing constant but change, however paradoxical that statement may appear. Every drop of rain that falls, for instance, exerts a levelling action on the hills and mountains, and carries down with it in its course to the ocean a minute yet sensible portion of earthy material. In the moral world the like incessant change is going on, and no one can predict what the final result ef that change will be. Our globe may, it seems to me, be fitly compared with the laboratory of the philosopher. The one, to our finite understandings, may appear the scene of social and political experiments, just as the other is the scene of chemical and physical experiments. But of this we may be sure, that invariable and irresistible law guides all things, immaterial as well as material. When I reflect on the intricate social problems of the day, the solution of which excites dread in the minds of many, I fancy I see the social molecules, if I may use such an expression, actively at work in rearranging and adjusting themselves to new conditions, and producing results as surprising as they are remarkable. The mysterious forces, whatever they may be, which regulate the movements of those molecules, are as certain in their operation as those which determine the course of the planets in their orbits. Both are equally uncontrollable by the agency of man, and politicians will in vain struggle against them.

"There is a question that must often occur to us, namely, what will Great Britain be when our vast reservoir of material force, coal, is exhausted—a result which many members of the Iron and Steel Institute are doing their utmost to accelerate? The time must come when, in consequence of that exhaustion, Great Britain will cease to be a great manufacturing nation, unless some new source of force should be discovered, which there is not the least reason to anticipate. But, as I wrote many years ago, however mournful and unwelcome this proposition may be, we have the satisfaction of knowing that we are now laying the foundations of prosperous and mighty kingdoms in various parts of the world, which we hope will be the strongholds of virtue, of order, and of freedom. When our great manufactories shall have crumbled into ruins, and their sites have become green pastures or golden corn-fields, the old country may yet be precious in the eyes of her children. Every spot of her soil will be classic, and command reverential respect. There is no other land more worthy of everlasting remembrance, whether as to its heroes, its poets, its philosophers, its statesmen, or its philanthropists. The glory of Old England may, after all, not depart. On the sites of her soot-stained Birminghams and Manchesters, new and splendid cities may arise, where the merchant-princes of Anglo-Saxon descent, from the remotest regions of the globe, shall rejoice to dwell and end their days in peace."

After the address the President presented the Bessemer Medal to Mr. Lowthian Bell for delivery to Prof. Äkermann, after which the papers were read. The first paper read was that of Mr. Lowthian Bell, on "The Blast-Furnace Value of Coke, from which the Products of Distillation from the Coal used in its Manufacture have been collected." The experiments which formed the foundation of the paper were made upon the same coal coked in the beehive and Simon Carvé's oven, the total quantity of coke operated upon being 5605 tons; it was found that the beehive coke was about 10 per cent. more economical, although the other was 13·83 per cent. denser. In order to ascertain the cause of the inferiority, samples were finely ground and analysed. Similar samples were exposed for half an hour to the full heat—sufficient to soften porcelain—of a gas blast-furnace, access of air being excluded by placing the crucible containing the sample within a larger one and covering it with charcoal. From the loss of weight and the analysis of the original and residual coke, and from the previously-ascertained moisture, it was found that 5·23 per cent. of the Simon Carvé's coke was expelled by ignition, and 3·27 per cent. of the beehive. This accounts for an inferiority of 1·96 per cent. only out of about 10 per cent. It is, however, a well-known fact that certain forms of carbon are less easily burnt than others, and the author sought to account for the superiority of beehive coke in this manner, and found it to be due to the less solvent action of carbonic acid upon it.

At the Wednesday evening meeting Dr. H. C. Sorby, F.R.S., gave an account of his microscopical examination of the structure of iron and steel. His results were based upon the examination of flat surfaces, carefully ground and polished, as the study of fractured surfaces is unsatisfactory, not only on account of optical difficulties, but because a fracture shows the line of weakness between the crystals and not their internal structure. In some cases the surfaces were acted upon by very dilute nitric acid to develop the structure; in others it was found best to polish with dry rouge on parchment, and not to use acid. Thin glass covers were afterwards mounted over the surface with Canada balsam. The objects thus prepared were examined by means of two special kinds of surface illumination, viz. first the side parabolic reflector now common, but which the author believes was originally made for this purpose, which gives oblique light; and secondly, by means of a small silver reflector covering half the object-glass, which throws the light directly down on the object, from which it is reflected back through the other half of the lens. With oblique illumination a polished surface looks black, but, with direct, bright and metallic. A truly black substance looks black in both cases. A magnifying power of about sixty linear is most generally suitable, but the sections will bear a higher perfectly well. The lecturer exhibited photographs and drawings of the microscopic appearance of the surfaces, the peculiarities of which he described.

The following is a summary of some of the chief results:—Iron containing little or no carbon, and of uniform character, shows little, if any change, when acted upon by dilute acid, and no well-marked structure is developed. Hammered blooms show an intimate mixture of varying crystals of iron, with minute or larger portions of slag. In iron bars rolled *hot*, the slag is drawn out into long thin rods, which in some cases are so numerous as to form a very considerable portion of the whole bulk, whilst the iron shows no elongation of the ultimate crystals, the metal apparently recrystallising on cooling. When hammered *cold*, the crystals are compressed, broken up, and elongated in the line of the bar. Many specimens of malleable iron show clearly that two constituents are present, viz. iron, and a compound of iron and carbon, which has a pearly structure; one of these is like the main constituent of such bar iron as contains little or no carbon, having no trace of linear marking, after being acted upon by dilute acid, whereas the other constituent shows linear markings, varying in distance, but often about 1-20,000th of an inch apart, which, when the acid has acted to a proper extent, gives rise to all the splendid colours of mother-of-pearl, the tints being raised when the section is seen in water, and still more so when mounted in balsam. By oblique and direct illumination the colours are nearly complementary. Swedish iron partly converted into blister steel by cementation, shows a mixture of well-formed crystals of free iron and of the pearly compound in the centre; around this a ring of the pearly compound, with colours of great variety and beauty; whilst on the outside is a part in which occurs a network of veins of an extremely hard substance, giving an intensely brilliant reflection and no trace of colour, which seems to contain more carbon than the pearly constituent. The three constituents just described are totally distinct from one another. There is no more passage from one to the other than there is between the mica, felspar, and quartz of granite.

The varying character of ingots of soft and hard steel to a great extent depends on the varying proportion of the three principal constituents. Soft Bessemer steel is seen to be a mixture of free iron and the pearly compound. In medium steel this latter occurs almost alone, whereas in hard steel there is little, if any, free iron, but numerous thin plates of the very hard compound. Besides these three constituents in steel, the microscope gives evidence in cast-iron of the presence of graphite and silicon. The specimen of spiegeleisen studied, consisted mainly of the intensely hard compound, crystallised in large plates, the inter-spaces being filled up with a mixture of very much smaller crystals with a little of the pearly substance, so as to have a most beautiful and fine-grained structure. Taken, then, as a whole, the various kinds of iron and steel are seen to be varying mixtures of three or four out of six or seven substances having very different properties, viz. free iron, the pearly compound with carbon, the intensely hard compounds, probably with more carbon; the residual, probably variable, substance; graphite; possibly crystallised silicon; slag, including fused iron oxide.

On the second day the attention of the meeting was occupied with the subject of the coking of coal by different processes and the recovery of bye-products. Mr. Head's paper contained a description of a modified form of the Siemens old type gas-producer, in which the latter result is effected by dividing the gas-producer by means of a vertical wall into two compartments, one of which receives the hydrocarbons—the volatile constituents of the coal—and the other the carbonic oxide formed by the decomposition of its solid carbonaceous matter. Two other papers referred to results obtained in connection with the Simon-Carvé's coking process. Prof. Armstrong's note with reference to the methods proposed for coking coal and recovering volatile matter has much scientific interest, and we propose to refer to it shortly. The problem consists in as complete a recovery as possible of the matters latent in coal, in the most economical manner and advantageous forms, the treatment depending upon the class of coal acted upon. The author considers the compounds in coal to be mainly of two kinds—phenolic compounds, which are the primary source of the phenols (carbolic acid, &c.) contained in coal tar; and paraffinoid compounds, capable of yielding hydrocarbons such as are obtained on distilling shale; the high-temperature tars such as are obtained at gas-works, not being primary but secondary products of distillation, may be considered final products, the quality of which it will be impossible to improve, whereas the object should be to produce low-temperature tars, which by after-treatment might be made to produce a large proportion of benzene and other valuable products.

The author's idea of a theoretically perfect coking oven is one more or less like the present beehive, with the upper part extended. Heat should be *radiated* upon the surface of the charge of coal, which would soon become coked, thus forming a protecting layer, below which distillation would take place, the products of distillation being sucked away as rapidly as possible through the cool bottom of the oven. The products of combustion which penetrate below would carry no oxygen with them. On this account, and on account of the large volume of steam and other gases generated within the mass, and of the low temperature, the ammonia would probably almost entirely escape destruction. The gas would be of low illuminating quality, but would be available for carbonising, oil and ammonia being removed from it by efficient scrubbing. The author was of opinion that nothing was known practically of what happens when coal is distilled, and that the coking of coals and manufacture of gas were now only empirical operations, and could not be conducted scientifically, with our present imperfect knowledge, but that the interests involved were so great, the subject being one of national importance, that failure to initiate and execute the necessary systematic experiments without further loss of time would be inexcusable.

On the last day of the meeting Mr. Carnegie's paper on "Natural Gas Fuel and its Application to Manufacturing Purposes" was read. This fuel is found in the Pittsburg district, and one of the wells is estimated as yielding 30,000,000 cubic feet of gas in the twenty-four hours; the pressure of the gas as it issues from the mouth of the well is about 200 lbs. to the square inch, and even at the works, nine miles from the wells, it is 75 lbs. per square inch. Eleven lines of pipe convey the gas from the various wells to the manufacturing establishments in and around Pittsburg. The number of men whose labour will be dispensed with when gas is generally used is 5000. In the steel-rail mills, for instance, where before would have been seen thirty stokers, stripped to the waist, firing boilers which require a supply of about 400 tons of coal in twenty-four hours—ninety firemen in all being employed, each working eight hours—there would now be found one man walking around the boiler-house, simply watching the water-gauges, and not a particle of smoke is to be seen.

Dr. Hermann Wedding's paper on "The Properties of Malleable Iron deduced from its Microscopic Structure" draws attention to the value of microscopic analysis, as, though the chemical and physical properties of iron are closely connected, the one cannot be directly deduced from a knowledge of the other, nor do either of these aid in acquiring a knowledge of the mechanical properties. The pieces of iron to be tested are carefully polished, and then etched with very dilute nitric acid. After etching, the section is carefully heated, whereupon the portions attacked acquire varying tints, mostly golden-yellow, purple-red, violet, or dark blue. It is the difference of colour that is characteristic. As regards the formation of grains and fibres, the size of grain increases with slowness of cooling, and decreases with increase in the proportion of carbon up to 2 per cent. Each individual grain in malleable iron is ductile, the malleability of the entire piece depending on that of the separate grains, which are drawn out into fibres; the strength of fibrous iron depending on the fact that, like the individual hemp-fibres in a rope, the fibres lie with their ends in various sections. The microscope shows, further, that none of these wires or fibres is directly connected with its neighbours, either in a longitudinal or lateral direction. In fact each fibre may, by careful etching, be picked out like those of a muscle in the human body. The paper treats also of the constitution of individual iron crystals and of welding. The general result of the analysis shows that the strength of a finished piece of iron depends on the sectional area of the mass of iron it contains, the slag inclusions in weld-iron and blow-holes in ingot-iron being deducted.

It was announced that the autumn meeting of the Institute would be held at Glasgow.

SUNLIGHT AND THE EARTH'S ATMOSPHERE[1]

II.

We have been compared to creatures living at the bottom of the sea who frame their deceptive traditional notions of what the sun is like from the feeble changed rays which sift down to them. Though such creatures could not rise to the surface, they might swim up towards it, and if these rays grew hotter, brighter, and bluer as they ascended, it would be almost within the capacity of a fish's mind to guess that they are still brighter and bluer at the top.

Since we children of the earth, while dwelling on it, are always at the bottom of a sea, though of another sort, the most direct method of proof I spoke of, is merely to goup as far as we can and observe what happens, though as we are men, and not fishes, something more may fairly be expected of our intelligence than of theirs.

We will not only guess, but measure and reason, and in particular we will first, while still at the bottom of the mountain, draw the light and heat out into a spectrum, and analyse every part of it by some method that will enable us to explore the invisible as well as record the visible. Then we will ascend many miles into the air, meeting the rays on the way down, before the sifting process has done its whole work, and there analyse the light all over again, so as to be able to learn the different proportions in which the different rays have been absorbed, and, by studying the action on each separate ray, to prove the state of things which must have existed before this sifting—this selective absorption—began.

It may seem at first that we cannot ascend far enough to do much good, since the surface of our aërial ocean is hundreds of miles overhead; but we must remember that the air grows thinner as we ascend, the lower atmosphere being so much denser, that about one-half the whole substance or mass of it lies within the first four miles, which is a less height than the tops of some mountains. Every high mountain, however, will not do, for ours must not only be very high, but very steep, so that the station we choose at the bottom may be almost under the station we are afterwards to occupy at the top.

Besides we are not going to climb a lofty lonely summit like tourists to spend an hour, but to spend weeks; so that we must have fire and shelter, and above all we must have dry air to get clear skies. First I thought of the Peak of Teneriffe, but afterwards some point in the territories of the United States seemed preferable, particularly as the Government offered to give the Expedition, through the Signal Service, and under the direction of its head, General Hazen, material help in transportation and a military escort, if needed, any where in its own dominions. No summit in the eastern part of the United States rises much over 7000 feet, and though the great Rocky Mountains reach double this, their tops are the home of fog and mist, so that the desired conditions, if met at all, could only be found on the other side of the Continent in Southern California, where the summits of the Sierra Nevadas rise precipitously out of the dry air of the great wastes in lonely peaks, which look eastward down from a height of nearly 15,000 feet upon the desert lands.

This remote region was, at the time I speak of, almost unexplored, and its highest peak, Mount Whitney, had been but once or twice ascended, but was represented to be all we desired could we once climb it. As there was great doubt whether our apparatus, weighing several thousand pounds, could possibly be taken to the top, and we had to travel 3000 miles even to get where the chief difficulties would begin, and make a desert journey of 150 miles after leaving the cars, it may be asked why we committed ourselves to such an immense journey to face such unknown risks of failure. The answer must be that mountains of easy ascent and 15,000 feet high are not to be found at our doors, and that these risks were involved in the nature of our novel experiment, so that we started out from no love of mere adventure, but from necessity, much into the unknown. The liberality of a citizen of Pittsburgh, to whose encouragement the enterprise was due, had furnished the costly and delicate apparatus for the expedition, and that of the trans-continental railroads, enabled us to take this precious freight along in a private car, which carried a kitchen, a steward, a cook, and an ample larder besides.

In this we crossed the entire continent from ocean to ocean, stopped at San Francisco for the military escort, went 300 miles south so as to get below the mountains, and then turned eastward again on to the desert, with the Sierras to the north of us, after a journey which would have been unalloyed pleasure except for the anticipation of what was coming as soon as we left our car. I do not indeed know that one feels the triumphs of civilisation over the opposing forces of Nature anywhere more than by the sharp contrasts which the marvellous luxury of recent railroad accommodation gives to the life of the desert. When one is in the centre of one of the great barren regions of the globe, and, after looking out from the windows of the flying train on its scorched wastes for lonely leagues of habitless desolation, turns to his well-furnished dinner-table, and the fruit and ices of his desert, he need not envy the heroes of Oriental story who were carried across dreadful solitudes in a single night on the backs of flying genii. Ours brought us over 3000 miles to the Mojave desert. It was growing hotter and hotter when the train stopped in the midst of vast sandwastes a little after midnight. Roused from our sleep, we stepped on to the brown sand and saw our luxurious car roll away in the distance, experiencing a transition from the conditions of civilisation to those almost of barbarism, as sharp as could well be imagined. We

[1] Lecture delivered at the Royal Institution, April 17, 1885, by S. P. Langley. Communicated by the author. Continued from p. 20.

commenced our slow toil northward with a thermometer at 110° in the shade, if any shade there be in the shadeless desert, which seemed to be chiefly inhabited by rattlesnakes of an ashen gray colour, and a peculiarly venomous bite. There is no water save at the rarest intervals, and the soil at a distance seems as though strewed with sheets of salt, which aids the delusive show of the mirage. These are, in fact, the ancient beds of dried-up salt lakes or dead seas, some of them being below the level of the ocean; and such a one on our right, though only about twenty miles wide, has earned the name of "Death Valley," from the number of human beings who have perished in it. Formerly an emigrant train, when emigrants crossed the Continent in caravans, had passed through the great Arizona deserts in safety until after their half-year's journey, their eyes were gladdened by the snowy peaks of the Sierras looking delusively near. The goal of their long toil seemed before them; only this one more valley lay between, and into this they descended, thinking to cross it in a day—but they never crossed it. Afterwards the long line of wagons was found with the skeletons of the animals in the harness, and by them those of men, women, and little children dead of thirst, and some relics of the tragedy remained at the time of our journey. I cite this as an indirect evidence of the phenomenal dryness of the region—a dryness which, so far, served our object, which was, in part, to get rid as much as possible of that water-vapour which is so well known to be a powerful absorber of the solar heat.

Everything has an end, and so had that journey, which finally brought us to the goal of our long travel, at the foot of the highest peak of the Sierras, Mount Whitney, which rose above us in tremendous precipices, that looked hopelessly insurmountable and wonderfully near. The whole savage mountain region in its slow rises from the west, and its descent to the desert plains in the east, is more like the chain called the Apennines, in the moon, than anything I know on the earth. The summits are jagged peaks like Alpine "needles," looking in the thin air so delusively near, that, coming on such a scene unprepared, one would almost say they were large grey stones a few fields off, with an occasional little white patch on the top, that might be a handkerchief or a sheet of paper dropped there. But the telescope showed that the seeming stones were of the height of many Snowdons piled on one another, and the white patches occasional snow-fields, looking how invitingly cool, from the torrid heat of the desert, where we were encamped by a little rivulet that ran down from some unseen ice-lake in that upper air. Here we pitched our tents and fell to work (for you remember we must have two stations, a low and a high one, to compare the results), and here we laboured three weeks in almost intolerable heat, the instruments having to be constantly swept clear of the red desert dust which the hot wind brought. Close by these tents a thermometer covered by a single sheet of glass, and surrounded by wool, rose to 237° in the sun, and sometimes in the tent, which was darkened for the study of separate rays, the heat was absolutely beyond human endurance. Finally, our apparatus was taken apart and packed in small pieces on the backs of mules, who were to carry it by a ten days' journey through the mountains to the other side of the rocky wall which, though only ten or twelve miles distant, arose miles above our heads; and, leaving these mule trains to go with the escort by this longer route, I started with a guide by a nearer way to those white gleams in the upper skies, that had daily tantalised us below in the desert with suggestions of delicious, unattainable cold. That desert sun had tanned our faces to a leather-like brown, and the change to the cooler air as we ascended was at first delightful. At an altitude of 5000 feet we came to a wretched band of nearly naked savages, crouched around their camp-fire, and at 6000 found the first scattered trees; and here the feeble suggestion of a path stopped, and we descended a ravine to the bed of a mountain stream, up which we forced our way, cutting through the fallen trees with an axe, fighting for every foot of advance, and finally passing what seemed impassable. It was interesting to speculate as to the fate of our siderostat mirrors and other precious freight, now somewhere on a similar road, but quite useless. We were committed now, and had to make the best of it—and, besides, I had begun to have my attention directed to a more personal subject. This was, that the colder it grew the more the sun burnt the skin—quite literally burnt, I may say, so that by the end of the third day my face and hands, case-hardened, as I thought, in the desert, began to look as if they had been seared with red-hot irons, here in the cold where the thermometer had fallen to freezing at night; and still as we ascended the paradoxical effect increased: the colder it grew about us, the hotter the sun blazed above.

We have all heard probably of this curious effect of burning in the midst of cold, and some of us may have experienced it in the Alps, where it may be aided by reflection from the snow, which we did not have about us at any time except in scattered patches, but here by the end of the fourth day my face was scarcely recognisable, and it almost seemed as though sunbeams up here were different things, and contained something which the air filters out before they reach us in our customary abodes. Radiation here is increased by the absence of water vapour too, and on the whole this intimate personal experience fell in almost too well with our anticipations that the air is an even more elaborate trap to catch the sunbeams than had been surmised, and that this effect of selective absorption and radiation was intimately connected with that change of the primal energies and primal colour of the sun which we had climbed towards it to study.

On the fourth day, after break-neck ascents and descents, we finally ascended by a ravine, down which leaped a cataract, till, at nightfall, we reached our upper camp, which was pitched by a little lake, one of the sources of the water-fall, at a height of about 12,000 feet, but where we seemed in the bottom of a valley, nearly surrounded as we were by an amphitheatre of rocky walls which rose perpendicularly to the height of Gibraltar from the sea, and cut off all view of the desert below or even of the peak above us.

The air was wonderfully clear, so that the sun set in a yellow rather than an orange sky, which was reflected in the little ice-rimmed lakes and from occasional snow-fields on the distant waste of lonely mountain summits on the west.

The mule train sent off before by another route, had not arrived when we got to the mountain camp, and we realised that we were far from the appliances of civilisation by our inability to learn about our chief apparatus, for here, without post or telegraph, we were as completely cut off from all knowledge of what might be going on with it in the next mountain ravine as a ship at sea is of the fate of a vessel that sailed before from the same port. During the enforced idleness we ascended the peak nearly 3000 feet above us, with our lighter apparatus, leaving the question of the ultimate use of the heavy ones to be settled later. There seemed little prospect of carrying it up, as we climbed where the granite walls had been split by the earthquakes, letting a stream of great rocks, like a stone river, flow down through the interstices by which we ascended, and, in fact, the heavier apparatus was not carried above the mountain camp.

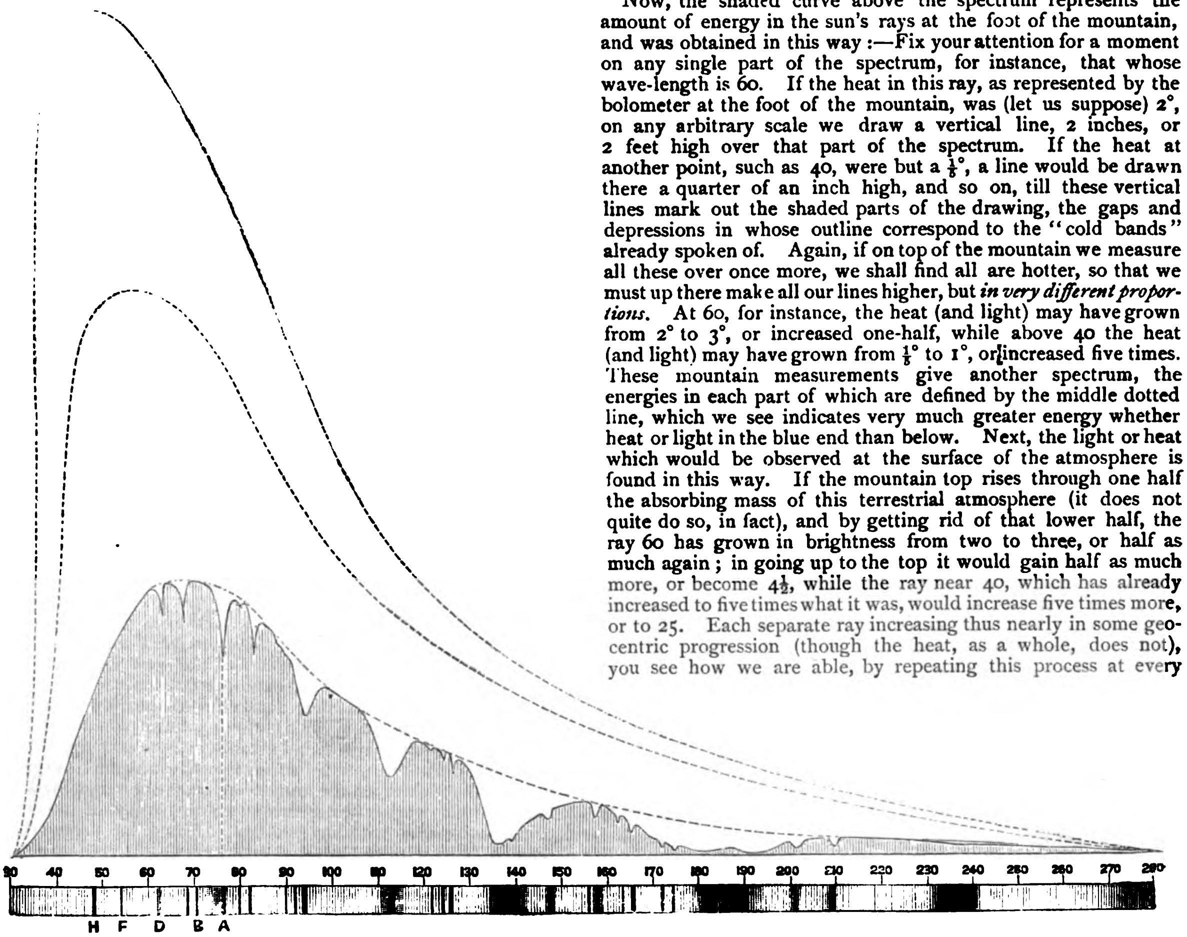
The view from the very summit was over numberless peaks on the west to an horizon fifty miles away, of unknown mountain-tops, for, with the exception of the vast ridge of Mount Tyndall, and one or two less conspicuous ones, these summits are not known to fame, and, wonderful as the view may be, all the charm of association with human interest which we find in the mountain landscape of older lands is here lacking.

It was impossible not to be impressed with the savage solitude of this desert of the upper air, and our remoteness from man and his works, but I turned to the study of the special things connected with my mission. Down far below the air seemed filled with reddish dust that looked like an ocean. This dust is really present everywhere (I have found it in the clear air of Etna), and though we do not realise its presence in looking up through it, to one who looks down on it, the dwellers on the earth seem indeed like creatures at the bottom of a troubled ocean. We had certainly risen towards the surface, for about us the air was of exquisite purity, and above us the sky was of such a deep violet blue, as I have never seen in Egypt or Sicily, and yet even this was not absolutely pure, for, separately invisible, the existence of fine particles could yet be inferred from their action on the light near the sun's edge, so that even here we had not got absolutely above that dust shell which seems to encircle our whole planet. But we certainly felt ourselves not only in an upper, but a different region. We were on the ridge of the continent, and the winds which tore by had little in common with the air below, and were bearing past us (according to the geologists) dust which had once formed part of the soil of China, and been carried across the Pacific Ocean; for here we were lifted into the great encircling currents of the globe, and, "near to the sun in lonely lands," were in the right conditions to study the differences between his rays at the surface and at the bottom of that turbid sea where we had left the rest of mankind. We descended the peak and hailed with joy the first arrival of our mule trains with the requisite apparatus at the mountain camp, and found that it had suffered less than might be expected, considering the pathless character of the wilderness. We went to work to build piers and mount telescopes and siderostats, in the scene shown by the next illustration on the screen, taken from a sketch of my own, where these rocks in the immediate foreground rise to thrice the height of St. Paul's. We suffered from cold (the ice forming 3 inches deep in the tents at night) and from mountain sickness, but we were too busy to pay much attention to bodily comfort, and worked with desperate energy to utilise the remaining autumn days, which were all too short.

Here, as below, the sunlight entered a darkened tent, and was spread into a spectrum, which was explored throughout by the bolometer, measuring, on the same separate rays which we had studied below in the desert, all of which were different up here, all having grown stronger, but in very different proportions. On the screen is the spectrum as seen in the desert, drawn on a conventional scale, neither prismatic nor normal, but such that the intensity of the energy shall be the same in each part, as it is represented here by these equal perpendiculars in every colour. Fix your attention on these three as types, and you will see better what we found on the mountain, and what we inferred as to the state of things still higher up, at the surface of the aëreal sea.

You will obtain, perhaps, a clearer idea, however, from the following statement, where I use, not the exact figures used in calculation, but round numbers, to illustrate the process employed. I may premise that the visible spectrum extends from H (in the extreme blue) to A (in the deepest red), or from near 40 (the ray of forty one hundredth thousandths of a millimetre in wave-length) to near 80. All below 80, to the right, is the invisible infra-red spectrum.

Now, the shaded curve above the spectrum represents the amount of energy in the sun's rays at the foot of the mountain, and was obtained in this way:—Fix your attention for a moment on any single part of the spectrum, for instance, that whose wave-length is 60. If the heat in this ray, as represented by the bolometer at the foot of the mountain, was (let us suppose) 2°, on any arbitrary scale we draw a vertical line, 2 inches, or 2 feet high over that part of the spectrum. If the heat at another point, such as 40, were but a $\frac{1}{5}$°, a line would be drawn there a quarter of an inch high, and so on, till these vertical lines mark out the shaded parts of the drawing, the gaps and depressions in whose outline correspond to the "cold bands" already spoken of. Again, if on top of the mountain we measure all these over once more, we shall find all are hotter, so that we must up there make all our lines higher, but *in very different proportions*. At 60, for instance, the heat (and light) may have grown from 2° to 3°, or increased one-half, while above 40 the heat (and light) may have grown from $\frac{1}{5}$° to 1°, or increased five times. These mountain measurements give another spectrum, the energies in each part of which are defined by the middle dotted line, which we see indicates very much greater energy whether heat or light in the blue end than below. Next, the light or heat which would be observed at the surface of the atmosphere is found in this way. If the mountain top rises through one half the absorbing mass of this terrestrial atmosphere (it does not quite do so, in fact), and by getting rid of that lower half, the ray 60 has grown in brightness from two to three, or half as much again; in going up to the top it would gain half as much more, or become $4\frac{1}{2}$, while the ray near 40, which has already increased to five times what it was, would increase five times more, or to 25. Each separate ray increasing thus nearly in some geocentric progression (though the heat, as a whole, does not), you see how we are able, by repeating this process at every point, to build up our outer or highest curve, which represents the light and heat at the surface of the atmosphere. These have grown out of all proportion at the blue end, as you see by the outer dotted curve, and now we have attained, by actual measurement, that evidence which we sought, and by thus reproducing the spectrum outside the atmosphere, and then recombining the colours by like methods to those you have seen on the screen, we finally get the true colour of the sun, which tends, broadly speaking, to blue.



Distribution of Solar Energy at Sea-level and at various Altitudes.

It is so seldom that the physical investigator meets any novel fact quite unawares, or finds anything except that in the field where he is seeking, that he must count it an unusual experience to come unexpectedly on even the smallest discovery. This experience I had on one of the last days of work on the spectrum on the mountain. I was engaged in exploring that great invisible heat region, still but so partially known, or, rather, I was mapping in that great "dark continent" of the spectrum, and by the aid of the exquisite sky and the new instrument (the bolometer) found I could carry the survey further than any had been before. I substituted the prism for the grating, and measured on in that unknown region till I had passed the Ultima Thule of previous travellers, and finally came to what seemed the very end of the invisible heat spectrum beyond what had previously been known. This was in itself a return for much trouble, and I was about rising from my task when it occurred to me to advance the bolometer still farther, and I shall not forget the surprise and emotion with which I found new and yet unrecognised regions below,—a new invisible spectrum beyond the farthest limits of the old one.

I will anticipate here by saying that after we got down to lower earth again the explorations and mapping of this new region was continued. The amount of solar energy included in this new extension of the invisible region is much less than that of the visible spectrum, while its length upon the wave-length scale is equal to all that previously known, visible and invisible, as you will see better by this view, saving the same thing on the normal as well as the prismatic scale. If it be asked which of these is correct, the answer is "both of them." Both rightly interpreted mean just the same thing, but in the lower one we can more conveniently compare the ground of the researches of others with these. These great gaps I was at first in doubt about, but more recent researches at Alleghany make it probable that they are caused by absorption in our own atmosphere, and not in that of the sun.

We would gladly have stayed longer, in spite of physical discomfort, but the formidable descent and the ensuing desert journey were before us, and certainly the reign of perpetual winter around us grew as hard to bear as the heats of the desert summer had been. On September 10 we sent our instruments and the escort back by the former route, and, ourselves unencumbered, started on the adventurous descent of the eastern precipices by a downward climb, which, if successful, would carry us to the plains in a single day. I at least shall never forget that day, nor the scenery of more than Alpine grandeur which we passed in our descent, after first climbing by frozen lakes in the northern shadow of the great peak, till we crossed the eastern ridges, through a door so narrow that only one could pass it at a time, by clinging with hands and feet as he swung round the shoulder of the rocks—to find that he had passed in a single minute from the view of winter to summer, the prospect of the snowy peaks behind shut out, and instantly exchanged for that below of the glowing valley and the little oasis where the tents of the lower camp were still pitched, the tents themselves invisible, but the oasis looking like a green scarf dropped on the broad floor of the desert. We climbed still downward by scenery unique in my recollection. This view of the ravine on the screen is little more than a memorandum made by one of the party in a few minutes' halt part-way down, as we followed the ice-stream between the tremendous walls of the defile which rose 2000 feet, and between which we still descended, till, toward night, the ice-brook had grown into a mountain torrent, and, looking up the long vista of our day's descent, we saw it terminated by the Peak of Whitney, once more lonely in the fading light of the upper sky.

This site, in some respects unequalled for a physical observatory, is likely, I am glad to say, to be utilised, the President of the United States having, on the proper representation of its value to science, ordered the reservation for such purposes of an area of 100 square miles about and inclusive of Mount Whitney.

There is little more to add about the journey back to civilisation, where we began to gather the results of our observation, and to reduce them—to smelt, so to speak, the metal from the ore we had brought home—a slow but necessary process, which has occupied a large part of two years.

The results stated in the broadest way mean that the sun is blue—but mean a great deal more than that; this blueness in itself being perhaps a curious fact only, but in what it implies, of practical moment.

We deduce in connection with it a new value of the solar heat, so far altering the old estimates that we now find it capable of melting a shell of ice sixty yards thick annually over the whole earth, or, what may seem more intelligible on its practical bearings, of exerting over one-horse power for each square yard of the normally exposed surface. We have studied the distribution of this heat in a spectrum whose limits on the normal scale our explorations have carried to an extent of rather more than twice what was previously known, and we have found that the total loss by absorption from atmosphere is nearly double what has been heretofore supposed.

We have found it probable that the human race owes its existence and preservation even more to the heatstoring action of the atmosphere than has been believed.

The direct determination of the effect of water-vapour in this did not come within our scope; but that the importance of the blanketing action of our atmospheric constituents has been in no way overstated, may be inferred when I add that we have found by our experiments that if the planet were allowed to radiate freely into space without any protecting veil, its sunlit surface would probably fall, even in the tropics, below the temperature of freezing mercury.

I will not go on enumerating the results of these investigations, but they all flow from the fact, which they in turn confirm, that this apparently limpid sea above our heads, and about us, is carrying on a wonderfully intricate work on the sunbeam, and on the heat returned from the soil, picking out selected parts in hundreds of places, sorting out incessantly at a task which would keep the sorting demons of Maxwell busy, and as one result, changing the sunbeam on its way down to us in the way we have seen.

I have alluded to the practical utilities of these researches, but practical or not, I hope we may feel that such facts as we have been considering about sunlight and the earth's atmosphere may be stones useful in the future edifice of science, and that if not in our own hands then in those of others, when our day is over, they may find the best justification for the trouble of their search, in the fact that they prove of some use to man.

May I add an expression of my personal gratification in the opportunity with which you have honoured me of bringing these researches before the Royal Institution, and of my thanks for the kindness with which you have associated yourselves for an hour, in retrospect at least, with that climb toward the stars which we have made together, to find, from light in its fullness, what unsuspected agencies are at work to produce for us the light of common day.

ZOOLOGICAL RESEARCH[1]

THE *Vettor Pisani* is soon expected in our port, on her return from a long voyage of no little scientific importance. We think we cannot better hail her arrival than by publishing that portion of Prof. Dohrn's report in which he speaks of the scientific mission fulfilled by this vessel—a mission which, besides meeting with a success far surpassing the highest expectations, has redounded not a little to the benefit of our "Stazione Zoologica."

The time has now arrived, writes the illustrious Professor, for me to speak of an event which took place towards the end of 1881, and which has since borne no inconsiderable fruit. And this, in its turn, takes me back to a conversation which I had in 1878 with the Italian Minister of Marine. I had already proposed that, instead of sending out a young naturalist on board the frigates which sail around the world, a young naval officer should be sent to the "Stazione Zoologica," where, in about four months, he might pick up so much knowledge as would enable him to collect and preserve specimens of marine animals. Owing to a change in the Ministry, my proposition, though accepted in the main, was forgotten; and I only succeeded in getting it put into execution in 1881.

On December 27, 1881, a young naval lieutenant, Signor Gaetano Chierchia, a Neapolitan by birth, introduced himself to me with these words: "I have been sent by the Ministry to learn under your direction at the 'Stazione Zoologica' how to collect and preserve specimens of marine animals. I present myself accordingly, and beg to be allowed to begin work at once." These few words, modest, yet full of energy, made a deep impression on me; for they not only marked the beginning of a new epoch in the active life of the Zoological Station, but also promised a more intimate connection between it and the officers of the Italian navy—an intimacy to which I had looked forward from the very day in which I conceived the idea of the future floating Zoological Station.

With the same modest energy which characterised his first interview with me, Signor Chierchia continued for four months his studies under the special direction of the Curator, Salvatore Lobianco; and all the employes and naturalists of the Zoological Station were astounded at the rapid progress he made in a field so entirely new to him. And when the moment came for establishing my laboratory on board the corvette *Vettor Pisani* (which came most appositely to Naples), and there had been put on board all the fishing apparatus, chemical reagents, alcohol, glass vessels, &c., we accompanied him as a dear friend, and looked forward to results which should mark a distinct advance in the culture of our science. And our expectations, far from being disappointed, were widely surpassed. After only five months there arrived the first consignment—the product of deep-sea work, of dredging and coast-fishery along the shores of Gibraltar, Brazil, and Montevideo. The whole collection was in excellent preservation, carefully labelled and packed, and accompanied by a minute report as to the place and circumstances of each find. And I do not for a moment hesitate to affirm that never has so important a collection of oceanic

[1] From the *Pungolo*, April 23, 1885. Naples, Italy.

animals before reached Europe. Scarce four months had elapsed when there arrived a second consignment, still more extensive than the first, and the result of collections made during a voyage from Montevideo to Cape Horn, around the islands of the Patagonian archipelago (a course which the obliging commander of the corvette, Capt. Palumbo, had followed at my especial desire).

This collection, too, contained most interesting specimens, among which are especially worthy of mention a vast number of tubes filled with the produce of deep-sea fishing (pelagic products). In the same way there have come to hand two other consignments from the Peruvian coast, from the Galapagos Isles, from the coast of Panama; and also some most interesting animals found in small pools and rivers in Peru. Among these, of special importance are two complete series of embryonic forms—first, of a Peruvian ray, and secondly of a toad, which Lieut. Chierchia, at my desire, and to aid my studies in the history of the origin of vertebrate animals, reared with great care, and kept in an excellent state of preservation. In this he was assisted by Dionigi Franzese, who had been trained in the Zoological Station, and had embarked as a sailor on board the *Vettor Pisani*. The *Vettor Pisani* continued its course from Peru across the ocean towards the Philippine Islands and China, and we may look for a new shipment of specimens. In this we have a striking confirmation of my opinion that zoology might receive material aid in its work from naval officers trained for the purpose, rather than from the employment of young naturalists. The example thus presented has been followed by other individuals, and already three more naval officers, Lieuts. Cercone, Orsini, and Colombo, have been trained in the same way at the Zoological Station. It is a matter for regret that the first-mentioned has made but one voyage, a short one towards the West Indies, in which violent gales were encountered. The result of his researches may be seen at the "Station." Lieut. Orsini is in the colony of Assab, at the mouth of the Red Sea, and has despatched thence a valuable and well-preserved collection. Lieut. Colombo is the only one of the three whose studies have been of a more extensive and continuous nature, and for them opportunitp has on several occasions been given him by the Minister of Marine. On board the vessel attached to the Hydrographical Survey, commanded by Capt. Magnaghi (equally well known as a man of science and an officer), he has made excellent collections in the Mediterranean itself, and has now returned once more to the "Stazione" to further prosecute his studies there.

From the very first it has been my intention to invite the naval services of other nations to join us in this line of research, and accordingly, in the autumn of 1882, I proposed to the German Minister of Marine that he should send a naval officer or surgeon to Naples to receive a training such as I have indicated. The head of the Admiralty then, Herr Von Stosch, accepted my proposal, and sent a naval surgeon, Dr. Sander, for four months to Naples. In the autumn of the following year Dr. Sander embarked on board the frigate *Prinz Adalbert* for Eastern Asia. We still await its arrival, and hope for valuable results from the expedition.

A preliminary conversation which I had last summer at St. Petersburg with the head of the staff of the Russian Marine Admiral Tchichatchoff, leaves room for hope that Russia too will consent to join us in the matter, and that so in the course of a few years we may look for a still further and wider development of this connection between the "Stazione Zoologica" and the various marine war services of the world. From such a connection great advantages would accrue, not only to science in general, but also to the naturalists of those several countries, which in their turn would be the richer for the collections made by their respective navies.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—There will be an examination in certain branches of natural science for minor scholarships at Downing College, on Tuesday, June 2 next, and following days. Persons who have not entered at any college in the University are eligible to the minor scholarships, which will be of the value of from 40*l.* to 70*l.* per annum, and tenable until their holders are of standing to compete for a Foundation Scholarship. Further information will be given by Dr. Perkins or the Rev. J. C. Saunders, tutors of the College.

SCIENTIFIC SERIALS

Annalen der Physik und Chimie, No. 3, March, 1885.—Prof. R. W. Bunsen, on capillary absorption of gas. Shows a direct dependence between the capillary pressures and the volumes of gas absorbed. This discovery, doubtless, has important relations in physiological processes. Prof. G. Quincke, electric researches (No. 10), on the measurement of magnetic forces by hydrostatic pressure. The author adopts the formula

$$p = \mathfrak{K}_1 H_1^2/8\pi,$$

where H_1 is the intensity of the magnetic field, and $\mathfrak{K}_1$ a "dimagnetisation constant" analogous to the dielectric constant in the analogous formula for the pressure in the electric field. Observations have been made on many magnetic liquids to ascertain the numerical values of this constant.—O. Lummer, on the theory and form of some newly-observed interference curves. These relate to certain phenomena of thick plates.—C. Christiansen, researches on the optical properties of finely-divided bodies. —W. Möller, on Wild's photometer.—E. and L. Natanson, on the dissociation of the vapour of hyponitrous acid.—M. Thiesen, researches on the equation of state; a discussion of the laws of gaseous pressure.—Prof. L. Pfaundler, on the action of strongly-compressed carbonic acid on glass under the influence of light. W. Voigt, reply to Prof. Wüllner's remarks respecting Jamin's observations on metallic reflection.

Journal of the Russian Chemical and Physical Society, vol. xvi. fasc. 9.—On the oxidation of acetones (second memoir), by G. Wagner. The behaviour of ketones to chromic acid mixture are described, and the general laws of their oxidation are deduced. —On the action of the iodides of allyl and zinc on epichloridrine, by M. Lopatkin. —On isopropyl allyl dimethyl carbinol, by M. Kononovitch.—On the relation between diamagnetism and the temperature of fusion of bodies, by P. Bachmetieff. The absolute heat of fusion being represented by the equation $W = (t + 273) cs + bs$, where c is the specific heat, b the latent heat of fusion, and s the specific weight of the body; then, the series $(t + 273) s$ being taken according to the figures of Regnault and M. Carnelley—it appears to be in reverse order to Faraday's diamagnetic series, the bodies appearing in the following series which culminates with Bi and Sb:—K, Na, P, Br, S, Mg, Ca, I, Al, In, Sn, Bi, Sb, Zn, Cd, Pb, Ag, Cu, Pd, An, Ur, W, Pt, Ir, Os.—On the atmospheres of planets, the temperature of the sun in cosmic space, and the earth's atmosphere, by E. Rogovsky.—On some new demonstrations of the conditions for a minimum of deviation of a prism, by N. Poltschikoff.—A note in answer to M. Stankevitch, by the same. —Studies in cosmical physics: III. the heating of meteorites when falling on to the earth, by Th. Schwedoff.—Answering to an objection made at the British Association of 1882 by Sir William Thomson to his cosmic theory of hail, the author discusses the heat which a meteoric stone may receive when piercing our atmosphere. He shows by several examples, by our experience of meteorites, and by M. Daubrée's testimony, that they never have been brought to fusion. The meteorite must be compared to a fire syringe (*Briquet pneumatique*), which condensates the air and raises its temperature, remaining nearly cold itself when its conducting power is feeble. The *vis viva* of the meteorite is spent in piercing the layers of air—that is, in bringing them into motion (like a bullet which would spend its force in piercing 1000 sheets of paper before reaching the target), and to admit that its *vis viva* be transformed into heat, would be to forget the force spent in piercing the air.—Index to the sixteenth volume.

Bulletin de la Société des Naturalistes de Moscou, 1884, No. 2. —Materials for the flora of Central Asia, by Prof. N. Sorokine. After having twice visited several parts of Russian Turkistan and the delta of the Amu-daria, M. Sorokine returned with a rich collection of phenogams, which proved this part of the Central Asian flora to be very rich, original, and interesting. The department of Gasteromycetes alone offered the greatest interest, on account of its containing forms peculiar to Algeria, Egypt, Cuba, and so on. There are even several indices which would seem to indicate that the Aral-Caspian region has been a centre of dispersion of several forms, whose sporæ were transported by winds across the Red Sea to Africa, and thence to Spain and France. The whole work of the author could not be published at once, on account of its numerous plates. The description of the Chytridiaceæ has appeared in the *Archives botaniques du Nord de la France*, the remainder will appear in the Moscow *Bulletin*, which contains now the descriptions, with five plates, of the Hypodermei and the Gasteromycetes.—Plantæ Raddeanæ Monopetalæ, by Ferd. von Herder (continued).—Solution of a problem of the theory of comets, by N. Joukovski (Russian). The geocentric position of a particle of the tail which has left the nucleus since a given time under the action of a given repulsive force, to determine the displacement of the particle for a given change in the repulsive force—such is the problem treated. —Analyses of salt and mud from a volcano of Trans-Caucasia. —An essay on the solution of the geodetical problem, by Th. Sloudsky (in French). The already-known formulæ already give the possibility of embodying all anomalies less than 30" in latitude and less than 15 oscillations of the pendulum in twenty-fours against the calculated ones. The author tries, however, to give a more theoretical formula, which might at the same time embody larger anomalies.—List of the herbaria of the Moscow University and of the Society of Naturalists, by J. Goroshankin.—Studies on the averages of the relative moistness, by Dr. K. Weihrauch (continued; in German).—Necrology and Annual Report.

Rendiconti del R. Istituto Lombardo, March 26.—History of the first century (1783–1883) of the Reale Istituto, by G. B. Venturi.—On the persistence of the thymus gland in children and adults, by Prof. Giovanni Zoja.—Account of a successful operation performed on a young girl for the purpose of closing an open sore on the left cheek produced by a severe attack of typhoid fever.—Further notes on conformable representations in higher mathematical analysis, by Prof. Giulio Ascoli.—Meteorological observations made at the Royal Observatory of Brera, Milan, during the month of March.

Rivista Scientifico-Industriale, March 31.—A new explanation of the red crepuscular lights that have been attributed to the Krakatoa eruption, by Prof. Carlo Marangoni.—Variations in the electric resistance of solid and pure metallic wires according to the temperature (continued), by Prof. Angelo Emo.—A visitation of caterpillars (*Lithosia caniola*, Hl.) in Florence during the present season, by P. Bargagli.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 23.—"On the Changes produced by Magnetisation in the Length of Rods of Iron, Steel, and Nickel." By Shelford Bidwell, M.A., LL.B.

The earliest systematic experiments on the effects produced by magnetisation upon the length of iron and steel bars are those of Joule, an account of which is published in the *Phil. Mag.* of 1847. Joule's experiments have many times been repeated, and his general results confirmed. In particular, Prof. A. M. Mayer carried out a series of very careful observations with apparatus of elaborate construction and great delicacy. The conclusions at which he arrived were in accord with those of Joule, so far as regards iron; in the case of steel there was some apparent discrepancy, which, however, might to a great extent be accounted for by differences in the quality of the metal used and in the manner of conducting the experiments. In 1882 Prof. Barrett published in NATURE an account of some experiments which he had made, not only on iron but also on bars of nickel and cobalt, with the view of ascertaining the effect of magnetisation upon their length.

The knowledge on the subject up to the present time may be summarised as follows:—

(1) Magnetisation causes in iron bars an elongation, the amount of which varies up to a certain point as the square of the magnetising force. When the saturation-point is approached the elongation is less than this law would require. The effect is greater in proportion to the softness of the metal.

(2) When a rod or wire of iron is stretched by a weight, the elongating effect of magnetisation is diminished; and if the ratio of the weight to the section of the wire exceeds a certain limit, magnetisation causes retraction instead of elongation.

(3) Soft steel behaves like iron, but the elongation for a given magnetising force is smaller (Joule). Hard steel is slightly elongated, both when the magnetising current is made and when it is interrupted, provided that the strength of the successive currents is gradually increased (Joule). The first application of the magnetising force causes elongation of a steel bar if it is tempered blue, and retraction if it is tempered yellow: subsequent applications of the *same* external magnetising force cause temporary retraction, whether the temper of the steel is blue or yellow (Mayer).

(4) The lengh of a nickel bar is diminished by magnetisation, the maximum retraction being twice as great as the maximum elongation of iron (Barrett).

In order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetising forces with which they worked. From data contained in their paper, it was calculated that the strongest magnetising force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetising force was carried up to about 312 units. The metal rods, too, were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten-millionth part of this length.

By using thinner iron rods and greater magnetising forces than those previously employed, the following curious and interesting fact was established. If the magnetisation be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetising force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetisation; and if the magnetisation be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetising force in a thin iron rod was greatly reduced by stretching; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetising forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetisation of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalise from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetisations referred to are temporary only; before the beginning of an experiment the rod was permanently magnetised by passing through the magnetising coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetisation was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one-twenty-fifth part of the whole.

I. IRON

(1) The length of an iron rod is increased by magnetisation up to a certain critical value of the magnetising force, when a maximum elongation is reached.

(2) If the critical value of the magnetising force is exceeded, the elongation is diminished until with a sufficiently powerful magnetising force the original length of the rod is unaffected, and, if the force is still further increased, the rod undergoes retraction. Shortly after the critical point is passed, the elongation diminishes in proportion as the magnetising force increases. The greatest actual retraction hitherto observed was equal to about half the maximum elongation, but there was no indication of a limit, and a stronger magnetising force would have produced further retraction.

(3) The value of the external magnetising force corresponding to maximum elongation is for a given rod approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetisation of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetising force.

(4) The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

(5) The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

(6) The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetising force when the rod is stretched than when it is unstretched.

II. Steel

(7) In soft steel magnetisation produces elongation, which, as in the case of iron, increases up to a certain value of the magnetising force, and afterwards diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

(8) The critical value of the magnetising force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetising force is a minimum; in steel of a yellow temper the value of the critical magnetising force is lower than in steel which is either softer or harder.

(9) In soft steel a strong magnetising force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

(10) A temporary elongation when once produced in soft steel may be maintained by a magnetising force which is itself too small to originate any perceptible elongation.

III. Nickel

(11) Nickel continues to retract with magnetising forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

(12) A nickel wire stretched by a weight undergoes retraction when magnetised.

Anthropological Institute, April 28.—Francis Galton, F.R.S., President, in the chair.—Mr. A. L. Lewis read a paper on the past and present condition of certain rude stone monuments in Westmoreland. The highest point of the railway between Lancaster and Carlisle is a little to the south of the village and station of Shap, in Westmoreland, where there were formerly some very extensive rude stone monuments, now unfortunately almost entirely destroyed. Allusion is made to them by Camden and Dr. Stukeley, and a circle is said to have been destroyed when the railway was made; some remains of this circle may be seen from the train, but only a few stones are left on the spot. The most interesting monument now remaining in the vicinity of Shap is situated at a place called Gunnerskeld, two or three miles to the north, and consists of two irregular, concentric, slightly oval rings, about 50 and 100 feet in diameter respectively, the longest diameters being from north to south.—A paper by Admiral F. S. Tremlett on quadrilateral constructions near Carnac was read. These inclosures were explored by the late Mr. James Miln; in each case the boundary walls are formed of coarse, undressed stones, put together without any kind of cement, and having built up in them a series of small menhirs; they also contained beehive structures for cremation, reddened and become friable from the effects of great heat. It would appear that the cremation had been perfect, as not a particle of calcined bone was found in either of the inclosures.—A paper by M. Jean L'Heureux on the Kekip-Sesoators, or ancient sacrificial stone of the North-West Territory of Canada, was read. Elevated two hundred feet above the level of the surrounding plain, Kekip-Sesoators, the Hill of the Blood Sacrifice, stands like a huge pyramidal mound commanding an extensive view of both Red Deer and Bow River Valleys. A natural platform of about one hundred feet crowns its summit; at the north end of the platform, resting upon the soil, is the Sesoators, a rough boulder of fine-grained quartzose, fifteen inches high and about fourteen in diameter; upon its surface are sculptured half an inch deep the crescent figure of the moon with a shining star over it. Two small concave basins about two inches in diameter are hollowed into the stone, one in the centre of the star, the other about seven inches from it in a straight line; around them are traced various hieroglyphic signs, and all over the surface are numerous small circlets, which remind one of the sacrificial stone of Mexico. Here at a time of private or public necessity, when extraordinary blessings are sought, comes a solitary warrior, himself the priest and the victim; from the time of sunset he sits in solemn vigil gazing in the far east for the coming of the star-god of his ancestors; and when the first ray of the morning star lights the distant horizon, he lays a finger of his left hand on the top of the stone and cuts it off, leaving the blood to flow into the basin. He then presents the bleeding finger to the morning star, and, leaving it in the basin of the star-like figure, retraces his steps towards the lake at the foot of the hill, where he dresses his wound, and at sunrise enters his own village, where he is received with triumphant honours. Amongst the Blackfeet these self-inflicted wounds ranked equal to those received in battle, and are always mentioned first in the public recital of the warrior's great deeds in the national feast of Ocan.

Geologists' Association, May 1.—William Topley, F.G.S., President, in the chair.—A paper was read on wingless birds—recent and fossil—and on birds as a class, by Dr. Henry Woodward, F.R.S. The author prefaced his remarks on wingless birds by giving first a brief account of the characters of birds as a class. He described the peculiarities of the skull and the fore- and hind-limb, the cervical, thoracic, sacral, and caudal vertebræ, with the shoulder-girdle and pelvis. He compared the highly-specialised fore-limbs in existing birds with that of *Archæopteryx*, the former, with three rudimentary digits, having the metacarpal bones anchylosed together; the latter, with three free digits in each manus, armed with claws. He compared the bones of the hind-limb of an adult *Iguanodon* with those of a young *Dinornis*, and showed how closely the characters observable in the former are repeated in the latter. Many interesting analogies were also pointed out in the form of the ilium, ischium, and pubis in *Struthio* and Iguanodon. The *Archæopteryx*, although possessing so many points of divergence from the Avian type, was shown to be the earliest known ancestor of the great division of *Carinatæ* (birds with a keel to the sternum) to which nearly all modern (flying) birds belong. For the *Ratitæ* (or boat-breasted birds), to which division the Ostrich, Rhea, Emu, Cassowary, Apteryx, Dinornis, Æpyornis, &c., belong, an earlier ancestor must be sought. The author contended that, on the evidence before us we have a right to claim a higher antiquity for the *Ratitæ* than for the *Carinatæ*, not only from the present wide distribution of this division of the class, but also from the fossil evidence which embraces for the Struthious order even a still larger geographical area than that shown from existing species. And if we are at liberty to add to this the evidence of the footprints of bipedal animals in the Trias (which agree with the tracks of birds in the number of digits in the foot), then these footprints may be taken as further evidence of their priority in geological time. For the primitive forms of this class we must evidently look to the palæozoic rocks.

Zoological Society, May 5.—Prof. Alfred Newton, F.R.S., Vice-President, in the chair.—A communication was read from Mr. Jean Stolzmann, containing observations on the theory of sexual dimorphism.—Mr. J. Bland Sutton, F.Z.S., read a paper on hypertrophy and its value in evolution, in which he attempted to show that material changes in structure might be the result of what was originally a pathological condition.—Mr. E. T. Newton, F.Z.S., read a paper on the remains of a gigantic species of bird (*Gastornis klasseni*), which had been obtained by Mr. H. M. Klaassen from the "Woolwich and Reading Beds" of the lower Eocene series. The author observed that these fossils proved that in early Eocene times England was inhabited by a race of birds which equalled in their proportions some of the more massive forms of the New Zealand moas.—A communication was read from Mr. R. B. Sharpe, F.Z.S., containing the description of a new species of Hornbill from the Island of Palawan, which he proposed to name *Anthracoceros lemprieri*.—Prof. E. Ray Lankester, F.R.S., read some notes on the right cardiac valve of the specimens of *Apteryx* dissected by Sir Richard Owen in 1841.—A communication was read from Lieut.-Col. C. Swinhoe, F.Z.S., being the third of his series of papers on the Lepidoptera of Bombay and the Deccan. The present paper treated of the second portion of the Heterocera.—A communication was read from Dr. St. George Mivart, F.R.S., containing a correction of a statement concerning the structure of *Viverricula*, contained in a former paper.

Manchester

Literary and Philosophical Society, Feb. 16.—Thomas Alcock, M.D., in the chair.—A proposed revision of the species and varieties of the sub-genus Cylinder (Montfort) of Conus (L.), by Mr. J. Cosmo Melvill, M.A., F.L.S.

March 10.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—On making sea-water potable, by Thomas Kay, President of the Stockport Natural History Society. Communicated by F. J. Faraday, F.L.S.

March 16.—Thomas Alcock, M.D., in the chair.—On the breeding of the Reed Warbler (*Acrocephalus arundinaceus*) in

Cheshire, by Francis Nicholson, F.Z.S.—On *Lagena crenata*, by Dr. Alcock.—The Post-Glacial Shell-beds at Uddevalla, Sweden, by Mark Stirrup, F.G.S.

PARIS

Academy of Sciences, May 4.—M. Bouley, President, in the chair.—Summary of the meteorological observations made during the year at four stations on the Upper Rhine and in the Vosges district (Schlucht, Munster, Colmar, and Thann), by M. G. A. Hirn. Tables are given of the actinometric observations, of the prevailing winds with their mean and greatest velocities, of the mean and extreme temperature, of the atmospheric pressure and rainfall for each month of the year at all these stations. During the period in question the most salient phenomena were the severe frosts of the month of April, which proved very destructive, especially to the vines, and the sudden and violent hurricane of July 16, which swept with tremendous rapidity over the Vosges, almost unaccompanied by rain, and with very little thunder.—Remarks on the influence exercised by seismatic disturbances on Phylloxera, by M. S. Villalongue. The case is mentioned of a vineyard near Malaga affected by this parasite and supposed to have been destroyed, which nevertheless broke into leaf with fresh vigour after the earthquakes which recently devastated the southern provinces of Spain.—Application of the general laws of the theory of the partition of numbers to numerical functions, by M. N. Bougaieff.—On an easy method of controlling the velocity of electric motor currents (one illustration), by M. Marcel Deprez.—Note on the suppression of the nitrous vapours of the Bunsen pile, and on a new pile which becomes depolarised in the atmosphere, by M. A. d'Arsonval.—On a new variety in the anomalous group of Cyclocephalians, by M. A. Lavocat. This variety, for which the term "ophthalmocephalous" is proposed, is illustrated by the recent case of a still-born lamb, in which nose and eyes were entirely absent, and, in place of the orbits, showing in the median plane a cavity formed by the union of the two temporal fosses. At the same time the tongue, the ears, and all the parts corresponding with these organs were in the normal state.—On the system of canalisation present in the cellules of plants, and on the continuity of the protoplasm in vegetation, by M. L. Olivier. In opposition to the generally accepted views, the author infers from his microscopic studies that in the thickness of the membranous walls of plants there is a highly developed network of canals, by means of which the continuity of the protoplasm is effected throughout the cellular system.—An attempt to determine the relative age of the Grand'-Combe Carboniferous deposits by means of their fossil vegetation, by M. R. Zeiller.

ROME

Reale Accademia dei Lincei, January 4.—On pleasurable and periodic respiration. Prof. Mosso communicated an abstract of a memoir in which he expounds various observations made by him on respiration. By means of tracings taken from a man in a state of complete rest, he has recognised that in the respiratory movements periods of greater or less depth in breathing alternate with one another, and that such periods are observable in all animals, especially during sleep. The author has likewise ascertained that man breathes a greater quantity of air than is necessary, and it is that respiration that he calls pleasurable (*respirazione di lusso*). It is in consequence of this excess in the ordinary breathing that a man does not increase the extent of his respiratory movements in ascending a mountain or in undergoing a change of atmospheric pressure. Prof. Mosso has determined the limit of this pleasurable respiration which is manifested in sleep when no cause would render it necessary. According to the pauses which the periodic respiration undergoes, the author divides it into *remittent* (*remittente*) and *intermittent* (*intermittente*). These pauses do not depend on the movements of the blood-vessels nor on psychical factors. It is a recognised fact that respiration has not a single centre, but that various muscles subserve this function independently of each other. Prof. Mosso concludes that not only is periodic respiration a normal physiological phenomenon, but that it is nothing else than the respiration of Cheyne and Stokes, which has hitherto been looked upon as a morbid condition. The author closes his own paper with a critical review of the theories of the nature of the movements of respiration.—Other communications:—Dr. Piccini described the analyses and the methods of preparation of certain fluor salts of titanium, corresponding to the sesquioxide, which had been obtained by him.—Drs. Ciamician and Silber described the results of the action of nitric acid on pyril-methyl-ketone.—Drs. Ciamician and Magnagui communicated a first note on the action of carbonyl chloride on the potassic compound of pyrrol.—The sanction of the Academy was likewise given to the printing, in the *Atti Academici*, of a memoir by Prof. Belloni, in which the author describes the olfactory and olfactory-auditory apparatus of the teleosteans (the *nuclei rotundi* of Fritsch).—The Secretary, Signor Blaserna, read a communication by Signor Laure, in which the author insists on the necessity of paying great attention to the barometric variations in cases of earthquakes and volcanic eruptions.

January 18.—Articles belonging to the Stone Age discovered in the commune of Breonio Veronese. Prof. Pigorini observed that of all the localities containing remains of the Stone Age Breonio Veronese is the most interesting and the richest, on account of its numerous caves in which primitive man has left his traces. The numerous flint implements found in that locality were attributed by ancient writers to the Cimbri. Some of these have common forms, but others are of very singular shape, and the use of the latter cannot be determined. The importance of such articles, which are found also in the sepulchres of the Stone Age near the caves, but which are there reproduced almost in miniature, consists in the fact that articles of the same form are found among the remains belonging to the prehistoric American stations, which leads us to surmise the existence of a bond of connection in the earliest times between the inhabitants of the Old World and the New. Prof. Pigorini, while dwelling on the great value of the collection of such curiously-shaped articles made by Signor S. de Stefani, and described by him before the Congress at Venice, was glad to be able to announce to the Academy that the collection had been acquired by Prof. Landberg, whose attachment to Italy and whose philanthropic character were well known, and that it was his generous intention to present the collection to the Prehistoric and Ethnographical Museum at Rome. This valuable scientific material is thus to remain in Italy.—On the observations on the solar maculæ and faculæ made in the Observatory of the Collegio Romano in 1884. From the observations made, Signor Tacchini believed that he could conclude that the solar activity was diminishing and that it would very soon reach its minimum. Comparing the observations of 1883 with those of 1884, he found that in 1884 chromospherical phenomena attained a considerable development. Signor Tacchini, although he has not yet completed his labours in reducing the observations, i sof opinion that 1884 will have to be remembered as a year of maximum frequency of hydrogenic perturbations, but he intends to return to the question when he has completed the calculations relating to it.—On an ancient vase representing Sappho.—Signor Comparetti read some preliminary notes regarding an ancient vase belonging to the collection of the Archæological Society of Athens. On this vase, the drawing on which is rather rude, Sappho is represented in the midst of her disciples, she herself being in the act of reading some epic lines written on a roll held in her hand. This vase belongs to the fourth century B.C., and hence to the period in which Sappho was most popular in the refined and gallant society of Athens. According to Prof. Comparetti, the two disciples who are listening to Sappho, must, judging from their names which are written on the vase, be two Athenian hetæræ.—Discovery of an ancient encyclopædia, and the plagiarism practised on it. Signor Narducci announced that he had discovered in the Biblioteca Angelica, at Rome, a parchment MS. belonging to the end of the thirteenth century, containing in its first 129 pages an encyclopædia, hitherto unknown, compiled by Egidio Colonna, of Rome. After giving an account of the contents of this work, Signor Narducci drew attention to the shameless manner in which the encyclopædia of Colonna had been plagiarised by the Englishman Bartholomew Glanville, commonly called *Bartholomeus Anglicus*, who flourished about 1630. This writer acquired the greatest reputation by a book of his called "Liber de proprietatibus rerum," which is in great part copied word for word from the encyclopædia of Colonna.—Other communications: Signor Fiorelli gave an account of the excavations of antiquities made during the month of December.—Dr. Nasini made a communication regarding some researches he had made on the atomic refraction of sulphur, and on the higher value of that refraction.—Dr. Piccini read a note containing some general considerations on peroxides of the type of peroxide of hydrogen, and made a communication as to the continuation of his researches on a new series of titanium compounds.

February 1.—On the hydrogenic protuberances of the sun, observed at the Royal Observatory of the College of Rome in 1884.—Prof. Tacchini, in continuation of his previous note to the effect that 1884 must be considered as a year in which the phenomena of the chromosphere had attained their maximum development, presented the results of observations made by him on 242 days. From these it appeared that the number of the protuberances increased from March to October. In order to get rid of the anomalies which are met with in various observations, and to obtain a curve representing the course of the phenomena in the quinquennial period 1880 to 1884, Prof. Tacchini has taken as monthly means the means of three months, considering each month along with the month before and after it. The curve so constructed shows three culminating points or periods of maximum activity, these corresponding to July, 1880, September to October, 1881, and March, 1884, which last is the highest in the whole series. The maximum of the protuberances follows that of the sunspots, and recent observations make it probable that 1885 will be a year of greater activity in the chromosphere and solar atmosphere.—On the degree of precision in the determination of the density of gases. Dr. Agamennone stated that the first to experiment with a certain amount of success on the density of gases were the physicists Dumas and Boussingault, and that Regnault had introduced the most important improvements in the methods of working adopted by them. He observed, however, that even these improved methods of Regnault were not exempt from certain errors, the nature of which the author pointed out and described, indicating the precautions that had to be used in the various operations of weighing, in order to avoid some of these errors by taking advantage of the accurate instruments which we possess at the present day. The author insisted specially on the constant source of error proceeding from the property which glass has of condensing gases on its surface, and on the exactness of measurement required in determining the pressure at which the gas to be weighed is contained in the vessel in which the weighing is effected. Dr. Agamennone has repeated in the Royal Physical Institute of Rome all the experiments of Regnault, and, correcting an error found in one of the experiments of that physicist, he finds that for the value of the weight of a litre of air, which, according to the corrections made by Kohlrausch and Lasch, would be 1·292756 grammes, there ought to be substituted 1·292767 grammes—a determination which, according to Dr. Agamennone, is subject to a maximum uncertainty of about $\pm$ 0·0005 gramme, and to a mean uncertainty of $\pm$ 0·000067 gramme.—Determination of the density of the air. Dr. Agamennone having in his previous paper shown how in the determination of the density of gases the errors affecting the final result proceed from the measurements of weight and pressure, announced that he had executed two series of experiments for the determination of the density of the air, making use of weights and pressures separated from one another by pretty wide limits. The pressures employed in the two series of experiments were: (1) that of the atmosphere; and (2) one of two atmospheres. The author, after describing his methods of procedure and the precautions taken by him, communicated his results, which showed a great difference between the mean values of his two series, and that because the air under pressure departs from Mariotte's law. Dr. Agamennone concludes that when the density of a gas is to be determined, the gas being weighed in a compressed state, it is necessary above all to know by direct experiments the variations in volume of the gas operated on, and to know what amount of condensation there is on the walls of the vessel in which the gas is compressed. For the determination of the deviation of a gas from Mariotte's law, which is a matter of so much importance in researches of this kind, the gas might be weighed at different pressures in a resisting vessel with a sufficiently delicate balance. Some experiments of Regnault have shown this method to be sufficiently satisfactory.—Consequences of a new hypothesis of Kohlrausch on thermo-electric phenomena. Dr. Battelli, after giving a *résumé* of the theoretical explanations offered by Thomson and Tait to account for the results obtained experimentally in thermo-electric phenomena, stated also the hypothesis of Kohlrausch on the electrical transport of heat, and showed how, from the conclusions of Kohlrausch, all the formulæ confirmed by experiment might be deduced.—Other communications:—Drs. Ciamician and Silber have continued their studies on the compounds of pyrrol, and explained minutely the method by which they had succeeded in converting pyrrol into pyridin.—Prof. Cassani communicated a paper on the angles of linear spaces.—Dr. Tonelli presented a note on the analytical representation of certain singular functions.—An abstract was communicated of a memoir by Messrs. Vanecek, entitled "Sur la Génération des Surfaces et des Courbes gauches par les Faisceaux de Surfaces."

February 15.—On the worship of stone weapons in the Neolithic age. Signor Pigorini exhibited a singular flint implement which had been found in one of the caves in the commune of Breonio Veronese, referred to the Neolithic age. It has the triangular form of a lance- or arrow-head, but is of rather large dimensions. It weighs, in fact, 1·710 kilo., and one of the equal sides of the triangle is more than 21 cm. in length. It cannot be supposed that this colossal spear-head could have been used as a weapon, chiefly because its dimensions would have required a shaft of quite unmanageable size, but also because the cavity at its base would have rendered the shafting extremely fragile. Signor Pigorini called to mind how, even at the present day, the common people attributed a celestial origin to the weapons of stone—a superstition which also existed among the ancients; but there are proofs that at the very time when these weapons were made they were held as emblems of divinity. There was, in fact, in the Neolithic age, a worship of the axe, since specimens of that weapon are found, of dimensions so small or so large, like that of Breonio Veronese, that they cannot be regarded as anything else than votive offerings.—Concerning a fragment of a manuscript of Cicero belonging to the ninth century. Signor Narducci found, in the Vatican Library, a valuable manuscript containing numerous Ciceronian fragments collected by a certain Hadvardo. Signor Narducci transcribed the manuscript page by page, in the hope that, by collating it with the works of Cicero, now known, he might find some fragments of lost books of the great orator. After identifying each of the fragments, he found that the compiler had not had at his disposal any of the works of Cicero known in the Middle Ages, but not at the present day. Signor Narducci gave a short specimen of the manuscript, with the various readings found at the present day in the most esteemed versions of the various works of Cicero, and he announced that Prof. Schwenke is preparing a critical study of the manuscript in question.

CONTENTS

THURSDAY, MAY 21, 1885

THE BRITISH MUSEUM CATALOGUE OF LIZARDS

Catalogue of the Lizards in the British Museum (*Natural History*). By George Albert Boulenger. Vol. I. *Geckonidæ*, *Eublepharidæ*, *Uroplatidæ*, *Pygopodidæ*, *Agamidæ*. Second Edition. (1885.)

IT would be difficult to name any order of vertebrates more urgently in need of cataloguing than the lizards. The last general work on the group published in any country was Dr. J. E. Gray's Catalogue, which appeared forty years ago, only six years after the completion of the volumes devoted to lizards in Dumeril and Bibron's great work on Reptiles. The additions made in Dr. Gray's Catalogue were considerable, but many of them were of doubtful value. Thus of fourteen new genera therein added by him to the family of Geckoes alone, but three survive in the present edition, the remainder swell the synonymy.

Mr. Boulenger's Catalogue is a boon to herpetologists and to biologists generally, not only because it places within their reach in a few handy volumes descriptions that have hitherto been widely scattered, but also because the classification proposed, whether it be generally accepted or not, is a distinct advance upon the artificial system hitherto in vogue. It is to be hoped that lizards so closely resembling each other as do, for instance, *Gongylus*, *Ablepharus*, and *Euprepes*, will no longer be classed in three distinct families solely because of trivial differences in the form of the nasal shield and in the development of the lower eyelid. At the same time, as naturalists have but rarely access to a collection of lacertilian skeletons, it is to be regretted that a few diagrams have not been added to the present catalogue, to show the cranial characters and the forms of the vertebræ, clavicles, &c., upon which Mr. Boulenger's families are founded.

A considerable change in some well-known reptilian genera is proposed in the present work, and it is probable that the union, for instance, of *Stellio* and *Trapelus* with *Agama* and of *Brônchocela* with *Calotes* will not be universally acceptable. But no change appears to have been proposed without valid reasons, and the tendency to excessive multiplication of genera on insufficient grounds has become so serious a nuisance in zoology that a diminution in the number is welcome. It is satisfactory to find, on comparison with the catalogue of 1845, that whilst the species attributed to the *Geckonidæ* have increased from 97 to 270, the genera have only augmented in number from 40 (or if *Eublepharis* and *Uroplates*, now placed in other families, be excluded, 38) to 49, whilst the *Agamidæ* which, in the earlier list, comprised 79 species, distributed amongst no less than 34 genera (35, including *Hatteria*) now contain 202 species, but only 30 genera. But six new generic names are proposed by Mr. Boulenger in the present work, and only three of these are used for generic groups not previously recognised, the others being intended to replace terms that are inadmissible.

It is almost impossible to form an adequate opinion of the descriptions and synopses in a catalogue of this kind without testing them extensively, and the only thorough test is to try, by means of them, to identify unknown forms without having a series of specimens of allied species at hand. Most museum publications are deficient in this respect, because the writers do not make sufficient allowance for the difficulties under which those who have occasion to identify animals find themselves. An example or two may be taken from the present work. In the synopsis (p. 114) of *Hemidactylus*, one of the largest and most difficult genera of Geckoes, two groups of species are distinguished, the one by having the "free distal joints of all the digits remarkably short," the other by having them long. In a museum, with other species for comparison, this is a good distinction, but away from any specimens except the one that he is endeavouring to identify it is difficult for a naturalist to tell whether the joints of the lizard he is examining are remarkably short compared with those of other forms. Again, in *Draco* (p. 254) several species are distinguished by having the snout longer or shorter than the diameter of the orbit, but it is not stated how the snout is measured. It is but right to say that such instances appear exceptional in the present catalogue, and that it is very rare to find a work in zoology from which similar examples might not be taken.

One of the chief desiderata in books like the present is accuracy as to localities. The museum catalogues of a past age left much to be desired in this respect, and their shortcomings have had a pernicious influence on the progress of a study of wide biological and geological interest, that of the geographical distribution of animals. It will probably be a long time before all the erroneous localities are weeded out, but it is satisfactory to note the great improvement that has taken place in British Museum catalogues of late years. Where so much care has been expended on the subject as is shown in the present work, it appears almost ungracious to point to such trifling shortcomings as appear, though a few mistakes have naturally crept in. Thus the locality for *Acanthosaura* (*Oriocalotes*) *Kakhienensis* is not in the Khasia hills as stated at p. 305, but Ponsee, in the Kakhyen hills, on the borders of Yunan. Again, considering the extensive collections that have been made of late years throughout Bengal, it is very extraordinary, if *Hoplodactylus duvancelii* and *Gonyocephalus bellii* really occur in the province that neither of them has been rediscovered, and the locality should not be recorded without doubt.

Altogether the present volume quite maintains the level that the best recent museum catalogues have led naturalists to expect. Why it should be called a "second edition" is not clear. A comparison of the two editions resembles an antiquarian research. It is necessary to recall a state of zoological knowledge as extinct as the dodo before the conditions under which the so-called first edition was produced can be understood. When the head of the zoological department in the British Museum could propose to divide reptiles into two sections, one called *Squamata*, comprising the orders of lizards and snakes, and the other, called *Cataphracta*, consisting of tortoises, crocodiles, and amphisbænians, on the ground that the former were clad with scales and the latter with plates, the knowledge of the animals classified was evidently in a rudimentary stage. As if the classification thus proposed was not sufficiently startling, it was gravely suggested (p. 2) that the five orders of reptiles were "analogous" to similar subdivisions in birds and mammals; the lizards as "climbers" representing the *Insessores* in the former and the *Primates* in the latter, serpents being "carnivorous" corresponding to *Accipitres* and *Feræ*, Emydosaurians (crocodiles) because they are "aquatic" to *Anseres* and *Cete*, tortoises in virtue of being "large-footed" to *Gallinæ* and *Ungulata*, and *Amphisbænians* for no particular reason to *Grallæ* and *Glires*. It is doubtful whether the authorities of the British Museum would not have done wisely by leaving this farrago of nonsense, one of the last echoes evoked by the once popular quinquennial system of Vigors and Swainson, in well-merited oblivion, and in not calling attention to it by suggesting a comparison between the work by Dr. Gray and that by Mr. Boulenger. However great may be the changes in zoological classification during the next forty years, the difference between the views now held and those that may prevail in the future will scarcely be so revolutionary as that which exists between the first and the second edition of the British Museum Catalogue of Reptiles.

THE SILVER-LEAD DEPOSITS OF NEVADA

The Silver-Lead Deposits of Eureka, Nevada. By J. S. Curtis. 4to. 200 pp. (Washington, D.C., Government Printing Office, 1884.)

THE remarkable mineral district which is dealt with in this memoir is situated in the eastern part of the State of Nevada, about the centre of the dreary region known as the Great Basin, between the Great Salt Lake of Utah and the Sierra Nevada range of California. The business centre of the town, or "mining camp," of Eureka is about 90 miles south of the Palisades Station, on the Central Pacific Railway, with which it is united by a narrow-gauge branch railway. The principal mines situated about Ruby Hill, about 1½ miles west of the town, extend for about a mile along the contact of a limestone, supposed to be of Cambrian age, with an underlying quartzite. The quartzite forms the axis of a steep anticlinal arch, which has been modified on one side by a great fracture known as the Ruby Hill fault, and between this and some secondary fractures, an enormous mass of crushed limestone is included, containing the mineral deposits, or ore bodies proper, which are essentially cave deposits, the hollows between the limestone fragments, which are of all sorts of shapes and sizes, being filled with products of the oxidation of galena, pyrites and mispickel, such as sulphate, carbonate, and arsenate of lead, and brown iron ore, in addition to the unaltered minerals in smaller quantities. The chief mineralogical find of these mines has, however, been of Wulfenite or molybdate of lead, which has been produced in considerable quantity, both in detached crystals of great beauty and interspersed through the mass of the other minerals. As a whole, the ores contain about 33 per cent. of lead, 30 ozs. of silver, and about 1⅝ ozs. of gold per ton. These ore bodies are of every possible form and size, from small strings up to masses measuring upwards of 100 feet in all directions; but in spite of this great irregularity of form, they are generally connected with systems of fissures or channels, and it is by following these fissures that most of the great discoveries have been made.

Although mines extend for nearly a mile along the hill, the most valuable portions of the deposit are included within a length of about 500 yards at the north-western end belonging to the Eureka and Richmond Mining Companies; and, as the largest development of ore has been on or near the boundary dividing the two properties, disputes as to the ownership of different masses have been followed by litigation culminating in a law-suit which in some way recalls the famous Torbane Hill case of the Scotch courts; the principal mining and geological experts of the United States, when called in as witnesses, being about equally divided in opinion as to whether the zone of limestone containing the ore was a lode or not. In the first judgment the affirmative view prevailed, and was maintained on appeal, although the case appears to have been ultimately decided upon considerations of previous agreements as to boundary lines between the two companies rather than on technical definitions. The absurdity of attempting to apply precise definitions to such essentially irregular objects as mineral deposits has never been so well demonstrated as in this famous case.

As regards the origin of the ores, the author considers them to have been deposited by hot springs constituting the final episode of a period of volcanic activity, evidence of which is found in the neighbourhood, though not in the immediate vicinity of the mines. A large number of assays of the limestone and quartzite rocks enclosing the deposits have been made, proving them to contain silver of the value of from fourpence to twenty-two pence per ton, which, however, in the author's opinion shows conclusively that the materials for the ore could not have been derived from any of the sedimentary formations.

The systematic assaying of the rock has been attempted to be utilised as a method of discovering ore bodies, as have also experiments upon variations in electrical activity, but as yet without practical results, although a curious coincidence has been observed in the indications given by the two methods.

The yield of precious metals of the Ruby Hill mines between 1869 and the date of the author's report, 1883, has been about 15,000,000*l.*, the value in the proportion of about one-third of gold to two-thirds of silver, in addition to about 225,000 tons of lead. Both the smelting and desilverising of the ore are done on the spot, the latter being effected by the inverse Pattinson process of Luce and Rozan, in which the lead is crystallised by injecting steam, and the liquid lead is run off from the impoverished crystals. This is perhaps the largest application that this process has yet received.

The lower workings of the mines, although they have been extended to a depth of 1200 feet, have not as yet led to any discoveries comparable with those made between 300 and 700 feet below the surface. The author, however, considers the chances of finding ore in depth to be favourable.

Taken as a whole the volume is a very interesting one, and is well illustrated, although for practical purposes the scale of the plans and sections is rather small, and the description of the underground workings is scarcely sufficient to enable the reader to appreciate exactly the value of the author's theoretical conclusions.

H. B.

OUR BOOK SHELF

Den Norske Nordhavs-Expedition, 1876 to 1878. XIII. Spongiadae. Ved G. Armauer Hansen. 25 pp., 7 plates, 1 map. (Christiania, 1885.)

THE thirteenth report on the zoological collections of the Norwegian North Sea Expedition treats of the sponges, and is by one who, though well known as a student of other branches of zoology, has not, we fancy, been hitherto known as a spongologist. We do not know whether we may not associate with this fact the somewhat alarming percentage of new species which he describes; of the forty-five enumerated, thirty, or two-thirds of the whole, are new; many of the species, among which it is interesting to note there is a new Hyalonema, *H. arcticum*, are very briefly described; on the other hand, the figures, as in other parts of this report, are well executed, and will be of considerable assistance in the detection of the species by other workers. The author was, unfortunately, unable to obtain any preparations in which he could trace out the canal system, or the structure of the soft parts, and he has, therefore, confined himself to an account of the spicules. With regard to these he has, we are glad to note, made use of the stenographic system which was invented by Dr. Vosmaer; any and every proposition for abbreviating the descriptions of species ought to be tested, for the abundance of "literature" is a very threatening danger to science. It is not likely that all the methods that have been from time to time suggested will be found to be useful; no one, for example, has followed the two methods proposed by the late Prof. Garrod, or that adopted by Prof. Jeffrey Bell in the description of species of starfishes; on the other hand, Dr. Herbert Carpenter has taken up and improved the method suggested by Prof. Bell for the species of Comatulids, and will, we understand, adopt it in his forthcoming *Challenger* Report. The chief objections to formulæ as applied either to species, or spicules, or other organs, are, of course, that a particular method has to be learned, and that, if it is too brief, it tells us too little. The latter, for example, is true of the Owenian method of formulating the dental characters of Mammalia; it tells us that, while *Gymnura* has eight premolars above and below, *Erinaceus* has six above and four below, but it does not tell us which are missing in the latter. If we desire to register our knowledge on this point, we must make use of the more elaborate system devised by Prof. Flower and Dr. Dobson. As to the former objection, we must bear in mind that some spicules have had such names as floricomo-hexradiate, or patento-ternate, applied to them, and we can well imagine that a formula may well be accepted as a not unpleasant alternative.

The Hunterian Oration. Delivered at the Royal College of Surgeons, by John Marshall, F.R.S., &c. (London: Smith, Elder, and Co., 1885.)

NOT only the wide range and perennial importance of the work of John Hunter—the surgeon and anatomist whom the clear judgment of Buckle places second only to Aristotle among inquirers into organic nature—but also the fertility of human ingenuity, is shown by the fact that, for nearly a century, every year has seen some eminent surgeon discourse with more or less variety and freshness upon the life and achievements of this graet man.

The novelties of Mr. Marshall's treatment of the well-worn theme are, first, recounting the life of his hero backwards in successive decennia from his grave to his cradle; and, secondly, bringing Hunter into the modern world of science, and imagining the way in which he would be affected by modern methods and modern results. No doubt he would be delighted to see the splendid collection which has grown out of his "Hunterian Museum," but whether he would be more pleased or puzzled by the technics of histology and the elaborate machines of a physiological laboratory may perhaps be doubted.

An orator must be an eulogist, and in this case there is ample room for praise; but it would be a valuable contribution to criticism if Mr. Marshall, or some equally qualified man, would discuss Hunter's achievements as an anatomist, compared with Meckel and Cuvier; as a surgeon, with his contemporary Pott, and his successors Astley Cooper and Brodie; as a physiologist with Haller and Bichat; and as a naturalist—on the broad ground which includes human and "comparative" anatomy, normal and morbid structure, "the physiology of disease" (to use Hunter's own phrase), as well as that of health—with the only successor he has had, or, we may predict, ever will have, the illustrious Johannes Müller.

To such a critic might be suggested as shades in the intellectual portrait, Hunter's neglect of the aid of magnifying glasses such as were used to good effect before him by Leewenhoeck and Grew; his want of learning and cultivation, with a certain consequent narrowness of mind; and such occasional obscurity of language as may not unfairly be taken to imply some obscurity of thought. "Definitions," he says, "of all things on the face of the earth are the most cursed." But may not the use of terms without definition sometimes excuse a choleric word?

After the most exacting criticism, there is no question that Hunter's name would remain one of the glories of this country—to be mentioned next to those of Harvey, Newton, and Darwin. It is therefore most fitting that his fame should be kept green by the annual piety of successive orators, and of these Mr. Marshall is a worthy compeer.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Notes on the Action of the Wimshurst Induction Machine

AN interesting notice on the different influence-machines now in use occurs in NATURE, vol. xxviii. p. 12. Of these ingenious instruments, that lately devised by Mr. Wimshurst is likely to recommend itself beyond others, on account of the ease with which it may be excited, even in a damp atmosphere, and the high tension of the electricity discharged from its accumulators.

The following remarks lay no claim to originality, but they may nevertheless afford some interest to those who would witness its effects at a small pecuniary outlay; indeed its construction is well within the powers of the amateur mechanic.

Makers advertise sparks of fabulous length from comparatively small machines, but dense discharges of $4\frac{1}{2}$ inches may be obtained under favourable circumstances from disks of 15 inches diameter, if care be taken adequately to insulate the collecting apparatus. It is obvious that an *unassisted* spark of 9 inches cannot be produced from plates whose minimum air-spaces of insulation do not exceed $3\frac{1}{2}$ inches. The weakest part of insulation in these machines is usnally between the metal inductors and the attachments of the driving-gear and spindle. In the dark, beautiful brushes of light flash across these spaces, and thus they point where the electricity leaks away from the accumulators. The tendency to form these brushes may be much diminished by cementing a small disk of sheet caoutchouc over the inner ends of each metal-inducing strap.

The machine in full work presents several points of interest, the explanation of which, perhaps, is not very obvious. The first I would notice is, that although 15-inch plates will scarcely give an *unassisted* spark of more than 1¼ inches in length, the interposition of a trifling condenser, showing only a coated surface of 6 square inches, will entirely change the character of this spark, the almost continuous stream of short sparks giving place to fewer, zigzag, snapping, 4-inch discharges, of much increased density and brilliance. The attachment of a condensing tube, constructed as follows, will be found a valuable addition to such machines as collect separately the positive and negative electricities.

About 18 inches of thin glass combustion-tubing of ¾-inch diameter is taken. Within, and at 4 inches distance from each end, a space of 2 inches is coated with tinfoil, leaving a space of 5 inches or so of clear glass between them. Two similar pieces of foil are fixed by a thin coat of gold-size on the exterior of this tube. They superpose the inner pieces of foil, and act as the outer coats of two small Leyden jars united as it were in one. These outer coatings are connected by a strip of tinfoil. The inner coats are placed in contact respectively with the plus and minus collectors of the machine, by means of thick brass wires thrust through caoutchouc plugs. The wires are so bent that their ends may drop into suitable holes, from which they may be at any time detached.

A thin coat of spirit lac-varnish spread within and without much favours the insulation of the tube.

Thus arranged, bright angular sparks of 4 or more inches in length will pass between the knobs of the discharger at *every three-quarter turns* of the handle.

Another point of interest offers itself when the knobs of the discharger are placed beyond their usual striking distance. In such a case the spark very frequently passes within the tube from coating to coating, quite silently, and with an optical illusion of comparative slowness of transit. When first I noticed these bright flashes of light, they suggested the form of an undulating fire-ball, and this brought to my remembrance the often-described but obscure phenomenon of "ball-lightning." I could not, however, detect any real retardation of the discharge by a somewhat rough experiment with the ordinary spark-wheel.

When two large jars are connected with the machine the disruptive discharge of 4 inches is accompanied by a sharp report, like that of a small pistol. I was not prepared for the fact that such a noisy discharge made to pass through the condensing-tube is quite silent, just as if it flashed through a partial vacuum. It may also be noted that the spark through the tube may be made much to exceed the length of the discharge in the ordinary way.

The last point I now mention, and concerning which I should value the remarks of Mr. Wimshurst, or any other competent electrician, is the increasing intensity of charge taken up by the metal inducers, or sectors, as they pass each other between the point of their contact with the earth through the metallic brush and the next following comb-collector. In the electrophorus such a contact is required once between the delivery of each spark; whereas in the machine here used, having perhaps twenty-eight sectors, a contact is given only once in seven inductive processes.

It will be found that well-varnished jars, without the usual wooden tops, are much the most efficient. Nevertheless, even these sometimes become so highly charged, that the electricity will force itself over their edges, doubling back, as it were, over a distance of 5 inches.

A pretty, but somewhat trifling experiment may be made by attaching two jars of unequal capacities to the collectors. Thus a jar of half a pint capacity placed on one side may be flanked by a quart jar on the other. Here the small jar, if the coatings be not too distant from the lip, will discharge itself three different times, whilst the large jar is getting sufficient tension to strike, say, at 3½ inches. Both jars will then discharge together across the upper knobs. It may thus be shown that four half-pints of electricity make one quart of the same, as in liquid measure.

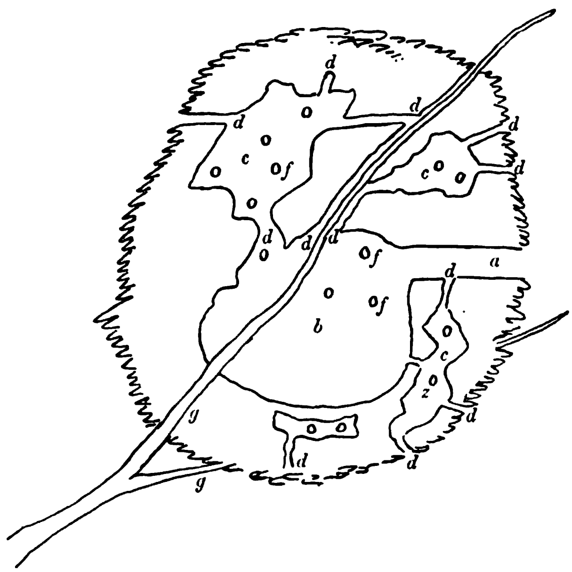
G. B. BUCKTON

Nesting of Micropternus Phæoceps

IN continuation of the communication from my friend, Mr. Wm. Davison, regarding the nesting of woodpeckers in ants' nests, published in NATURE (vol. xxxi. p. 438), perhaps the following note may be of interest:—

Camp Meplay, Thoung-yeen Valley, Tenasserim, April 20, 1882

This morning, in going from my camp to the Meplay Forest Reserve, I had to pass through several densely overgrown phonzohs.[1] While making my way along with some difficulty, I startled a brown woodpecker (*Micropternus phæoceps*) from a small pyingado tree (*Xylia dolabriformis*). Looking up into the branches I saw a large ants' nest, in the centre of which appeared a circular hole so exactly like the borings made by woodpeckers ordinarily in the trunks of trees, that I sent up a Karen boy who was with me to ascertain whether it was possible the Micropternus had been boring into the ants' nest, as, I had heard was the bird's curious habit. The ants' nest was only about ten feet above the ground, placed in a fork of the pyingado, two small branches of which passed clean through it. Climbing up, putting in his fingers and then a twig, my Karen follower announced that there were two eggs. Leaving the nest alone for the time being, in the evening I returned by the same route, and was able not only to cut off and carry into camp the whole nest as it was; but I managed to secure also the hen bird as she flew from the eggs. Arrived in camp, I got the two eggs out, and then very carefully made a cross-section through the



a, entrance tunnel made by woodpecker; *b*, retort-shaped nesting-chamber of woodpecker; *c*, excavations made by the ants; *ddd* ...... *d*, entrances to them; *fff* ...... *f*, tunnels made by the ants; *gg*, fork of pyingado branch—one twig passing through the egg-chamber excavated by the woodpecker.

ants' nest so as to divide the boring made by the woodpecker longitudinally.

The accompanying is a rough diagrammatic sketch of the appearance of the cross-section of the nest as hollowed out by the woodpeckers. The ants' nest was a large, spherical, solid mass of leaves and clay, the leaves outside being arranged one over the other something like the tiles on the roof of a house, but riddled in many places with the entrance tunnels made by the ants—a small black and red species of *Myrmica*, the trivial or specific name of which I do not know. It is probably closely allied to the *Myrmica* mentioned by Sir J. Lubbock in his "Ants, Bees, Wasps" as having been described by Sykes in the *Trans. Ent. Soc.*, vol. i. Very few of the ants

[1] The wild hill-tribes of Burmah and Tenasserin have a wasteful system of cultivation called "toung-yah." Yearly, in February, the heads of families in a village choose, each head for himself, a spot of well-grown, often virgin forest, generally on a hill-side, and within as convenient a distance of the village as is obtainable, cut down all the trees big and small, and allow them to dry during the hot months of March, April, and May, and towards the latter end of the last month set fire to them. The ashes thus obtained from the timber forms a splendid manure for paddy, and *toung-yah* rice is preferred by the Karens to ordinary *quin* (field) rice. The "toung-yah," or clearing after the paddy has been gathered in, is abandoned, and in two or three months, under a hot sun and excessive moisture, becomes an inaccessible jungle, full of thorny bamboos, creepers, and elephant grass. Such deserted *toungyahs* are called *phonzohs*, and are not again cultivable for from ten to fifteen years.

remained in the nest, and the few that were about seemed agitated and stung virulently. Probably the mass of them had been driven off or eaten by the woodpeckers. The tunnel the latter had made was about two inches in diameter and four inches long, bored horizontally in, and ending in an irregular-shaped egg-chamber about ten and a half inches in cross diameter, but narrowed by the branch of pyingado which pierced the nest through and through, and crossed the egg-chamber diagonally. The bottom of this chamber alone was smooth, but there was no lining, and the two translucent white eggs of the woodpecker had rested on the bare boards, so to speak, of the ants' house. In the excavations *c c c* made by the ants themselves there were neither eggs, larvæ, nor pupæ; probably these all had been removed when the woodpeckers invaded the nest.

CHARLES BINGHAM,
Deputy Conservator of Forests, British Burmah
Henzada, British Burmah, April 12

Staminody of Petals

The cases of staminody of petals not being very frequent, it may be of interest to draw the attention of the readers of NATURE to such a modification as observed in Fuchsia.

The places of the four petals of the flower examined are occupied by four almost colourless filaments of an average length of three-fifths of an inch. Each of them bears on its top a nearly circular dark red lamina of three-tenths of an inch diameter. These laminæ are so strongly vaulted as to have the shape of a segment of a globe, the hollow side being turned outward, the convex inward. At the base of the lamina, *i.e.* at the top of the filament, a short protuberance is seen, resembling in external shape the lower part of an anther. This anther occupies the concave side of the lamina and is consequently turned outward. Though the anther of one of the petals is only slightly developed, yet it may be admitted as a matter of fact that, instead of petals, this flower has produced four stamens, whose anthers bear a petaloid appendage. A microscopic examination, namely, showed not only the peculiar composition of the anther-wall, but also the presence of pollen-grains.

Of the stamens, properly so called, the outer whorl is present, but the inner one is only represented by two of the four. One of these two is inserted in the ordinary way, viz. at the base of the petal. The second, however, has grown together half way up with the petal's filament; there it has, in consequence of a spiral turning, arrived at the back side of the petal, whence it bends obliquely outward. By this union the impression is created of a stamen rising from the back of the (modified) petal, concealing its anther in the lamina's concavity. This occurrence brings to recollection the case of *Monarda fistulosa* as cited by Maxwell T. Masters from Turpin ("Vegetable Teratology," p. 298), with this difference, however, that what is probably only adhesion is mistaken for petalody, whilst the case above described offers an antheroid petal grown together with a true stamen.

J. C. COSTERUS
Amsterdam, May 4

Catalogue of Fossil Mammalia in the British Museum, Part I.

IN the review of the above work in a late number of NATURE (vol. xxxi. p. 597) the reviewer entertains such a complete misapprehension of my system of naming the premolar teeth of typical heterodont Eutherian mammals that I must beg space to correct it.

The reviewer asserts that this system is untrue because it implies that in general with a smaller number than the full complement of four premolars the diminution must have commenced with the first, proceeded with the second, and so on. In reality it implies nothing of the kind, and if he had taken the trouble to turn to pp. 152 (No. 39,732) and 174 (No. 48,787) he would have seen instances where I have mentioned the absence of the middle teeth (*pm.*2 and *pm.*3) and the retention of the terminal teeth (*pm.*1 and *pm.*4). Similarly in the "Palæontologia Indica," ser. 10, vol. iii. p. 48, I have adopted the same system for the incisors, and have shown that in *Hippopotamus* it is *i.*2, and not *i.*3, that disappears in some species.

I am well aware that in many of the Insectivora and Chiroptera there is often great difficulty in deciding on the homology of the individual premolars when these are reduced in number; and the reviewer might have noticed that in the former order I have not ventured to definitely determine the position of any tooth in advance of the last premolar. Among the Chiroptera I have considered the three premolars of *Vespertilio* (p. 13) as homologous with the last three of the typical series, as there is apparently no evidence to the contary; the small size of *pm.* 3 indicates, however, that an allied genus may retain only *pm.* 2 and *pm.* 4; but the minute size of the one tooth in advance of *pm.* 4 in *Rhinolophus* has induced me to regard it as *pm.* 3, although it may be *pm.* 2.

The advantage of the system employed in the "Catalogue" is well instanced when we contrast the premolar dentition of *Canis*, and *Lepus* or *Theridomys*; the homology of the last tooth of this series (and there is only one in *Theridomys*) being at once seen, whereas it is entirely lost if we employ a method like that used in Dr. Dobson's "Catalogue of Chiroptera," where the actual first tooth in each genus is called the first of the series. I claim for the system adopted by myself every advantage in those cases where it is possible to determine the homology of the individual premolars in any form in which the number does not exceed four; and even in cases where such determination is not absolutely certain, the error can be but very slight, and does not lead to the utter confusion caused by the system (or, rather, the want of system) which I presume the reviewer would prefer.

When we come to those mammals in which the number of premolars is more than four, my system fails; and, in view of this, some German writers have adopted the plan of numbering the premolars the reverse way—*i.e.* terming the premolar next the first molar *pm.* 1, and then counting towards the incisors. Although this system would be advantageous if we could always be sure of the division between the premolars and molars in homœodont mammals; yet it has several disadvantages, and has not, therefore, been adopted.

In reference to the suggestion of your reviewer, that instead of making a catalogue of the fossil Mammalia in the collection of the British Museum (as I was instructed to do by the Museum Authorities), I should have made one of all the known species of fossil Mammalia, any person having the slightest pretence to any knowledge of the present state of mammalian palæontology would have at once known that it would be utterly useless to attempt any such work at the present time, when new species and genera are being made almost daily, and a host of those already made are as yet but empty names.

As a minor matter, I may mention in regard to the lower jaws of *Crossopus*, alluded to in the review, that their identification rests solely on the authority of Prof. Sir R. Owen, and that perhaps I have acted in a too conservative spirit in admitting them.

Harpenden Lodge, May 2 RICHARD LYDEKKER

Fossil Insects

"THE Earliest Winged Insects of America; a Re-examination of the Devonian Insects of New Brunswick in the Light of Criticisms and of New Studies of other Palæozoic Types," is the title of a *brochure* by Mr. S. H. Scudder, of Cambridge, Mass., recently published.

These Devonian insects are fragments of five wings; a sixth is now dropped, as "too imperfect for any satisfactory discussion," though in 1881 its description filled about two quarto pages. These insects have been, since 1865, so often discussed that their literature is a rather voluminous one. A number of far-reaching conclusions elaborated by the author would have to be abandoned if the determination of the insects should be proved incorrect. This I endeavoured to do in *Bull. Mus. Comp. Zool.*, viii. No. 14, Cambridge, 1881, and in NATURE, xxiii p. 483. The principal aim of the author's new paper is to show that my determinations are erroneous. Concerning his statement that I have studied in nature only the (in most cases poorer) reverses, I may remark that his paper gives nothing more, after his study of the obverses; even less for Gerephemera.

These Devonian insects have been decidedly unfortunate from the very outset. Eminent palæontologists denied their Devonian origin, and put them to the Carboniferous or to the "Ursa Stufe" of the sub-Carboniferous. One of the insects, *Xenoneura antiquorum*, said to possess a stridulating organ on the wing, caused an unusual sensation. Poetic palæontologists were delighted to be introduced by this insect to the sounds of the Devonian woods. Now these woods are silent again, except in some text-books. "It does not appear reasonable," said the author, "to maintain my former hypothesis of a stridulating organ." Everybody acquainted with such organs will be of his opinion.

Another insect, *Homothetus fossilis*, was said to have a small basal vein, considered to be homologous with the arculus of the Odonata, and therefore to form a connecting link between Neuroptera and Pseudoneuroptera. A new synthetic family, Homothetidæ, was proposed. But now a re-examination of this wing convinces the author "that he had been mistaken about this arculus." It does not exist at all.

The third insect, *Platephemera antiqua*, was determined by me as the apical half of the wing of a gigantic dragon-fly. As this is the only species claimed now by the author to belong to the Ephemeridæ, he defends vigorously his determination by four objections:—(1) "In no dragon-fly, living or fossil, is there found beyond the nodus between the mediana and margin, more than a simple longitudinal vein, the marginal vein." If the author will examine any Odonate wing *from below*, he will find such a vein, which is the prolongation of the subcosta, bent on the nodus to the marginal vein, and running close to it. Near the nodus it is more widely separated in larger species. (2) "The reconstruction of the wing, after the dimensions given by Dr. Hagen, would, on the most favourable showing, make a wing of ridiculously extravagant appearance." But such forms occur in living species of Tramea, Rhyothemis, &c." (3) "The narrowing of the second cubital space is a common feature in Ephemeridæ (six genera after the Rev. Mr. Eaton's plates are quoted); and, as this varies in different species of the same genus, it seems to be a very unimportant matter." I had purposely stated *suddenly narrowing*, and *this* does not exist at all in Ephemeridæ, namely *not in the six quoted* genera, and cannot therefore vary in the different species of the same genus. It exists in Odonata. (4) "The sector subnodalis does not run unbroken to the tip, as in all dragon-flies I have examined, but is lost in reticulation shortly before the margin." This last-quoted character is a very common feature in dragon-flies (Tramea, Rhyothemis, &c.). Only *very exceptionally* this sector runs unbroken to the tip in the large sub-family of Æschnidæ (*cf.* De Selys's "Revue des Odonates d'Europe," p. 122).

As all objections have been proved *to be incorrect*, and only based upon insufficient knowledge of the venation of Odonata and Ephemeridæ, Platephemera belongs by the simple evidence of facts to the Odonata. The new proposed family of Palephemeridæ dies unborn, and the conclusions made from Palephemera are without value.

The fourth species, Gerephemera, gives much trouble to the author, and he is now inclined to bring it into the same group with the Protophasmida. As only a part about 4 mm. broad can be said to exist in both figures (Brongniart and Scudder) which could be compared, and as this part contains only a few sectors running to the margin, the relationship of Protophasma to Gerephemera is not at all obvious. The reverse of Gerephemera contains more than the author has seen. The basal part of a hind wing to the sector trigonali inferior, the basal part of a front wing with the same sector, and some veins belonging, probably, to another (front?) wing. The part figured and described by the author belongs, probably, to the other hind wing. No student of Odonata will be in doubt that Gerephemera belongs to this family, perhaps near Isophlebia. His statement "that the superior origin of the branches of the sector medius is entirely inconsistent with an Odonate hypothesis, and is the most salient point in the wing," is directly recognised as an error by looking at the figures in De Selys's "Monograph Caloptérygines" (*cf.* Cleis, Vestalis, Neurobasis, &c.). This statement is only surpassed by the emphatic repetition "that the marginal would then be an elevated, and the mediastinal a depressed, vein, *which combination is never the case*." This statement is just the contrary to what exists in all Odonata—unless it is preferred to examine the wings from beneath.

There exists still no monograph of the Sialidæ; therefore it is impossible to make conclusions and form new families for the other three Devonian species. The opinion on the Devonian insects given by Rev. A. E. Eaton (NATURE, vol. xxiii. p. 507) is still very just: "Palæontologists have adopted a ridiculous course with regard to some insect fossils. Whenever an obscure fragment of a well-reticulated insect-wing is found in a rock, a genus is straightway set up, and the fossil named as a new species. The species is then referred to the Ephemeridæ, and is immediately pronounced to be a synthetic type of insects at present distantly related to one another in organisation. This enunciation of synthetic types is often nothing less than a resort at random conjecture respecting the affinities of animals which the writer is at loss to classify. I thought that the Ephemeridæ had served quite long enough as an asylum for fossil cripples. I wished to intimate gently, that refuse of other groups of insects should be henceforth shot elsewhere."

Cambridge, Mass., March 12 H. A. HAGEN

High-Level Stations

IN NATURE, vol. xxxii. p. 17, I find the abstract of an address by Mr. Omond, on "Ben Nevis." There are many points of interest, but I regret that one was not mentioned—viz. the exceedingly rapid decrease of temperature with elevation from Fort William to the Ben, anything nearly approaching, in middle latitudes, being only found on the Brocken, and all high-level stations of the Alps showing a much smaller decrease. At the Brocken, as well as at the Ben, the great difference from the Alps is not in summer, but in the colder months of the year. The reason seems to lie in the nearly constant winds, which bring air from below, which is cooled by ascension. The cases of great dryness of the air with descending currents in anticyclones in the colder months of the year, when isolated mountains are often much warmer than the valleys,[1] are comparatively rare in the North of Scotland, but frequent in the Alps, and certainly must and do have a great influence on the mean temperature. Where they are frequent, as in the Alps—especially the eastern—the mean amount of decrease of temperature with elevation must be slower.

I think all meteorologists will concur with me that the greatest points of interest in the Ben Nevis station is the study of the meteorological phenomena near the centres of cyclones, as no high-level station in the world is so favourably situated as this for this study. A. WOEIKOF

St. Petersburg, May 1 (13)

Rainbow Phenomena

YOUR correspondent Mr. C. Croft (NATURE, No. 811, p. 30) has noticed phenomena which are perfectly familiar to students of physical optics. The internal bands of colour within the primary bow are the "supernumerary" bows due to diffraction. They were described by Langwith in the *Philosophical Transactions* for 1722: a partial theory of them was given by Young in 1804, and a complete theory by Sir G. Airy in 1836. The illumination of the sky in the regions within the primary and without the secondary bows, and also the relative darkness of the space between the two bows, Mr. Croft will find the desired explanation in any elementary treatise on optics; Osmund Airy's Geometrical Optics may be cited as giving a good account of these matters. The particular bow seen by Mr. Croft appears to have been of unusual brilliancy; did he notice any of the radial streaks, which I described in 1878 as frequently accompanying rainbows? SILVANUS P. THOMPSON

Finsbury Technical College, May 16

Aurora

LAST night at about 10.30 to 10.35 p.m. there was a well-marked aurora visible from here. It did not last long, the bright bands fading rapidly into a general glow towards the north. The wind, which was easterly yesterday, has gone round to north-west to-day with tendency to rain and low temperature.

J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green, Dublin, May 14

Red Hail

MR. W. H. MITCHEL, of Newry, has sent me the accompanying note, which he thinks may be of interest to the readers of NATURE. C. EVANS

Downshire Hill, Hampstead, N.W., May 18

On May 7, Mr. R. A. Mullan, solicitor, of Newry, was driving in a gig near Castlewellan, co. Down, when he was overtaken by a shower of hail. To his surprise he observed that some of the hail-stones—perhaps one in a hundred—were of a

[1] This is well explained in the "Handbuch der Climatologie" of T. Hann. See also my paper in the *Zeitschr. f. Meteorologie*, 1883, pp. 211, 241.

decided red colour, the rest being white, as usual. Taking up some that fell in the gig, Mr. Mullan found that the colour was not merely superficial, but pervaded the substance of the hailstone, and, on melting, they stained the fingers. He did not think, or had not the means, of preserving any of the water resulting. Has the like been observed before?

Spectral Images

MR. BIDWELL's notice of spectral images (NATURE, vol. xxxii. p. 30) calls to mind certain phenomena I witnessed while riding in a railway train in Kentucky last October. The fence of the railway consisted of posts of about 6 inches in diameter, and twenty paces apart, connected by wires. The posts had newly been painted green. I was seated on the right side of the carriage, face forwards; the speed fully twenty miles an hour, with the sun behind my right shoulder, when looking at the posts on the left side, brightly illuminated by the sun, I observed that each post had the appearance of a twin post immediately in advance of it—touching it—of a red colour. To make myself sure that I was not deceived by some abnormal affection, I called the attention of a niece of mine to the phenomenon, and she saw it quite as well as I did. Another niece, however, failed to make it out. I am under the belief that the red post was the complementary colour of the green one, appearing the instant after the latter had been seen, and though apparently in advance in space of the green post, really was seen later in time. The fact of both being apparently seen simultaneously, is accounted for by the well-known law of retinal images lingering on vision. HENRY MUIRHEAD

Cambuslang

THE NEW OUTBURST OF LAVA FROM VESUVIUS

YESTERDAY, May 2, up to two o'clock, Vesuvius appeared to be in its natural state of activity, such as persisted with slight variations for some considerable time. At that hour the lava, which was at some height within the cone of eruption, forced a way out at its base, traversing the plain of old lava filling the crater of 1872, and producing a rent about one quarter the way down the great Vesuvian cone. This rent represents the extension outwards of a volcanic dyke that has been in process of formation for over two years. A visitor during that period who walked around the southern rim of the 1872 crater, might have noticed a fissure varying from a few inches up to 2 feet wide, and extending inwards across the crater plain, until lost beneath the *ejectamenta* of the cone of eruption. From this fissure issued a powerful current of hot air, and in part of its course an abundance of HCl. This latter was indicated by the continual decomposition of the scoria and ash in its immediate neighbourhood, so that a large patch of yellow dust filled with the unattached pyroxene crystals was a point of bright colour in the black scoria-covered lava-plain. The lava at first actually issued, or, more properly, welled up from this fissure, but its point of exit was soon lowered by the cutting down of the outer slope. The lava soon commenced to flow down the cone with considerable rapidity, forming two distinct parallel streams averaging fifty metres apart, so that in the evening the landscape was lit up by these two brilliant streaks of fire. This morning I started early, and ascended on foot to the eastern side of the two streams, though often inconvenienced by the hot wind and exhalations blown off the lava. The streams take origin close together, and no doubt conjoin, but are covered by scoria—a vast quantity of *lapillo* and ash that has been slipped downwards and forward, forming a rough annular space which would require a drawing to explain. At the upper end of this we have part of the great cone slipped down, showing in section the dyke, which I may call hollow; we have a fissure which was filled by lava, and which consolidated and adhered to its sides, forming *salbam;* but before the central part solidified, the general level was lowered, and it drained away, leaving the dyke divided in two by an empty space. At 2 p.m. to-day the streams of lava had the following dimensions at their exit:—

	Eastern		Western
Breadth	about $1\frac{1}{2}$ metres	...	About $2\frac{1}{2}$ metres
Depth	estimated at 1 metre	...	at 2 metres

Rate of flow on both, about 1 metre per second.

The output therefore equals for the eastern stream about 90 cubic metres per hour, or 2160 cubic metres in 24 hours, whilst that of the western stream represents 300 cubic metres per hour, or 7200 in 24 hours. The two streams, therefore, represent an output of 9360 cubic metres during the 24 hours, from May 2 to 3, at 2 p.m. This quantity would equal a deposit of rock of about 1 km. long, 9 m. broad, and 1 m. thick, which is rather an under-estimation of what now lies on the side of the mountain, for the two streams had at the hour of observation traversed more than two-thirds of the *pedimenture.* The amount of lava represents far more than what occupied the chimney above the level of the lateral opening, and the mechanism of the increased quantity extruded I have gone into fully in a paper read last week before the Geological Society. The cone of eruption only now gives forth vapour, its stone-throwing propensities being stopped by the lowering of the magma level. In consequence of the want of support of its inner walls by disappearance of the fluid column, these are rapidly crumbling in, and the craterial inner cavity much increased in size. In the same way a breach has been made in the line of the dyke by falling in of that part of loose materials immediately above it.

This change in Vesuvius will no doubt be put down in history as an eruption, and possibly a relationship sought between contemporaneous earthquakes, or some other phenomena. It is nothing more nor less than the final giving way of part of the cone before a dyke that has been working its way out for years.

I send you these few notes after a long day's climb, exposed to great changes of temperature and mephitic vapours. I ask, therefore, that this will be taken as an excuse for these rough and ready notes, which I thought your readers would be interested to have quickly.

Naples, May 3 H. J. JOHNSTON-LAVIS

EXPERIMENTS WITH COAL-DUST AT NEUNKIRCHEN, IN GERMANY

IN a former article on this subject which appeared in NATURE of Nov. 6 last (p. 12), I described the apparatus employed by the Prussian Firedamp Commission in making their experiments, and at the same time I gave an account of four experiments that were seen by Mr. Wm. Thomas Lewis and myself.

No official account of these experiments had been published at that time, but quite recently Herr Hilt and Herr Margraf have made a joint report in the name of the Commission. As this report is intended to be only a preliminary one, it does not give the whole of the details of each experiment, but it shows as far as it goes that everything has been conceived and carried out in a spirit of liberality and thoroughness.

At the outset Herr Hilt states that the uncertainty which seemed to surround this important question, and in particular the peculiar views that had been enunciated by MM. Mallard and Le Chatelier, who reported upon it to the French Commission du Grisou,[1] had induced him to address a letter on the subject, dated December 15, 1883, to the Prussian Wetter-Commission, urging them as a matter of duty to take it up and investigate it by a series of large-scale experiments. The French Commissioners, referred to, stated at the end of their report that "they considered it established that coal-dust in the absence of fire-damp does not constitute an element of

[1] *Annales des Mines*, Janvier—Février, 1882.

danger." "It may, however, play an important part in aggravating the consequences of a firedamp explosion." I had myself keenly felt how difficult it would be after a verdict of this kind, emanating from such high authorities, to make further progress in the work of convincing practical mining men of the truth of the views I had previously advocated in the pages of the Royal Society's *Proceedings*. For that reason, and in the absence of some powerful weapon wherewith to meet the French Commissioners with some chance of success, I have hitherto desisted from doing battle with them, although I have been satisfied they were in error from the first. The required weapon has been provided by Herr Hilt, the spokesman of the Prussian Commission, and may now, I think, be made use of without much fear of future contradiction.

Speaking of coal-dust from Pluto Mine, in Westphalia, Herr Hilt says, as the outcome of a long series of practical experiments on the largest scale yet attempted: "Es kann keinem Zweifel unterliegen dass mann mit dieser Staubsorte bei Verlängerung der Strecke und Streuung auch der Flamme eine beliebige Länge würdegebenkönnen. Ganz ähnlich erhält sich der Staub von Neu Iserlohn." Or: "There can be no doubt that with this kind of dust the flame could be lengthened out to any desired extent, provided the gallery and the layer of dust on its floor were made equally long." "The dust of Neu Iserlohn behaves in exactly the same way."[1]

After carefully examining the details of this report, I think it not improbable that many, if not most, of the other twenty-four kinds of coal-dust that were subjected to experiment would have given results similar to those which led to the foregoing remarks had they been employed in the same state of minute subdivision. Differences in chemical composition do not appear to have as much effect in controlling the length of flame produced by a given dust under a certain set of conditions as the comparative fineness of the particles of which it is composed. In order to show the effect of fineness Herr Margraf has divided the dusts into five classes, as follows:—

Number of Dusts in each Class.	Designation of Class.	Length of Flame produced by firing 230 grm. of powder in cannon next floor, the floor being strewn with coal-dust for a length of 10 m.
Five, beginning with Pluto	Very fine ...	21 to 31 m.
Twelve, ending with Camphausen	Fine	13 to 21 m.
Four	Medium ...	12 to 15 m.
Five	Coarse	6 to 12 m.

Some experiments were also made with dust passed through sieves having meshes of various widths, which showed that the finer the state of subdivision, the longer was the corresponding flame.

From this it is obvious that before anything definite can be ascertained regarding the influence of chemical composition, it will be necessary to reduce the dusts to a uniform standard of fineness. Herr Margraf proposes to do this by passing them through a sieve with meshes 1 mm. wide. I am afraid, however, that some more exact method of effecting a separation of the very fine from the moderately fine particles will have to be resorted to before a satisfactory result can be looked for. A current of air ascending slowly at a uniform rate would be a better means than any conceivable kind of sieve.

I have on several previous occasions pointed out that when a colliery explosion has been begun in a dry mine the coarser particles of coal-dust are winnowed from the finer ones by the blast of air which sweeps through the workings in advance of the flame. It seems to me that under these circumstances experiments made with any other than the finest particles of each kind of dust can serve no practicable purpose whatever, and that any general conclusions drawn from them must necessarily be misleading. It is further highly probable that this is the rock upon which the French Commission was shipwrecked.

They had ascertained by actual experiment that, as the coarser particles of any given dust were removed by sifting, the flame produced under the same set of conditions became longer and larger in proportion to the fineness of the remaining dust. Yet they failed to carry the argument to its legitimate conclusion. They appear to have been misled either by too much speculation, or by the negative results of their experiments, due, it may be, to the smallness of the scale upon which they were made. They finally pronounced coal-dust to be an element of very secondary importance in colliery explosions, thereby allowing a splendid opportunity to slip from their grasp. The Prussian Commissioners were not slow to take advantage of the opening thus afforded them. Thanks partly to the large scale upon which they have set to work, partly to the natural fineness of Pluto and Neu Iserlohn dust, they have been fortunate in obtaining a series of positive results which amply confirm those previously obtained with the somewhat smaller apparatus belonging to the Lords of Committee of Council on Education set up in this country under the auspices of the Royal Society (No. IV. paper, "On the Influence of Coal-dust in Colliery Explosions," *Proc. Roy. Soc.*, 1881).

The dust brought from Camphausen Colliery does not appear to stand very high on Herr Margraf's list, and yet, since the publication of the memoir, that colliery has been devastated by one of the most violent explosions on record, in which it is admitted, I believe, that coal-dust, and not fire-damp, was the principal agent of destruction. Are we to conclude from this that the nine dusts which lie between Pluto and Camphausen in the order of relative danger are equally liable to produce a flame of indefinite length under like favourable conditions? and, if so, is it not obvious that the experiments are not as reliable as might be wished, since they fail to tell us so?

Before concluding, I might mention that Herr Hilt refers to and agrees with a remark made by MM. Mallard and Le Chatelier to the effect that the method of experiment followed by Sir Frederick Abel and myself when using the apparatus described in my first paper was "too little exact" to determine accurately what percentage of gas is required to render a mixture of coal-dust and air inflammable. My earliest experiments here referred to were made with the view of finding, if possible, some rational explanation of great colliery explosions which up to that time appear to have baffled every attempt to grapple with them, and were not intended to form a kind of counterpart on the large scale of the exact eudiometric processes resorted to in the laboratory. At the same time I may state, however, that, so far as I have been able to ascertain by reading and observation, the methods then employed will compare not unfavourably, as regards exactness, with any that have succeeded them, not excluding those of the Prussian Wetter-Commission.

W. GALLOWAY

[1] It may be instructive to compare this conclusion with the second sentence of No. 1 paper, "On the Influence of Coal-dust in Colliery Explosions," *Proc. Roy. Soc.*, 1876; the second last sentence of No. 2 paper, *ibid.*, 1879; the conclusion of No. 3 paper, *ibid.*, 1881.—(Abstract).

THE FAUNA OF RUSSIAN CENTRAL ASIA

UNTIL within the last thirty years Turkistan has been unknown to science, and what is now ascertained concerning its fauna and flora is for the most part inaccessible to the scientific world because written in Russian. Not that autoptic writers of eminence upon the zoology of the country are numerous. They do not number a dozen, the names most conspicuous being Prjevalsky, Alpheraky, Bogdanoff, Severtsoff, and especially Fedchenko. Prjevalsky's routes do not touch mine, except in the Kuldja region, where also Alpheraky travelled, and collected Lepidoptera, with a list of which he has favoured me. To Bogdanoff and Severtsoff I am indebted for information not previously published in English, whilst in connection with the immense work that bears Fedchenko's name I have had the valuable help of Madame Olga Fedchenko, who both accompanied her husband on his scientific journeys and, after his lamented death, edited his works. When I add that I have before me proofs of between three and four thousand species of fauna and flora, in about twenty lists with introductions, the scientific reader will not need to be told that in the compass of a single article I can but touch the fringe of the subject. I have ventured to think, however, the readers of NATURE might be interested in a plain statement that would give some idea of the little-known fauna of Turkistan, as well as indicate what I hope to publish shortly in fuller form.

The part of Russian Central Asia through which I recently travelled, and with which this paper will be mainly concerned, lies between the Oxus and Irtish Rivers, and between the 38th and 50th parallels of north latitude, which region comprises vertically all altitudes from the salt plains, 600 feet above the sea, to the mountain plateaus of the Pamir, 15,000 feet high.

The species of mammals in Turkistan exceed 80 in number. Among them may be mentioned 7 species of bats, the long-eared hedgehog, and the white-clawed bear. To these must be added the badger, otter, and other *Mustelidæ*, including three species of marten. Of the last I was able to secure some skins and skeletons, which are now in the British Museum. The wolf abounds; also a wild dog; 3 species of fox; the tiger, snow-leopard, cheetah, and other cats. The salt-plains are frequented by the souslik, and many other rodents, including the hairy-nosed porcupine. To these should be added the Persian gazelle, the Saiga antilope, the Siberian ibex, and the Maral stag. I saw at Kuldja and Tashkend specimens of the skull and horns of the Thian Shan sheep, which is bigger than a donkey. The horn is more than four times the length of the skull, and the head complete weighs upwards of 70 lbs. The yak is kept by the Kara-Kirghese. The Russians, too, as an experiment, have introduced some cross-breeds into the plains.

The birds of Turkistan number nearly 400 species, to which may be added 27 frequenting the Pamir. The diurnal birds of prey, such as vultures, eagles, hawks, &c., number 36 species, some of which the Kirghese train for hunting. Of nocturnal birds of prey there are 9 species of owls. There are thirteen species of crows, and no less than 40 of the finch family, including a new species of sparrow. The thrush family is represented by the blackbird, black-throated, misletoe, and some other thrushes. There are more than 40 of the warbler family, many of them being known in Western Europe, such as the greater nightingale, the bluethroat, redstart, redbreast, and others. Six species of the titmouse family are found in Turkistan, only one of which, however, the well-known oxeye, is common also to England. Two species of dipper are found throughout the country, and other small birds are the Nepalese and European wrens, the Syrian nuthatch, and no less than 10 forms of wag-tails. Of pipits there are 7 species, and 14 of larks. The hoopoe I saw when coming south from Sergiopol, and again in the streets of Vierny. Other Turkistan birds are the bee-eaters, the three-toed woodpecker, the ubiquitous cuckoo, and the wonderful Pallas's sand-grouse, which last, some twenty years ago, invaded Europe in such an astonishing way.

Among gallinaceous or game birds are found in Turkistan the black grouse, the capercailie, four species of partridge, the quail, Mongolian pheasant, pea-fowl, and common cock. Of the swan, goose, and duck tribes there are nearly 30 species. Wading-birds, again, are found in great variety, and among them a red-billed curlew, thought at first to be a new species. It has red legs, and a remarkably long red beak, bent at the end, and well adapted for picking up worms from between the pebbles of the beds of the mountain streams it frequents.

Reptiles are represented in Turkistan by 33 species of lizards, vipers, and tortoises. Of the last I tried to bring for the Zoological Gardens a species (*Homopus horsfieldi*), and it travelled asleep with me some hundreds of miles from Tashkend, but on approaching Odessa it was found to be the sleep of death. Almost all the serpents are non-venomous. Of amphibians there are five species, including the edible frog and green toad.

The fishes of Turkistan are composed half of European and half of Asiatic forms. The European forms belong principally to the lower course of the Syr-daria, Amu-daria, and part of the Zarafshan, whilst certain genera belong exclusively, so far as is known, to the high mountainous countries of Central Asia. The total number of Turkistan species probably exceeds fifty. Of these twenty-five at least belong to the carp family, and there are taken besides sturgeon, trout, pike, barbels, gudgeon, rudd, roach, bleak, bream, loaches, and perch. The fishes of the Zarafshan are particularly noticeable. Of fifteen species found therein not less than five belong to genera met with in numbers in Kabul, Kashmir, Nepal, and the Himalayas. To one of these genera belongs the *Marinka*, remarkable for its poisonous eggs. The greatest find, however, among the ichthyological fauna of Turkistan has been the *Scaphirhynchus*, of great importance, not only from a zoological, but also a biological point of view, on account of the extreme smallness of its eyes and the rudimentary condition of its air-bladder. This fish, and certain geological questions connected therewith, was referred to in NATURE in connection with a letter on the Oxus that appeared in the *Times* on January 7 last.

If for Mollusca we enlarge our area to take in Kashgar and Ladak, then we have in "Central Asia" thus formed 93 species known up to the present time, the land snails being scarce in the desert plains as compared with the larger number and more peculiar forms in the mountain regions. Among the fresh-water Mollusca the predominant feature is the large number of air-breathing species which live in stagnant water, and the almost total absence of the genera living in running water. It has been suggested that this scarcity may be due, as in Switzerland, to the low temperature and stony bed of the rivers.

Among the 50 species of Crustacea known in Turkistan there was not discovered for a long time a crayfish; but Madame Fedchenko informs me that one of a variety new to the species hitherto known in Russia has been recently found. Among the Crustacea inhabiting the fresh waters of Russian Central Asia a very large number of West European species is found, and the new species are, in the majority of instances, very similar to the commonest in Central and Southern Europe.

Of the 16 families to which European spiders are said to belong, all, except two groups very limited in number, have their representatives in Turkistan. The 146 species known there belong to 55 genera, which constitute approximately one-half of the total of European genera. The *Tarantulæ* are remarkable in that there are found in the Zarafshan Valley forms which in Europe are met with in countries far apart from each other, and have been reckoned as different species. The most widely distributed form is that with the lower part of the abdomen quite black; next comes the form with coloured edges; and, finally, that with the lower part almost entirely orange. The scorpions of Turkistan are identical with those met with in Trans-Caucasia, and the distribution of one species (*Solpuga intrepida*) is remarkable. First found in Spain, it was seen later on the Indersk Mountains, then in the Zarafshan Valley, besides which specimens of this harvestman have been found in Vierny.

The animal is reckoned poisonous, and its bite has in certain cases been followed by death, although nothing is yet known of its poison-apparatus.

The species of Turkistan beetles are estimated at 1000. I have before me a list of 500, some of them as yet unpublished. Amongst the most remarkable is the *Copris tumulus*, the largest specimen measuring one inch and three-quarters long.

The hymenopterous fauna of Turkistan is not yet fully worked out, but I may observe that of *Mellifera* there are known 438 species, and of *Sphegidæ* upwards of 150. As regards the latter, the valleys of Ferghana and the Zarafshan do not present many specialities. On the other hand, the Kizil Kum desert abounds in new species and even genera, sharply distinguished from known species both in the form of the body and in the beauty and size of the individuals. There is, moreover, a remarkable similarity between the species belonging to the Kizil Kum and the Egyptian sands. Of *Scoliidæ* 30 species are known, whilst of *Mutillidæ* 18 species have been treated by Gen. Radoszkovsky, who informs me that Gen. Komaroff, now military governor of the Trans-Caspian district, has quite recently made scientific explorations between Askhabad and Merv, and that among the insects collected by him about Askhabad are six speces of *Mutillidæ*, four of which are marked as new, and one as a new genus. Of 36 species of ants collected in Turkistan, 7 only were new. The Formicidæ of the region seem to be very similar to those of South Europe. This is not astonishing, since the mean temperature of a Turkistan summer differs little from the mean summer heat in Southern Europe, and this case only proves once more that, in general, countries with summers alike have greater similarity with regard to fauna and flora than countries lying under identical isotherms with different summers. This peculiarity is evident with regard to Formicidæ, because, for example, in Italy and Turkistan they have an identical summer; and though the winter in Turkistan is long and cold, it does not appear to have much influence over the ants, which are protected therefrom. European species which live in trees and woods appear to be in most cases absent from Turkistan. Of the new Turkistan species one *Ischnomyrmex rhaphidiiceps*) is specially interesting, as closely allied to two species inhabiting countries between the tropical and subtropical zones of the southern hemisphere. It is remarkable, therefore, to meet with a species of the same genus in the temperate zone of the northern hemisphere, and it may be presumed that these last have existed in Turkistan since the Tertiary period. I have yet to mention *Chrysidiformes*, of which 53 species have been found in Turkistan, and among them 2 new genera and 15 new species.

Before passing from hymenopterous insects I may mention that, though saw-flies are not numerous in the Zarafshan Valley, yet there is one form particularly remarkable, for, with a normal male, related to the group *Selandridæ* is a female without traces of wings. Affected by this absence of wings, the thorax undergoes important changes, and appears greatly swollen, and all the females generally have the appearance of little bags. Its relation to this family is said to be astounding, since it is the only example of the wingless form in the whole family of saw-flies. All the other specialities of structure, however, as well as the wings of the male, confirm it.

One of the first lists made of the butterflies and moths of Turkistan enumerated 367 species, of which 122 species were of *Microlepidoptera*. The great majority (284) were caught in the oases and hilly districts between 750 and 4500 feet above the sea; 41 species also were taken on mountains up to 8000 feet high, and 28 species from 8000 to 13,000 feet. Mr. Alpheraky, of Taganrog, has furnished me with a list in manuscript of 377 species of Lepidoptera collected by him in 1879 in the district of Kuldja and the surrounding mountains; but even these two lists together, I am told, give only an incomplete enumeration of the Lepidoptera of Turkistan, which contains a large number of new forms.

As we travelled from Tashkend to Khojend dragon-flies were so numerous that we caught several specimens by extending a butterfly-net from our carriage. The neuropterological fauna, however, of Turkistan is only partially known. Mr. MacLachlan has treated upwards of 60 species, most of them European in character, and many of them belonging even to Western Europe, whilst there is also an unimportant mixture of the Indian element.

There is a mingling again of the Indian element in the orthopterous fauna of Turkistan, but the Indian species are much fewer than the European. This fauna is particularly like that of South Russia, and it contains a large number of West European species. The non-European species are from South Asia, among which are a few from more distant countries, particularly from Africa. The total number of species known in Turkistan exceeds 70. Among them should be mentioned two locusts, and a third called locally *Prus*. Ravages of the former have been complained of in the neighbourhood of Perovsk and of the "*Prus*" in the Zarafshan Valley.

Of *Hemiptera* I have no list of species, but I saw a fine collection at Tashkend, made by Mr. Oshanin.

I come, lastly, to *Cestodes*, or intestinal worms. Of 47 species known in Turkistan, 2 are found in man, 3 each in the dog and sheep, 2 each in the cat and goat, and 1 each in the horse, ox, and marmot; 30 are found in birds, 2 in reptiles, and 1 in fishes. Of all the Vermes the most interesting is what the Bokhariots call the *Rishta* (*Filaria medinensis*). The parasite is found at Bokhara and certain adjacent towns in the water of stagnant pools, which the natives drink, and suffer in consequence from the *rishta* disease. The worm develops under the skin, lengthening at the rate of about an inch in a week, until an abscess is formed, through which the head (as is said) of the parasite appears. The problem, then, is to extract the animal entire. Native specialists insert a needle, and one end is drawn out by the fingers of the right hand, whilst those of the left press the adjacent part. Russian medical men wind off the animal on a reel, so much as comes out daily without force, till the whole, commonly three feet in length, is extracted. If, however, the worm should break, thousands of fresh germs are liberated from the broken part, and the illness continues for several months. I met with an unsuccessful case at Samarkand, and was given by the doctor some pieces of the *rishta*, which I brought in spirits to London.

The appearance of the worm is of a milk-white colour, resembling cooked vermicelli, and it can be stretched like a piece of elastic. The investigations of Prof. Fedchenko brought to light some very interesting facts concerning the *rishta*, the first of which was that the germs of the parasite cannot live in very fresh water, which is in keeping with the fact that the parasite appears only in those places where the people are forced to use standing water. The *rishta* is the last of the Turkistan fauna that I can mention here, but I hope within a few weeks to publish fuller particulars, through Messrs. Sampson Low and Co., in a new work entitled "Russian Central Asia, including Kuldja, Bokhara, Khiva, and Merv, with Appendices on the Fauna, Flora, and Bibliography of Russian Turkistan."

HENRY LANSDELL

FIELD EXPERIMENTS AT ROTHAMSTED[1]

THE above Report, forwarded to us, bears the name of no publisher, and is not priced. It therefore may be taken as a private issue, copies of which can only be

[1] "Memoranda of the Field Experiments conducted on the Farm and in the Laboratory of Sir John Bennett Lawes, Bart., at Rothamsted, Herts., June, 1884."

had by application to Sir John Lawes at Rothamsted Park, St. Albans.

The task of reviewing matter of so condensed a character as this is by no means easy. Ever since 1840, Sir John Lawes has carried out field and stall experiments on a scale well worthy of a national enterprise. Elaborate papers by this most enterprising of experimentalists, and his equally well-known coadjutor, Dr. T. H. Gilbert, have poured forth from Rothamsted during the entire memory of the present generation. During the last twenty-five years the scientific staff presided over by Dr. Gilbert has consisted of two, and sometimes three, chemists, and as many competent assistants, a botanical assistant, two to four computors and record-keepers, besides laboratory men. From 1847 to 1884 ninety-six memoirs have been contributed upon subjects bearing upon the soil, the plant, the atmosphere, drainage water, and rainfall, utilisation of sewage, animal nutrition, feeding-materials, manures, the occurrence of fairy rings in pastures, &c., &c. There is, in fact, scarcely a topic of agricultural or pastoral life which has not been investigated at this great English Agricultural station, and that through the enterprise of one man.

The Memoranda commence with a summary of rainfall and drainage extending backwards to 1851. Not only is the local rainfall given for each month over a period of nineteen years, but also the amount percolated through gauges of 20, 40, and 60 inches in depth of soil, the amount evaporated, and the amount retained by capillary attraction in the soil. Thus, as a general summary of the total rainfall, we find 45·3 per cent. percolated through 20 inches depth of soil, 47·4 per cent. through 40 inches of soil, 41·9 per cent. through 60 inches of soil, as indicated by rain- or drain-gauge, while the remainder is accounted for by evaporation or retention in the interstices of the soil. The averages obtained by unremitting observation from 1851 to 1870 are used in comparison with subsequent years, as in the case of the last completed record from September, 1882, to August, 1883. The three last columns of the tables given are devoted to the nitrogen removed in solution by percolation of drainage-water calculated in pounds per acre, by which we see that, at the depths above-mentioned, from 36 to 44 lbs. of nitrogen per acre are annually carried down from the upper layers of the soil to a depth of 5 feet and more.

One of the most attractive series of experiments, extending now over a period of thirty years, is that carried out upon permanent grass-land in the Park at Rothamsted. Space forbids more than a most cursory sketch of these experiments. Like all the Rothamsted investigations, the first aim is practical and comparative. The questions asked are as follows:—What is the effect of various applications to grass land? Which gives the largest return? What is the effect upon the herbage of continuous and of varied treatment? What is the effect upon the soil of long-continued privation and of long-continued *feeding* with simple and combined dressings? The investigation is at once chemical, physical, and botanical, and the change wrought in the character of the herbage of various contiguous plots of natural pasture, as well as upon the soil to a great depth, is most remarkable.

Perhaps the chief interest in the experiments upon crop cultivation will still centre around wheat. Broadbalk field, on the Rothamsted estate, is unique, so far as treatment and cropping goes. In 1839 this field carried a crop of turnips, manured with farm-yard dung; in 1840 it was barley; in 1841, peas; in 1842, wheat; in 1843, oats; all the four last crops being unmanured. The field was, therefore, according to all farming rules, in an exhausted state when the first experimental crop of wheat occupied it in 1844. Every year since 1843 has this field carried wheat, and, with some exceptions, nearly the same description of manure has been applied to each plot. In this field the visitor, during the present summer, will see the forty-second wheat-crop growing without manure of any description upon the unmanured portion of the field, still keeping up a wonderfully uniform yield of about thirteen bushels per acre—or about the average yield of wheat-lands in the United States of America. This is a striking fact for those who fear the eventual exhaustion of our soils. Equally startling is the result from the continued use of nitrate of soda year after year. This fertiliser is looked upon by many landlords and agents with suspicion as a stimulator and exhauster of the soil; and yet after forty-one years application of nitrate of soda, and nothing else, we have the astounding result of an average of 23½ bushels per acre, or double the yield of the unmanured plot. And, although it is true that the yield of the unmanured and nitrate of soda plots is less upon an average from 1868 to 1883 than it was from 1852 to 1867, yet it is equally true of the plot manured with 14 tons of farmyard manure annually; and this falling off is therefore probably due to a succession of bad seasons, more than to any actual exhaustion of the soil. Another striking fact brought out in these experiments is the excellent results achieved by applications of artificial fertilisers as contrasted with those obtained from farm-yard manure. In the latter case, where 14 tons of dung have been annually applied to the wheat-plot for forty years in succession, the very satisfactory yield of 33½ bushels per acre has been obtained over the entire period. When, however, a well-compounded mixture of artificial fertilisers has been applied, a larger yield has been obtained. For example, 200 lbs. of sulphate of potash, 100 lbs. of sulphate of soda, 100 lbs. of sulphate of magnesia, 3½ cwts. of superphosphate, and 600 lbs. of ammonia salts, have given upon an average over the same long period 36 bushels per acre year by year. We must not draw these remarks to a conclusion without at least noting the interesting experiments upon barley, the leguminous crops, clover sickness, root crops, and potatoes. The memoranda close with a synopsis of a series of experiments upon rotations of crops commenced in 1848 in order to test the effect of growing crops in rotation, instead of continuously, and so to arrive at precise results when a system of mixed farming is pursued with and without manures, and in conjunction with sheep farming.

JOHN WRIGHTSON

RECENT EXPLORATIONS OF THE PAMIR

THE third fasciculus of the *Izvestia* of the Russian Geographical Society contains three very interesting papers, by D. L. Ivanoff, on the Pamir, being the results of the expedition of MM. Ivanoff, Putyata, and Bendersky, already mentioned in NATURE. The first of these papers deals with the journeys of the members of the expedition; the second contains the author's views on the orography of the Pamir; and the third gives a description of the flora, fauna, and inhabitants of this "Roof of the World." Leaving aside the purely geographical part (M. Ivanoff's papers should be translated into English), I shall sum up the most important orographical results arrived at by the author, as also his observations on the natural history of the Pamir.

As to its limits, so variously determined by geographers, M. Ivanoff places them—rightly in my opinion—as follows:—The Alay Mountains in the north, the Hindukush in the south, and the Kashgar Mountains in the east. As to its western limits, the following remarks ought to be made:—The whole of the highlands on the upper Amu-daria must be divided into two parts—the Eastern Pamir and the Western. The Eastern Pamir is a very high plateau, intersected by numerous valleys, rivers, and lakes, with an average height above the sea-level of 12,000 feet (from 10,000 to 14,000). These valleys are either separated by chains of mountains or by low swellings which mostly reach only from 1100 to 1500 feet above the level of the surrounding valleys, and very seldom 3000 feet. The slope of these swellings above the valleys is so gentle that water-sheds only 1100 to 1500 feet high are often twenty to fifty miles distant from their foot. These high valleys strictly correspond to what the inhabitants call "Pamir." "Pamir" signifies, in fact, "a flat roof," and when the inhabitants want to describe it in more detail, they add: "broad valleys between low mountains, so high, however, that nothing but grass may grow on them; where there is nothing," they say, "and the earth is like the palm of the hand, that is the Pamir." So they describe what a geographer would call a High Plateau. This plateau has, on the whole, the shape of a great horse-shoe, in the middle of which are situated the mountains of the Murghab and Alichur. This does not imply, however, that there are absolutely no mountain-ridges on the plateau; no *angehaufte Gebirge*, as Karl Ritter would say. The Pamir chain of mountains which runs east-north-east between the Pamir and the Alichur rivers in the south belongs to this category. It rises above the Great Lake as a stone wall 3500 to 5000 feet high; but it has its foot in the 10,000-feet-high valleys which surround the lake, and belongs to the category of the *angehaufte Gebirge*. Several other lower chains, such as the Alay, Trans-Alay, Riang-kul, Murghab, Alichur, and Vakhan, run in the same direction over the surface of the great plateau, and have the same character.

As to the Western Pamir, which might be described as the mountainous Pamir, it has quite another character. The whole of the plateau sinks towards the west, but, at the same time, numerous chains of mountains make their appearance. We have there, according to Ritter's classification, an Alpine country. The rivers, which flow lazily in the east, become rapid, their valleys narrow; crags, rocks, and hills confine them; the routes become difficult, and the mountain-passes very rare. The rich prairies of the east disappear also, giving place to forests, and, lower down, to agriculture, which rises as high as 8000 feet in the north and 10,000 feet in the south. Even the inhabited valleys are mere mountain-gorges. It is obvious that, under such conditions, the real western limits of the Pamir cannot be determined with exactitude; and we consider M. Ivanoff very near the truth when he says that the Western Pamir merges into the Alpine highlands of the Darwaz, Shugnan, and Badakshan. The limits are thus far more undefined in the west than in the north and east. The author considers, thus, that the Shugnan and Darwaz ought not to be included in the Pamir proper; they might be considered rather as a highland which has risen at the intersection of the eastern with the north-western ones of the Hindu-kush (as border ridges?). The Pamir would thus appear as a mighty plateau about 170 miles long, 200 miles wide in the meridional direction, and covering nearly 34,000 square miles.

As to the much-spoken-of meridional upheaval of the Bolor, M. Ivanoff points out that there are absolutely no traces of upheavals having a direction either from north to south, or even towards north-north-west or north-north-east. On the contrary, all his observations on the stratification of rocks—and they are numerous—show that the stratification follows the direction either of east-north-east (that of the whole Central Asian plateaux), or north-west, that is, that of the Hindu-kush. The same is true with regard to longitudinal valleys, which always follow a direction towards north-north-east. As to the Kashgar Mountains, still unexplored, they seem to represent a repetition of shorter chains running towards north-west, and arranged in *échelon*.

If this opinion of M. Ivanoff is confirmed—and it most probably will be, as it pretty well corresponds with the broad lines of the structure of the Central Asian plateaux, as also with what is already known as to their structure—we shall have definitely to renounce seeking for meridional chains in this part of Asia. We have already been brought to renounce them in North-Eastern Asia, where I believe I have proved that neither the Great Khingan nor the Kuznetzki Alatau, nor even the Sikhota-alin, have this direction. On the contrary, we will perceive that the Pamir is only the highest terrace of a series of plateaux extending throughout the central parts of Asia in a north-eastern direction from the source of the Amu to Behring Strait.

But let us return to M. Ivanoff's papers, and to his observations on the flora and fauna of the Pamir. The high valley of the Alay already belongs to the Roof of the World. It is covered with rich prairies, the chief elements of which are Gramineæ. Nearer to water you find a thick growth of *Carex physodes*, which has given its name, *Riang*, to so many parts of the Pamir highlands. Numerous species of Papilionaceæ, many of them relations of the flowers of our European meadows, give a pleasant aspect to the steppes of the Alay in June. The same character—a mixture of the vegetation of the steppes with that of cold climates and highlands—is found also on the Eastern Pamir as you advance further south. But it is sufficient to descend into the valleys of the west to find immediately a far richer flora and, very soon, corn-fields.

The animals inhabiting the Pamir are also a mixture of those of the steppes with those of Alpine regions. The tame yak (*Bos indicus*) is met with the well-known "arkhars." Although their horns are scattered in great numbers on the Pamir, they are far from disappearing, and M. Ivanoff has seen numerous herds of from 100 to 150, and considers that they ought to be counted by thousands in the neighbourhood of the Great Lake. In the mountains the "kiiks" (*Capra*, probably *sibirica*) are numerous, but very difficult to approach; the brown bear is common, and M. Ivanoff's men killed four of them. The wolf of the steppes unavoidably accompanies the herds of arkhars. The yellow marmots (*Arvicola caudatus*) are very numerous; the steppes of the Pamir are their true dwelling-places, and the expedition has met also with great numbers of small Siberian hare, which is common on the Issyk-kul. The Indian goose, the *Syrrhaptes* of the high steppes, the *Megaloperdix tibetana* in the rocky hills, and the *Perdix chukar*—this last met with only once at a height of 14,000 feet—are especially worthy of notice.

As to the climate of Pamir, it is, of course, very severe. The winter reigns in full for seven months. As to frosts, there is hardly one single month without them, and even on July and August nights the expedition experienced frosts of 6° below zero. There are places on the Pamir where snow rarely reaches a great depth, but, its distribution depending mostly upon the prevailing winds, there are places where it falls in thick layers. As to the rivers, even the Murghab freezes for some time.

The true inhabitants of the Pamir are the Kirghizes, namely, the Kara Kirghizes, who belong to four different stems—Teit, Gadyrsha, Nayman, and Kiptchak. The chief settlements are situated in the valleys of the Northern and Southern Ghezia, about the Riang-kul, on the Ak-baital, the Ak-su, the Alichur, and in the basin of the Kokui-bela. They are found also on the Upper Tagarma. These Kirghizes are very much like those of the Alay, but a special feature of them—very rare, on the whole, with the Mongolian race—is that they continually suffer from tooth-ache; perhaps it depends upon the climate; at any rate, common disease—an inflammation of the eyes—obviously depends upon the clouds of salt dust raised on the Pamir by the western winds. They spend the winter, at a height of 11,000 to 12,000 feet, in the same tattered *kibitkas*, that they inhabit in the summer, and know nothing of the warm dwellings erected for the winter by the Alay Kirghizes.

In the summer they ascend to the hilly tracts, reaching about 14,000 feet, in order to save their cattle from the mosquitoes. Though living chiefly on milk produce, they still are dependent upon the inhabited countries of the west, for they are accustomed to the use of bread. The other race inhabiting, if not the Pamir itself, then its outskirts, are the Tadjiks. In the high valleys of the Shugnan, the Roshan, the Darwaz, and the Karategin, they occupy the narrowest gorges of the mountains, trying to escape there from the persecutions of their khans, who are themselves vassals to the neighbouring larger states like Bokhara, Kokan, or China. Being Shiites, they are still more persecuted by their Sunnite rulers. Their dwellings are miserable hovels built of rough stones. Broad wooden platforms, under which fowls and young goats are kept, are divided into numerous compartments, which might be called rooms, each of them having its special destination as a kitchen or as a room for weaving, and so on. Notwithstanding the surrounding poverty, one feels comfortable in their poor hovels, the walls of which are decorated with numerous clay pillars, niches, and a variety of paintings very artistically made by the women, who have found the means of fabricating even boxes from clay mixed with husk. The pottery, all made by women without instrumental aid, is striking in the artistic feeling infused into its fabrication. Their fields are not less striking by the incredible labour which has been spent in clearing them from millions of stones. There are "fields" not larger than a common-sized table, cleared with effort, or artificially made by the side of a mountain stream. They keep some cattle, and, during the summer, mount with it to higher tracts. The Pamir is visited by many *savdagars*, or traders, from Kashgar, Badakshan, or Ferghana, who supply the Kirghizes and Tadjiks, at very high prices, with manufactured produce, receiving in exchange their own produce.

M. Ivanoff remarks that the small preliminary map published in the *Izvestia*, to illustrate the explorations of his expedition, is still incomplete, and does not quite correctly represent the results of his investigations. The larger completed map will therefore be welcomed when it appears.

P. K.

NOTES

A MEETING of the General Committee of the Darwin Memorial Fund was held last week at the rooms of the Royal Society, Prof. Huxley, President, in the chair, when it was stated by the treasurer, Dr. Evans, that, after payment for the statue and other expenses, a balance of about 2200*l*. would remain. The following resolutions were then passed :—"That the statue of Darwin be made over to the Trustees of the British Museum in trust for the nation." "That the balance of the fund, after payment for the statue and medallion and incidental expenses, be transferred, under the name of the 'Darwin Fund,' to the President, Council, and Fellows of the Royal Society in trust to invest the same in or upon any stocks, funds, or securities authorised by law as investments for trust moneys." "That the President and Council of the Royal Society apply from time to time the dividends and interest of such investments in such a manner as shall to them appear best calculated to promote biological studies and research." "That a list of subscribers and a statement of the accounts be printed and circulated, together with the resolutions now passed, and that a woodcut or some other representation of the statue accompany the statement." The statue, by Mr. Boehm, R.A., has been placed in the great hall of the British Museum (Natural History), Cromwell Road, and arrangements for its unveiling will be made shortly.

THE vacancy created by Prof. Bayley Balfour's retirement from the Regius Chair of Botany in the University of Glasgow, which we announced some time back (NATURE, March 12, p. 441), has been filled by the appointment of Mr. F. O. Bower, F.L.S., Lecturer on Botany in the Normal School of Science, South Kensington. Both as a teacher and by his important researches in the morphology of Gymnosperms and the Vascular Cryptogams, Mr. Bower has rapidly assumed a leading position amongst the younger generation of botanists, and the loss of his services to the Normal School is much to be regretted. Mr. Bower is an M.A. of Trinity College, Cambridge.

THE Goldsmiths' Company has contributed one hundred pounds towards the fund which is being raised for the family of the late Henry Watts, to which we have already drawn attention in these columns.

THE Court of Assistants of the Fishmongers' Company has unanimously resolved that a grant of 2000*l*. be made to the Marine Biological Association of the United Kingdom—1000*l*. to be paid this year, and the remainder in annual sums of 200*l*. during the next five years.

THE subject of Mr. Romanes's Rede Lecture on June 2 will be "Mind and Motion."

THE subject of Prof. W. G. Adams's British Association address will be "The Electric Light and Atmospheric Absorption."

AT a meeting of the directors of the Ben Nevis Observatory held on Thursday last week, it was agreed to add a printing press to the establishment, for printing each day the hourly observations, with a view to their distribution among the more distinguished meteorologists and prominent meteorological institutions in different parts of the world.

THE verdict of the jury who considered the case of the Usworth Colliery explosion, whereby forty men and boys were killed early in the present year, is important as marking what appears to be the commencement of a new era in the history of these phenomena. It is probably the first expression of opinion from a public body of this class to the effect that coal-dust and a small percentage of fire-damp can play the part that has hitherto been usually ascribed to fire-damp alone. They found that the explosion was caused by a shot, the fire of which acted upon "*the coal-dust and a small percentage of gas.*" The convenient and time-worn "outburst of gas" theory, which consigned the helpless miner to the vicissitudes of chance, and exonerated colliery owners and their agents from all responsibility, seems on the point of giving way before its rival the coal-dust theory, which points out an easy means of preventing great explosions of this kind. The latter theory has doubtless a hard battle still to fight against prejudice and ignorance, but it has all the advantages of youth and vigour on its side, and is supported by a number of facts which appear to be incontrovertible.

THE Russian Geographical Society has just issued a programme of climatological and phenological observations, which, it is to be hoped, will be adopted by numerous observers. The number of plants and animals enumerated is smaller than in most similar programmes, it being the aim of the Society to make the task of the observers as easy as possible. A new feature of this programme are observations on the condition of the snow covering the ground, the time of its appearance and thawing, the rise of water in the rivers at the melting of the snow, &c.

M. FAYE has been continued on the roll of teachers of the Paris Polytechnic School, in spite of his having passed the time of incapacitation by old age. The exception has been grounded by the Minister of War on the plea of continued services rendered to science. A banquet has been given to the worthy astronomer by his admirers on this occasion.

THE Sanitary Congress opened yesterday at Rome.

IN the Spanish Congress on Monday, Señor Castelar called attention to Dr. Ferran's experiments in inoculation against cholera, and asked the Minister of the Interior to give a subvention to enable Dr. Ferran to continue his experiments on a larger scale. The Minister, in reply, said he was unable to do so at present, but as soon as it lay in his power he would grant a sufficient sum, although, in his opinion, Dr. Ferran's experiments had not yet reached a sufficient degree of certainty to prove a complete success. He added that a commission of medical men would be appointed to visit Valencia and other towns in order to study the experiments that are being made. In reference to this subject Dr. Cameron, M.P., writes to the *Standard* that the Under-Secretary for Foreign Affairs has promised to instruct the British Minister at Madrid to send home translations of any reports bearing on the system of inoculation with cholera virus attenuated by artificial cultivation, as a protection against Asiatic cholera, discovered by Dr. Ferran, of Valencia. This having come to the notice of Dr. Ferran, that gentleman has sent Dr. Cameron a telegram giving the results up to date of a great test experiment which is at present being conducted by him, under the eyes of scientific commissioners at Alcira, a town near Valencia, where an epidemic of cholera is raging. According to Dr. Ferran's telegram the population of Alcira is 16,000, and since the first of the present month 5432 of its inhabitants have been inoculated with his protective virus. That would leave the number of those not inoculated about 10,500; or, accepting 16,000 as an exact figure, precisely 10,568. Of the 10,500 persons who are not inoculated, cholera has attacked 64, and proved fatal to 30. Of the 5432 who have been inoculated it has, according to Dr. Ferran, attacked only 7, and proved fatal in no single case. In other words, since the commencement of the experiment on May 1, one person out of every 163 has been attacked among the uninoculated population, and one person in every 352 has died of cholera; while among the inoculated population only one person in 776 has been attacked, and not a single person in the entire 5432 has died of the disease. Dr. Ferran concludes his telegram by expressing the desire that a British Commission should be sent to Alcira to verify these results.

THE floating dome presented by M. Bischoffsheim to the Observatory at Nice is now finished, and has been on exhibition in Paris during the past week. It is intended to cover a colossal telescope; it is 22 m. in diameter inside, and has a circumference of 60 m., or 2 m. more than the dome of the Pantheon. Instead of rendering it movable by placing it on rollers, according to the ordinary method, it is closed below by a reservoir for air, which rests on the water in a circular basin. This system of suspension is said to be so perfect, that in spite of its great weight, a single person can turn it completely round the horizon. To provide against the water freezing, it has been proposed to dissolve in it a salt to the point of saturation, but it is feared that this may cause corrosion of the apparatus. Frosts, however, are rare in Nice, and special experiments on this subject will be made.

ON Friday night the House of Commons agreed, without a division, to a motion by Sir John Lubbock for a select committee to inquire whether, by the establishment of a forest school, our forests and woodlands could be rendered more remunerative. The proposer pointed out that, while our interests in the subject were greater than those of any other country in the world, as we had 2,800,000 acres under wood in Great Britain and about 340,000,000 in the Colonies, yet this was almost the only country without a forest school. He referred to the effect of scientific forestry in the Landes in France, and in India, where the net forest revenue fifteen years ago was only 52,000*l*., while, since the establishment of a forest department, it had risen to over 400,000*l*. per annum. As a result of neglect of the science in this country, students for India had to be trained at Nancy, a school of course specially adapted for French requirements, and the forests in our Colonies and other possessions (Cyprus and the Cape, for example) had to be put under the control of foreigners, as there were no Englishmen trained for the work. Sir John Lubbock, however, declined to commit himself to the establishment of a Government school; it could not be left altogether to private enterprise, because a school necessarily required access to a considerable area of forest. He thought it worthy of consideration whether some intermediate system might be adopted which would enable some one or more existing institutions to benefit by national forests. Mr. Gladstone, whose interest in arboriculture is well known, could not bind the Government to the establishment of a School of Forestry, although he recognised the universal ignorance on the subject prevalent amongst land agents and others in England. He distinguished the circumstances in India, where there are important facts connected with the climate, and with the due supply of moisture in the atmosphere, which are not present in this country. The School of Forestry, moreover, he said, which was established by the Indian Government in England, was open to every one who could pay the fees. There was also the difficulty that forests of large extent are rare here, and that they are kept, not for purposes of profit, but of landscape beauty, or pleasure and sport. In conclusion he said the Government gave their hearty approval to Sir John Lubbock's proposal, reserving, at the same time, their freedom with regard to the recommeudations which the committee might make.

A TRANSLATION of Prof. Cremona's well-known work on the "Elements of Projective Geometry," by Mr. C. Leudersdorf, of Pembroke College, Oxford, will shortly be published by the Clarendon Press. It is hoped that this may be useful to students of a subject which has been, comparatively speaking, neglected in this country, although much attention has been paid to it on the Continent. The opportunity has been taken to considerably enlarge and amend the book. All the improvements to be found in the French and the German editions have been incorporated, and a new chapter on "Foci" has been added. The text has been carefully revised throughout, and has received many additions and elucidations, some due to the author himself and others to the translator.

ON the night of Friday the 15th inst. one of the most terrible storms ever witnessed in Vienna occurred there, by which shrubs, trees, and even houses were wrecked; and the cold accompanying was so severe that several persons exposed to it during the night were found frozen to death in the morning. In the Paris *Bulletin International* of the morning of the 16th it is reported that 139 millimetres of snow fell at Vienna. In all parts of Austria and Hungary snow covers vineyards and fields, where the crops were in an advanced condition, and incalculably great damage has been done. The festivals of Pancratius, Servatius, and Boniface, the Ice Saints of 1885, will long be remembered in this part of Europe.

WE have received the report of the Rugby School Natural History Society for the past year. That portion of it which relates to the Temple Observatory at Rugby has already been noticed in these columns. The editors observe that it appears to be a law of the existence of the Society (like that of the animalcule *Amœba proteus*) that an infusion of life into one part produces a corresponding decline in another. For some years the botanical, geological, and archæological sections absorbed all energy, but now there is a decided movement towards zoology and a decline in those sections once most vigorous. A fair start has been made with some zoological collections; the aquarium, however, has proved a failure, and the vivarium labours under the disadvantage of never being reached by the sunlight. Several short and interesting papers are published with the report.

THE Russian Government has sent an official of the Education Department to Vienna to study the State commercial and industrial schools of Austria, these establishments being regarded as models, and the Russian Government intending to organise similar ones.

THE Fish Culture Department at the International Inventions Exhibition has proved a great success and attracted a large concourse of visitors. During the past week many important additions have been made, including a magnificent model of a Fish Culture Establishment exhibited by Mr. T. J. Mann, and a series of oyster beds, demonstrative of the process of breeding and fattening oysters. A special feature has been made of oysters this year in the Aquarium, where they are to be seen in numerous varieties imported from various quarters of the globe. In close proximity to them are exhibited various dredges and implements used in this particular fishery.

THE Count Lütke Medal of the Russian Geographical Society has been awarded this year to a work which deserves a special notice. It is Prof. N. J. Zinger's work on the determination of time by means of corresponding heights of different stars (translated in German by H. Kelchner, and published at Leipzig with a preface of O. W. Struve, under the title: "Die Zeitbestimmung aus correspondirenden Höhen verschiedener Sterne.") The determination of time with great exactitude, for telegraphic determinations of longitudes, by means of easily transportable instruments, has already occupied the Pulkowa astronomers. W. Struve and W. K. Döllen proposed very skilful methods of observations. The latter had proposed to determine the time by means of a special Repsold's circle from two passages of two stars in the prime vertical. The exactitude reached by this means was from 0·05 to 0·06 of a second; the circle had to remain in an unaltered position for no more than five or six minutes; but the whole observation took about forty minutes. Prof. Zinger's method, which is a further development of the work begun by Maupertuis, Olbers, Hauss, Delambre, and Knorre, consists in making two successive observations of two stars chosen for that purpose, at the same altitude, by means of any instruments which may not be divided with great perfection, but whose level would only show the changes the telescope may undergo when directed on two different azimuths. This method was met first with some coolness, on account of the difficulty of finding two stars which would culminate soon after one another at the same altitude. But M. Zinger has shown that even with a moderate telescope it is easy to have two stars easily found and pretty well seen at daylight which pass at the same altitude at an average of no more than nine minutes one after another. His tables render the task of finding such stars very easy, there being in moderate latitudes no less than 160 pairs of stars appropriate to that purpose. As to the ease and accuracy of the method, it is sufficient to say that time is determined with a probable error of no more than 0·04 of a second in no more than half an hour, without even making use of the divisions of the Repsold circle, and with only one reading of the microscope. For several years Prof. Zinger's method has been submitted to a very extensive test by Russian astronomers. So we learn from Gen. Koversky's analysis of it, published in the last "Annual Report" of the Geographical Society, that, when determining by means of light-signals the difference of longitudes between Pulkova and Parlovsk, and using a very plain instrument prepared by M. Brauer on M. Zinger's principles, the difference has been determined with an error of only one-fiftieth of a second. M. Pyertsoff, in Mongolia; Gen. Stebnitzky, in the Caucasus, who considers the determinations of time from corresponding heights of two stars quite as accurate as that deduced from zenithal distances taken with a Repsold circle, but far shorter and easier; the Russian officers in Bulgaria, who have determined with telegraphic signals the longitudes of thirty-seven places in less than seventy evenings, spending no more than three hours each evening for a determination which gave the longitude with an error of only 0·04 to 0·02 of a second; the measurements around Omsk in 1878; those of M. Gladysheff in the Transcaspian, and of M. Mionczyorski on the Ural in 1882–84—all these have been made on the same method of Prof. Zinger, which has now become the most familiar one with Russian astronomers. The measurements are usually made with a Repsold's circle, which is ready for work half an hour after the astronomer has arrived at the place whose longitude he proposes to determine; and in chronometrical expeditions five minutes to a quarter of an hour of a bright sky give the possibility of measuring the longitude with an accuracy quite sufficient for geographical purposes.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. James Fleming; a Common Badger (*Meles taxus*), British, presented by Mr. C. Ethelstone Parke; a —— Wild Ass (*Equus tæniopus* ♂) from the Island of Diego Garcia, Chagos Archipelago, presented by Mr. F. D. Lambert, jun.; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mrs. G. A. Smith; four Red-faced Weaver Birds (*Foudia erythrops*) from South Africa, a Grenadier Weaver Bird (*Euplectes oryx*) from West Africa, presented by Mrs. Herman Kuhne; a Dominican Kestrel (*Tinnunculus dominicensis*), a —— Bittern (*Ardetta* ——), three Martinican Doves (*Zenaida martinicana*), two Moustache Ground Doves (*Geotrygon mystacea*), a Tuberculated Iguana (*Iguana tuberculata*) from the West Indies, presented by Dr. A. P. Boon; two Harvest Mice (*Mus minutus*), British, presented by Mr. G. W. Oldfield; two Demeraran Cock of the Rocks (*Rupicola crocea* ♂ ♂) from Demerara, presented by Mr. T. C. Edwards-Moss; two Mute Swans (*Cygnus olor*), British, presented by Mr. J. W. Gibson; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Master C. A. Greeven; three Common Vipers (*Vipera berus*), British, presented by Mr. W. H. B. Pain; four White-faced Tree-Ducks (*Dendrocygna viduata*), a White Gannet (*Sula piscata*) from Brazil, deposited; a Dark Green Snake (*Zamenis atrovirens*), South European, purchased.

GEOGRAPHICAL NOTES

THE following message from Col. Prjevalsky, dated Lob Nor, March 15 (probably O.S.), is published in the *Invalide Russe*:—"During the last autumn and winter we visited Eastern Zaidam as far as Lob Nor. The middle range of the Kuen Lun, hitherto unknown, has been examined with sufficient care. The ancient route leading from Khoten to China has been found and thoroughly explored. We have also discovered three enormous snow peaks, to which we have given the names of Muscovite, Columbus, and Enigmatical. The most elevated point of the first-named is Mount Kremlin, of the second Mount Djinri, and of the third the Crown of Monomachus, which are all of a higher elevation than 20,000 feet above the sea. The Thibetan plateau, skirting the middle Kuen Lun, has an average height of 4000 feet. No inhabitants were met with except in the Southern Zaidam. Further to the west the flora and fauna of the desert are extremely poor. In the month of December the cold was so intense that the mercury froze. We passed the month of February and the first fortnight of March at Lob Nor. We are just about to set out again, with the intention of crossing Cherchen, for the purpose of reaching Kiria, in the district of Khoten. During the three months of summer we shall traverse Northern Thibet, if the Chinese do not oppose us, and in the autumn we shall return to our own Turkestan. We are all in good health."

THE last issue of the *Izvestia* of the Russian Geographical Society (1885, 1) contains a very interesting paper, by M. Lessar, on "South-Eastern Turcomania," with a map, thirteen miles to an inch, of the region between Merv and Herat. This paper consists of a chapter on the occupation of Merv; a diary of the journey from Fol-otan to Penj-deh and in the Steppes; a geographical sketch of South-West Turcomania; and a translation of Sir Henry Rawlinson's note, by which M. Lessar's account of his first journey was accompanied in the *Proceedings* of the Royal Geographical Society, with a few remarks by the author. Capt. Abbot's remarks on South-West Turcomania and the Badhyz are also translated in an appendix. The geographical description of the region comprised between the oasis of Merv, the Murghab, the Borkhut mountains, and the Hari-rud, which region is described as "South-Western Turcomania," is especially worthy of notice, as a valuable contribution to the geography of the region.

THE Government of India has decided to appoint Mr. Ney Elias, one of the most distinguished of our Chinese travellers, and at present English Commissioner in Ladakh, to act as British Consul at Yarkand and Kashgar.

MR. HOLMAN BENTLEY sends to the *Times* news of the safe return of the Rev. G. Grenfell, F.R.G.S., in the Baptist Missionary Society's steamer the *Peace*, after a voyage on the Upper Congo River from Stanley Pool to Stanley Falls, a distance of 1060 miles. He has explored many of the tributaries on the way—the Mobangi to 4° 30′ N. lat., the Ukere to 2° 50′ N., and the Lubilanji to 1° 50′ S. The Mbura is navigable only for ten or twelve miles from its junction with the Congo, when cataracts bar the way. The Mobangi is a fine river, but the people are very wild.

IN a recent number of *Das Ausland*, Herr Habenicht, of Gotha, makes an important suggestion with regard to observations in Africa. He points out the dearth of accurate observations in latitude, longitude, and heights in the interior of that continent. For instance, with regard to the greater part of North Africa we are dependent on those of Vogel and Barth, while in South Africa those of Livingstone are almost the only ones we have. Even in the interior of the Cape Colony, the Orange Free State, the Transvaal, Namaqualand, the Kalahari desert, our knowledge of exact positions is still in the air. More is known of the central and lower Congo and the coast. To remedy these defects, Herr Habenicht proposes to geographical societies interested in African exploration that the field should be subdivided. Young men should be trained to make astronomical observations, barometrical measurements and itineraries, and two should be despatched on each route with separate sets of instruments. The routes suggested are the following: (1) Cape Town, through Stellaland, to the Zambesi; (2) Delagoa Bay to Stellaland; (3) Cape Town, through Namaqualand and Damaraland, to the Zambesi; (4) Loango to Zanzibar; (5) Zanzibar to the Egyptian Soudan; (6) the Lower Niger, through Darfur, to Khartoum; (7) the Gold Coast to Timbuctoo; (8) Morocco to Timbuctoo; (9) Tripoli to Socoto; (10) Bengazi, through Kufra and Borgu, to Kuka. All previous explorations, he says, would by these observations receive a sound scientific basis.

M. RADDE, the Director of the Natural History Museum at Tiflis, has been ordered by the Russian Government to investigate the mountain systems of the border-lands of Trans-Caucasia and Khorassan, between Ararat and Ala Dagh on the west and Elburz on the east.

FROM a report addressed by Col. Feilberg to the Argentine Minister of Marine on the subject of his mission to explore the Pilcomayo River, it appears that this stream is only navigable for eighty leagues from its mouth in the Rio Paraguay up to its confluent, the Rio Dorado. Five miles higher the rapids commence; there is then only two feet of water, the channel is narrow and very tortuous, and the current swift. The upper waters are lost in marshes, which the traveller crossed. On returning, the water had fallen considerably, and the journey was only accomplished with much trouble and after many accidents. During his stay on the Chaco he reports that he did not see a single Indian, although their tents were still standing in places. One of his officers had been sent with the chronometers to Corientes, to compare them by telegraph with the Observatory of Cordoba or Buenos Ayres. These comparisons are essential for the verification of the observations made, and as soon as they have been obtained, the maps which are to accompany the publication of the journal of the mission will be commenced.

ACCORDING to the *Colonies and India* a conference took place on March 31, by telegraph, between the Melbourne and Sydney branches of the Geographical Society of Australia, on the question of New Guinea exploration. It was decided to subsidise Mr. H. O. Forbes's expedition, to the extent of 500*l.*, on condition that the two Colonies receive copies of the explorer's diary and despatches, and duplicates of his collection of specimens. The Conference also decided to send an independent expedition from the Aird River, the whole expenses to be defrayed by the Society. The expedition will be placed under the leadership of Capt. Everell, who will be accompanied by Herr von Leudenfelt.

THE Report on the trade of Persia by our Consul at Teheran, which has just been laid before Parliament, contains some interesting statistics on the population of Persia, in order to judge how far the country has recovered from the effects of the great famine of 1871–72. The area of the dominions of the Shah is 1,647,070 square kilometres, and the population is estimated at 7,653,000, contained in 99 towns with a total population of 1,963,800, while the villages and rural districts contain 3,780,000, and the nomads are estimated at 7,909,800. It is curious to notice how the number of nomads are made up: the Arabs number 52,020; Turks, 144,000; Kurds and Leks, 135,000; Beluchs and gipsies, 4,140; Bakhtiaris and Lurs, 46,800. The statistics of the creeds are: Sheeahs, 6,860,600; Sunnis and other Mohammedan sects, 700,000; Parsees, 8,000; Jews, 19,000; Armenians, 43,000; Nestorians and Christians, 23,000. Of the Armenian population 52·8 per cent. are males and 47·2 females. Of the Mussulman population the mean proportion is 50·5 per cent. females and 49·5 males. The following is a list of some Persian towns with their respective populations:

Tabreez	164,630	Zenjan	24,000
Ispahan ...	60,000 to 70,000	Cazoin	40,000
Yezd	40,000	Resht (including adjoining villages) ...	40,000
Kerman	41,170	Astrabad	10,000
Shiraz	30,000	Nishapore	11,000
Shuster	under 20,000	Sebzevar	12,000
Dizful	25,000	Meshed	60,000
Burujird	20,000	Kashan	30,000
Kermanshah	30,000	Koom	20,000
Hamadan	30,000	Mianeh	7,000
Maragha	13,250	Mohammera	15,000
Soujboulak	5,000		

Mr. Dickson, taking the medium between the highest and lowest figures he has obtained, estimates the population of Teheran at about 120,000, while Col. Ross estimates that of Bushire at 70,000.

IN *Astron. Nachr.*, vol. cx., Prof. Dr. Auwers has published the results of his researches and calculations about the longitude of some places in Australia. Since these data will have to be altered by the result of the determination of the difference in longitude between Port Darwin and Banjuwangi (Java) we may omit particulars and only state that Mr. Auwers has found to be:—

	h.	m.	s.
Longitude of Sydney	10	4	49·75
" Windsor	10	3	20·92
" Melbourne...	9	39	54·32
" Adelaide	9	14	20·57

INFORMATION has been received in Berlin of the death, in the Cameroons, of Lieut. Tilly, the leader of another German expedition sent out to explore that part of Africa.

A PARLIAMENTARY paper just issued (Commercial, No. 5, 1885) contains an exhaustive report, by Vice-Consul Comberbatch, on the Dobrudja. Under the head of geography it refers to the name, limits, frontiers, area, topography, division, mountains, forests, mines, rivers, marshes, lakes, islands, harbours, and tides of the district. This is succeeded by sections on the climate, history, ancient remains, population, sanitary state, government, public works, religion, education, agriculture, commerce, industries, navigation, natural history, and principal towns. The report, which occupies fifty pages, is thus a short treatise on this district at the mouth of the Danube, of which much was heard in connection with political events a few years ago.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MAY* 24–30

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 24

Sun rises, 3h. 58m.; souths, 11h. 56m. 36·3s.; sets, 19h. 55m.; decl. on meridian, 20° 51′ N.: Sidereal Time at Sunset, 12h. 5m.

Moon (Full May 28, 21h.) rises, 15h. 16m.; souths, 20h. 59m.; sets, 2h. 33m.*; decl. on meridian, 5° 55′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	3 21 ...	10 21 ...	17 21 ...	11 3 N.
Venus ...	4 14 ...	12 19 ...	20 24 ...	21 47 N.
Mars ...	3 6 ...	10 29 ...	17 52 ...	14 56 N.
Jupiter ...	10 36 ...	17 50 ...	1 4* ...	13 25 N.
Saturn ...	5 19 ...	13 27 ...	21 35 ...	22 21 N.

* Indicates that the setting is that of the following day.

Occultation of Star by the Moon

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
28 ...	θ Libræ ...	... 4½ ...	2 10 ...	3 5 ...	148 253

Phenomena of Jupiter's Satellites

May	h. m.		May	h. m.	
26 ...	20 10	II. tr. ing.	29 ...	20 46	I. occ. disap.
	23 6	II. tr. egr.	30 ...	0 18	I. ecl. reap.
27 ...	21 57	III. occ. disap.		20 25	I. tr. egr.
28 ...	20 39	II. ecl. reap.		20 56	IV. occ. reap.
	23 37	I. tr. ing.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

May	h.	
25 ...	13 ...	Mercury at greatest elongation from the Sun 25° west.
30 ...	21 ...	Mercury in conjunction with and 3° 15′ south of Mars.

THE VALUE OF A MARINE LABORATORY TO THE DEVELOPMENT AND REGULATION OF OUR SEA FISHERIES[1]

It is a striking fact, to which attention has before now been drawn, that whilst the agriculturist, on whom we depend for a large part of our food supplies, has very largely availed himself of scientific knowledge in the treatment of crops and herds, the fisheries of our coasts, which provide an almost equally large amount of food to the people, have never been carried on with any regard to an accurate knowledge of the fishes on which they depend.

Agriculture is, in this country, a refined branch of chemistry; but there has been no demand for a knowledge of marine life which might enable the fisherman to pursue his calling to the greatest advantage. In fact, our fishery industries are still barbaric; we recklessly seize the produce of the sea, regardless of the consequences of the method, the time, or the extent of our depredations. In the same ignorant fashion as the nomadic herdsmen of Asia descend upon a fertile valley, and after exhausting it, leave it to time and natural causes for its recuperation, so do we treat the fishing-banks of our coast.

So long as fishing was relatively small in amount this method was not altogether objectionable. But with the increase of population, and the introduction of steam fishing boats and more effective instruments of capture, there is reason to believe that some at least of our coast fisheries are being destroyed, and that others may follow in the same direction.

Other civilised nations have perceived the necessity of attempting to regulate the various kinds of sea-fisheries on rational principles—that is to say, on principles based on an exact knowledge of the life and habits of the fishes which it is desired to capture. The French, the Norwegians, and above others, the Americans, have given attention to this matter.

There is reason to believe that the Romans had gained a special skill—now lost—in cultivating sea fish. Whatever that may have amounted to, it is certain that modern Europe has entirely neglected the cultivation, and even the care of sea fisheries. It has been the merit of the Fish Commission of the United States to make the first attempt in modern times to deal with sea fisheries in the spirit of civilisation, that is of men who are determined to understand and control, for the advantage of their race, the operations of nature, rather than to leave things to chance, the unknown development of physical causes.

The direct efforts of the American Commission, and the knowledge which scientific men have accumulated with regard to fishes, without designing aid in the regulation and development of fisheries, do not enable us at present to answer many of the questions with regard to different sea fishes which we urgently require to know if we are to deal like reasonable, practical men with our fisheries, so as to improve them, or even so as to prevent their extermination.

At the late Fisheries Exhibition Congresses, the universal cry, the one unanimous demand, was "more knowledge!" We cannot tell whether beam-trawling with steamboats is injurious or not to some of our most valuable sea fishes, until we have more knowledge. We have not sufficient knowledge to enable us to say that it would restore some herring grounds to their former richness, if the fishermen were kept off those grounds for a few years.

We do not know why soles are getting scarcer every year; we know nothing about soles, and so we can do nothing to remedy their constantly increasing diminution.

We do not know why oysters are scarce, or how to make them more abundant. A few hap-hazard attempts to cultivate oysters are now and then made, but have resulted in an immense loss of money rather than in gain, because we do not know all about oysters in the same precise and detailed way in which we know all about wheat, or all about pigs or chickens.

We do not know why some fishes swim in great shoals year after year at certain seasons near certain spots, and then to the dismay of the fishermen suddenly give up ever passing that way. We do not know whether we could hatch the young of soles, turbot, cod, and other valuable fishes, and stock the sea with them as we do our rivers with trout and salmon.

We do not know whether we could favour the increase of such fishes by cultivating in the sea their favourite food. In many cases we do not know what their food is.

We do not know whether we might increase these fishes by destroying their enemies.

In fact, we know exceedingly little about the minute details of the life of marine animals, and if we wish to deal with sea fisheries like rational men, we must find out these minute details, and gradually apply the knowledge so gained.

A laboratory on the sea-shore, provided with boats and fishermen, and having within its walls tanks for hatching eggs and watching sea fish, and conveniences for the work of naturalists trained in making such observations, is the way to meet the deficiency in our knowledge above noted.

This was perceived many years ago in France, and more recently various laboratories have sprung into existence on the Mediterranean and on the American coast.

There is not, as yet, any such place of investigation on the English coast, and it is this deficiency which the Marine Biological Association, of which my honoured friend, Prof. Huxley, is President, and H.R.H. the Prince of Wales is patron, proposes to meet by building and maintaining a really efficient and thoroughly organised laboratory and experimental aquarium on the shore of Plymouth Sound.

The Association does not propose merely to build this place, but to arrange for the carrying out there of most importan investigations on such questions as those I have a few minutes ago named. They have the hearty and earnest co-operation of all the naturalists in the United Kingdom, Scotch and Irish naturalists having united with their English brethren to form this institution.

Naturalists are glad to take part in the study of these practical questions, because the arrangements and the studies which are necessary to answer the questions of the practical fisherman, are also just those which are necessary to advance the knowledge of the order of nature which forms the single object of truly scientific investigation. They will systematically and eagerly join with one another in the operations of the Plymouth laboratory, to obtain thorough knowledge with regard to the habits, food, breeding, and life-conditions of all kinds of marine fishes, such

[1] Abstract of paper read at the Society of Arts, Wednesday, May 13, 1885. By E. Ray Lankester, M.A., LL.D., F.R.S., Professor of Zoology in University College, London, and Fellow of Exeter College, Oxford.

as will be not only valuable but actually indispensable to the practical fisherman; and in the reports of the work done in the new marine laboratory which will be published by the Association, I do not doubt that the basis for future legislation and for future methods of sea-fishery will be found.

I may here venture to mention some of the results obtained by the efforts of the naturalists who form the United States Fish Commission—at the head of which is Prof. Spencer Baird. I would, however, especially remark that the Commission has only been at work for ten years, and that very great practical results cannot be expected at once. A vast amount of knowledge has to be obtained before we can deal practically with all the various kinds of sea-fishes; and it is to me a proof of the wonderful sagacity and activity of the American naturalists that they have already been able to do what they have done in the practical direction.

Prof. Baird has especially attempted to artificially cultivate sea-fishes. It seems to him that it is better, if it be possible, to replenish the seas by stocking them with young fish, to take the place of those removed by fishermen, rather than to impose legislative restrictions and penalties upon the fishermen. The attempt to artificially cultivate sea fish is an admirable example of the relation of scientific knowledge—that is, thorough and cause-reaching knowledge—to practical commercial operations.

There are two distinct stages in this attempt at artificial cultivation. The first is the scientific. You must ascertain how, when, and where the fish naturally breeds; you must find out, experimentally, how to procure its eggs, fertilise them, and rear the young to a given size—on a small scale. That is the business of the scientific naturalist. When he has ascertained all the details of this operation—which differ entirely in the case of different fishes, and may take years to ascertain—then the second stage is entered on. The commercial man then comes forward, and in the light of the knowledge obtained for him by the scientific man, attempts the hatching of the fish on a large scale—not by the hundred, but by the million.

The American Fish Commission has undertaken both stages of the work, and the second is necessarily a very costly one. A very promising result has been obtained in the artificial breeding of codfish, and again in the case of the shad. [Details of these operations were here given by the author.]

Again, in dealing with the American oyster, the Commission has obtained what promises to be a very great success. [Details of this case were given.]

But there is an almost unlimited field of work before the American Commission.

Experiments and observations similar to those carried out by the American Commission, will be undertaken by the Biological Association at Plymouth. For example, the artificial cultivation of that most valuable of British fishes, the sole, will be at once taken in hand. At present absolutely nothing is known as to the spawning of the sole—the male fish is not even recognised. In the first instance the naturalists at Plymouth will study the eggs and the mode of spawning of the sole, and the way in which the eggs are fertilised naturally. Then the necessary conditions for the rearing of the young fish will be ascertained. After that it will be possible to hatch a vast number of young soles and turn them out into Plymouth Sound, and to determine in this particular area, which is admirably adapted by its natural delimitations for the experiment, whether the take of soles in the Sound has been increased by the operation.

Similar experiments will be tried with other fish; and also knowledge will be gained as to the food of various fishes, and the causes which determine their movements, their increase, and their diminution in the neighbourhood of Plymouth.

This knowledge will help us to form sound and reliable conclusions as to the supposed injurious effects of steam trawlers and other modes of fishing, and so lead on to sensible and valuable legislation in regard to the seasons and modes of fishing best suited to obtain the maximum benefit from the harvest of the sea.

The English oyster, though differing from its American congener, can no doubt be brought under control by a thorough-going knowledge of all the conditions affecting it at all periods of life; and this it will be a first duty of the Marine Biological Association to attain. [Suggested inquiries as to the oyster were here mentioned.]

Lastly, the subject of "bait" is one of great importance, which we shall be able to deal with effectively. Not only shall we find new and effective baits, at present neglected by our line fishermen, but we shall be able to direct the cultivation of such valuable baits as the mussel and the limpet.

There is no fact which gives one so vivid an idea of the immense commercial value of sea fisheries as the amount which is annually expended on mussels for use as bait in those fisheries. There are few statistics on this subject, or indeed on any matters relating to our sea fisheries, and it will be one object of the Marine Biological Association to collect such statistics. But there is a certain amount of information as to the use of mussels for bait. Thus between October, 1882, and May, 1883, twenty-eight boats engaged in the haddock fishery at Eyemouth, in the North of Scotland, used 620 tons of mussels (about 47,000,000 individuals), costing nearly 1800*l.* to the fishermen, that is to say, over a million and a half of mussels for the whole time, or about 7000 a day to each boat—at the rate of one penny for twelve mussels. The total value of mussels used for bait in the deep sea line fisheries of the British coasts must amount to many hundred thousand pounds in a year—and we can only roughly guess at the value of the fish caught by this large expenditure on bait. In spite of the great economic importance of the mussel, its complete history of reproduction and growth is not known, and though in France and Germany it is carefully and profitably cultivated, very few attempts have been made on the British coast to protect or to artificially favour mussel scalps so as to make them remunerative properties.

This is a subject with which a marine laboratory would enable us to deal in a very short time. The same general remarks, *mutatis mutandis*, apply to the second most important bait, viz, the limpet.

Before concluding this sketch of the work which lies before the managers of a marine biological laboratory, I may say a few words as to the nature of the buildings and equipment required for such an institution.

The most efficient scientific laboratory of the kind is that erected at Naples by Dr. Dohrn, a drawing of which is exhibited. The Naples laboratory, with its tanks, row boats, and steam launches, has cost about 20,000*l.*, and involves an annual expenditure of about 4000*l.* A staff of observers is paid out of this sum, and the efforts of the institution have hitherto been entirely directed to the obtaining of accurate scientific knowledge with regard to the fauna and flora of the Bay of Naples. It is justly regarded as one of the most important scientific institutions in Europe.

The United States Fish Commission have erected, from time to time, various small laboratories, and are now about to expend 10,000*l.* on a laboratory at Wood's Hole, and 20,000*l.* on building fish-ponds protected by piers of masonry. Since its commencement, the United States Commission has received from the Imperial revenue about 300,000*l.* In 1884 alone it received 70,000*l.* It must be remembered that these large sums cover the expense of very extensive operations in fish-breeding on a commercial scale, and are not solely for the purpose of preliminary investigation.

The Marine Biological Association proposes to proceed in a modest manner, arranging in the first instance for the carrying out of the necessary experimental inquiries. A site has been obtained on the Citadel Hill, at Plymouth, by permission of the authorities of the War Office, and here will be erected a laboratory, comprising on the ground floor large and small tanks, and above, a series of working rooms fitted with small tanks. Through all a stream of sea-water will be driven by pumping apparatus, from large tanks in the basement, containing several thousand gallons. These reservoirs will only be replenished two or three times in the year. Boats, including a steam-launch, will be required, and two or three fishermen, who will act as attendants. A resident superintendent, who will be a thoroughly qualified naturalist, will be appointed at a salary of 200*l.* a year, and will be lodged on the premises. Naturalists will frequent the laboratory at their own expense for the purpose of study, and from time to time competent investigators will be appointed to carry out particular inquiries. The latter will be paid for their work from special sources, not from the general income of the Association until that reaches a large amount. Great assistance will be afforded to the work of the Association by the local fleet of fishing boats, which is very numerous, and comprises some vessels of large size. It is estimated that a capital sum of 10,000*l.*, and the prospect of an income from annual subscribers, members of the Association and others, of about 500*l.* a year, will enable the important work which has been taken in hand to be commenced. The Council of the Association feel very great confidence that they will be able to obtain annually sufficient funds to keep the laboratory in efficient working order when once the capital sum of 10,000*l*. has been subscribed. Towards the latter amount they have already raised a sum exceeding 5000*l*. From Plymouth as a centre, in the course of future years, the operations of the Association will extend, and additional laboratories will no doubt be constructed hereafter by the Association on other parts of the coast of the United Kingdom, should the first one prove a success, and the work carried out through its agency meet with public approval and support.

Whilst the Marine Biological Association aims at obtaining, by the operations of its laboratory and experimental aquarium, that knowledge which is clearly necessary for the improvement and regulation of our sea fisheries, it must be remembered that its work will necessarily enlarge and advance the great science of biology, and that to many of us this is its surest promise of utility, for we cannot always directly govern the march of scientific progress. The whole field of knowledge must be cultivated, in the simple faith that the increase of knowledge is the greatest good which human effort can achieve. By adopting a thorough and comprehensive scheme of study of the problems connected with the life of fishes, we shall, as invariably happens in the history of science, obtain results which at present we cannot foresee, but which, we may feel assured, will yield in unexpected ways rewards and blessings to humanity.

METEOROLOGICAL INSTRUMENTS

THE Royal Meteorological Society recently held its sixth Annual Exhibition of Instruments at the Institution of Civil Engineers, 25, Great George Street, S.W. This Exhibition was devoted to sunshine recorders, and solar and terrestrial radiation instruments.

The first attempt at obtaining an instrumental record of the amount of sunshine was made by Mr. J. F. Campbell, of Islay, in the year 1853, when he mounted a hollow glass sphere filled with acidulated water, in the centre of a cup of mahogany, so arranged that the sun's rays were focussed on the interior of the cup and burned it. The lines of burning, therefore, indicated the existence of sunshine. Solid glass spheres have been substituted for the hollow ones, and cards in metal frames have replaced the wood; but in its principle the sunshine recorder of 1885 differs little from that erected on Richmond Terrace, Whitehall, thirty years ago. Other modes of recording sunshine are based on the action of the rays of the other end of the spectrum on the actinic instead of the heat rays. Among workers in this direction may be mentioned Marchand of Fécamp, Sir Henry Roscoe, and others. The most recent improvements in this direction are those by Prof. McLeod and by Mr. Jordan.

With regard to solar radiation thermometers, the successive stages in the assumed perfecting of these instruments have been as follows:—An ordinary mercurial thermometer acts as a spherical mirror, and reflects the rays which fall upon it. To lessen this the bulbs were first made with black glass; moreover, originally the degree marks were put upon the supporting slab, then they were put upon the tubes of the thermometers. It was then found that in a position where two thermometers with similarly coated bulbs were exposed to the sun, but one was exposed to more wind than the other, the indicated temperatures varied greatly. To avoid this it was proposed that the thermometer should be inserted in a glass shield exhausted of air. Various forms of mounting have been adopted, but the chief efforts have been expended in determining the influence of the amount of air left in the so-called vacuum. The next stage was that, inasmuch as black glass had a bright surface, there was still much light reflected, and therefore the surface was dulled with a coat of lamp-black—so that all heat falling upon the bulb might be absorbed. Subsequently, owing to the influence of the lower temperature of the unblackened thermometer tube, about one inch of it was coated like the bulb. As evidence of the degree of exhaustion, a small mercurial pressure gauge was attached to the thermometer, and by other makers platinum wires were soldered through the shield so that the stratification of the electric arc might indicate the amount of air still left.

With regard to terrestrial radiation thermometers, the pattern of instrument used has varied very little. The Rutherford minimum has almost always been used, but its sensitiveness has gradually been increased: the spherical bulb was replaced by a cylinder, the cylinder was elongated and bifurcated, and eventually, in order to strengthen the forks, they were united into what is known as a "link." Another plan was to flatten the cylindrical bulb into as thin a plate as possible, this giving a maximum of surface in proportion to the contents. The bulb was also made double, and thus we have the so-called "bottle" pattern, and then the tube was let into the side of the bottle, and both ends of the bottle were left open, and so we have the "open cylinder"—a remarkable specimen of glass-blowing. Then there have been two patterns of mercurial thermometers—Casella's and Negretti's. Difficulties have arisen from the degree marks being obliterated by the weather. To guard against this the tube has been inclosed in what are known as Leach's shields, and many attempts have been made to render the joint at the entrance of the tube watertight. This is not easy, because the thermometer is exposed to a great range of temperature, and the air inside the shield varies so much in volume that it forces its way through almost every joint. The object is, however, effected when the external jacket is sealed on the stem near the bulb.

In addition to specimens illustrating the various patterns of the above instruments, the Exhibition also included a number of new instruments, and many interesting photographs, sketches and diagrams. The photographs of clouds and lightning were very good.

At the meeting of the Society the President, Mr. R. H. Scott, F.R.S., read a paper giving a brief account of the various instruments and arrangements to be found in the Exhibition for the purposes of recording solar and terrestrial radiation and the duration of sunshine both in regard of its light and its heat, the last-named being obtained by means of the sunshine recorders, which are now pretty generally used. He exhibited twelve monthly maps showing the percentage proportion of hours of recorded sunshine to the hours the sun was above the horizon in the various districts of the United Kingdom. He stated that the features which strike any one on examining the maps of sunshine, which are for the most part for the five last summers and for the four last winters, excluding January to March, 1885, which has not yet expired, are:—First, the broad fact that the extreme south-western and southern stations are the sunniest, as has already frequently been pointed out. Jersey is undoubtedly the most favoured of our stations in this particular. Second, that in the late autumn and winter Ireland is much sunnier than Great Britain, Dublin having absolutely the highest percentage of possible duration of sunshine in November and December, and being only equalled by Jersey in January. The Dublin instrument is not situated in the city, but at the Mountjoy Barracks in the Phœnix Park, beyond the Vice-regal Lodge. The north-east of Scotland is also exceptionally bright, as the station, Aberdeen, lies to leeward of the Grampians. In April the line of 40 per cent. of possible duration takes in Jersey, Cornwall, Pembrokeshire, the Isle of Man, and the whole of Ireland except Armagh. The absolute maximum of the year occurs in May, and the amount rises to 50 per cent. (nearly to 60 in Jersey) over the district just mentioned as enjoying 40 per cent. in April. In June there is a falling off, which is continued into July and even into August in the Western Highlands. In the South of England, however, a second maximum occurs in August, the figure for Jersey rising to 50 per cent. This is mainly due to the exceptionally bright weather of August, 1884, in the southern counties of England. In September, Ireland shows a falling off, and the greatest degree of cloudiness is in Lincolnshire. In October, the Midland Counties of England are the worst off. In November the line of 40 per cent. encloses two districts, one Dublin, already mentioned; the other the Eastern Counties (Cambridge and Beccles). The absolutely highest monthly percentages in the period under consideration are in the month of May, 1882, in which St. Anne's Head, Milford Haven, had 62 per cent., while Geldeston (Beccles), Douglas (Isle of Man), and Southbourne (Bournemouth) show 61 per cent.

SCIENTIFIC SERIALS

THE *American Journal of Science*, April.—On the use of carbon bisulphide in prisms, being an account of experiments made by the late Dr. Henry Draper of New York. The results so far obtained by Dr. Draper in his investigations on the cause of the difficulties encountered in the use of carbon bisulphide in prisms seemed so valuable and so likely to prove useful to others engaged in photographing the prismatic spectrum that it was decided to publish them in the *American Journal of Science*.

With the assistance of Mrs. Draper, Mr. George F. Barker was accordingly requested to collect from Dr. Draper's copious notes the facts here detailed in connection with his experiments. Some supplementary measurements have also been made to test the efficiency of the apparatus.—The genus Pyrgulifera, Meek, and its associates and congeners, by Charles A. White. These molluscan forms, constituting the Bear River Laramic fauna of the author, are not found among any other North American fauna, either fossil or recent, but appear to have their congeners in a fauna still surviving in Lake Tanganyika, Central Africa, as well as in the Upper Cretaceous fresh-water deposits of Hungary.—On the occurrence of native mercury in the alluvium in Louisiana, by Ernest Wilkinson. Native mercury has recently been unexpectedly discovered at Cedar Grove Plantation, Jefferson Parish, Louisiana, where it is found disseminated in small globules in the mean proportion of 0·002934 per cent. throughout the alluvial soil. It also occurs elsewhere in the same region in such large quantities and under such general conditions that its presence can hardly be attributed to human agency. Yet no other explanation is offered of this curious phenomenon.—Remarks on the series of earthquakes that have recently devastated the southern provinces of Spain, by C. G. Rockwood, jun.—On the structure of the spores or spore-like bodies (*Sporangites huronensis* of Sir J. W. Dawson) occurring in the Devonian formations of North America, by J. M. Clarke.—Denudation of the two Americas, by T. Mellard Reade. In this paper the author follows up the calculations already made by him regarding the quantity of matter annually removed in river water from the surface in England and Wales and some of the river basins of the European continent. Here the Mississippi, Amazons, and St. Lawrence basins are dealt with, the results confirming the provisional assumption that about 100 tons of rocky matter are dissolved by rain per English square mile per annum throughout the world.—On Arctic Interglacial Periods, by Dr. James Croll. It is argued that the Polar Interglacial periods were more marked than the Glacial, and that they neither did nor could exist *simultaneously* in both hemispheres. In a concluding note the author remarks that this will probably be his last paper on questions relating to geological climate, advancing years and declining health obliging him to abandon the subject in order to finish some work in a different field of inquiry which has been laid aside for over a quarter of a century.—Notes on some apparently undescribed forms of fresh-water Infusoria, No. 2 (with Plate III.), by Dr. Alfred C. Stokes.—Palæozoic notes; new genus of Cambrian Trilobites Mesonacis, by Charles D. Walcott.

Bulletin de la Société d'Anthropologie de Paris, 4e Fascicule, 1884.—The sequel to the "Anthropology of California," by M. Ten Kate.—Observations on the anthropological character and social conditions of the M'zabites, by Dr. Charles Amat, who has added to the results of his personal study of the people a brief summary of their history, derived from the chronicle of Abou Zakaria, translated by M. Masqueray, while he is indebted to a brother officer, M. Motylinsky, for much interesting information regarding the language, which differs entirely from Arabic, and presents close affinities with the dialects of the Berbers. The people, who are a remnant of the ancient sect of the Karidjites, retain many traces of pre-Moslem usages and forms of belief, follow agricultural pursuits, and are the main purveyors of corn in the Sahara.—Notes, by Dr. Hyades, on the Fuegians, considered from a hygienic and medical point of view.—On the significance of the name of the Aryans, by M. Ploix, who attempts to prove its derivation from a Sanscrit root indicating "white." This hypothesis is very forcibly attacked by M. O. Beauregard, who, in a subsequent communication to the Society, brings forward strong evidence to show that the etymological meaning of the term is "noble" or "venerable."—A report on the project of instituting an official anthropometrical examination of the pupils in the primary schools of Paris, by M. Manouvrier.—On the influence of the American medium on the races of the Old World, by M. de Quatrefages.—Notes by M. Pietrement in support of his opinions regarding the age of iron, which had been called in question by M. Mortillet.—Communication, by M. de Rialle, of M. Macey's account of a grave, discovered near Saïgon, Cochin China, in 1882. According to the opinion of the few natives who are versed in local archæology, this grave, which was discovered twelve feet below the surface, dates back at least 400 years. From the lower of the two superposed coffins, besides a few vertebræ and the tibiæ, a cranium was extracted which presents a deep perforation above the right temporal that may be regarded as the cause of the death of the Annamite chief to whom the remains belonged.—Report, by M. de Ujfalvy, of the finds obtained from a Celtic cemetery near Rosegg, in the valley of the Drave. The tumuli, of which there are more than 300, resemble in structure and general contents those opened at Hallstadt and in Styria, but in addition they have yielded a large number of curious little leaden figures of wheels, birds, men on horses, &c., attached to the surface or margins of the various vases.—On some crania from the Merovingian graves at Fermes (Oise), by M. de Maricourt, with an extensive series of measurements, which, according to him, afford strong presumptive evidence of diseases having a scrofulous or syphilitic origin.—On the Gallic rock-tumuli of Port Bara (Quiberon), by M. Gaillard.—On an elephant's tusk found in the valley of the Drance (H. Savoie), by M. D'Acy. This find was obtained at 3000 feet above the level of the sea, and is believed to belong to a relatively recent representative of *Elephas primigenius*.—On the manufacture of fire-flints still existing in France, by M. P. Salmon. This industry is chiefly carried on near Percheriou (Loir-et-Cher), whence large numbers of flints are annually exported to supply the demand still existing for them among Central African and other savage tribes.—Communication, by Dr. Verrier, regarding the work of Dr. Engelmann, of Louisville, on the various modes of delivery prevalent amongst women of different races.—On the different powers of resisting cold shown by various races, by M. Maurel.—On a placental anomaly in a case of twin-delivery, by Dr. Verrier.—Notes on the crania of three idiots, by Drs. Doutrebente and Manouvrier.—Observations on the static and dynamic conditions by which man is enabled to stand erect, by Dr. Fauvelle.—Researches on the so-called "Maye" of Provence, by Dr. Berenger-Ferand. The paper is an enlarged exposition of an earlier notice, which appeared in 1883, on the Provenzal customs of our own times, in which the author sees a survival of the ancient worship of Maia—as are our own May queen, Florrie games, jack in the green, and other May festivals—the long ages of Christianity having modified but not obliterated the traces of paganism.

Rendiconti del Reale Istituto Lombardo, March 12.—Note on the kinetic theory of the gases and on the limits of the terrestrial atmosphere, by Prof. R. Ferrini.—On some geometrical, statical, and kinematic properties of articulated polygons, by Prof. G. Jung.—A comparison of the respective merits of Bellani's lucimeter and the English heliograph constructed by Negretti and Zambra, of London, by Giovanni Cantoni.—On some uniform representations in the higher mathematical analysis, by Prof. Giulio Ascoli.—On some remarkable features of the stratified rocks in the Valtravaglia district, North Lombardy, by Prof. Taramelli.—On the question whether rice should be considered as a contraband of war, by Ercole Vidari.

April 9.—Historical notes on the comet of the year 1472, by Prof. G. Celoria.—On the geometrical movement of invariable systems, by Prof. C. Formenti.—Remarks on the cholera bacilli observed and described by Pacini in his various medical publications, by Prof. L. Maggi.—Further observations on uniform representations, by Prof. Giulio Ascoli.—Note on the traces of Roman jurisprudence in the Longobard edicts, by Prof. P. del Giudice.—Critical examination of the proposed Italian penal code punishments, by E. A. Buccellati.

Bulletin de l'Académie Royale de Belgique, March 7.—A word on the two Balenopteræ cast ashore at Ostend in the years 1827 and 1885, by P. J. Van Beneden.—Observations of Wolf's comet made at the Brussels Observatory (0·15 m. equatorial), by L. Niesten.—Observations of Encke's comet made at the same observatory, by E. Stuyvaert.—On the early epochs of Flemish history, by Alphonse Wauters.—Note on Louis du Tielt, painter and engraver, who flourished at Ypres during the seventeenth century, by Ch. Piot.

SOCIETIES AND ACADEMIES

London

Royal Society, January 22.—"Observations on the Chromatology of Actiniæ," by C. A. MacMunn, M.A., M.D. Communicated by Prof. M. Foster, Sec.R.S.

The conclusions arrived at may in part be summed up as follows.—

(1) *Actinia mesembryanthemum* contains a colouring matter which can be changed into *hæmochromogen* and *hæmatoporphyrin*;

this is present in the other species mentioned above, and from its characters it is provisionally named *Actiniohæmatin*.

(2) It is not actiniochrome (a pigment found by Prof. Moseley in the tentacles of *Bunodes crassicornis*), as its band occurs nearer the violet than that of antiniochrome. Moreover, both actiniochrome and actiniohæmatin can be extracted with glycerin, in which the latter is convertible into hæmochromogen, but the former remains unchanged. Actiniochrome is generally confined to the tentacles, and is not respiratory, actiniohæmatin occurs in the ectoderm and endoderm, and is respiratory.

(3) A special colouring matter is found in *Sagartia parasitica*, different from either of the above, and this too exists in different states of oxidation. It is not apparently identical with that obtained by Heider from *Cerianthus membranaceus*.

(4) In the mesoderm and elsewhere in *Actinia mesembryanthemum* and other species, a green pigment occurs which alone and in solution gives all the reactions of *biliverdin*.

(5) *Anthea cereus*, *Bunodes ballii*, and *Sagartia bellis*, yield to solvents a colouring matter resembling chlorofucin, and all the colouring matter, which in them shows this spectrum, is derived from the "yellow cells" (= symbiotic algæ), which are abundantly present in their tentacles and elsewhere. It is not identical with any animal or plant chlorophyll, as is proved by adding reagents to its alcoholic solution.

(6) When "yellow cells" are present, there appears to be a suppression of those colouring matters which in other species are of respiratory use.

April 23.—"Magnetisation of Iron." By John Hopkinson, M.A., D.Sc., F.R.S.

The paper contains an account of the results of experiments which have been made on a considerable number of samples of iron and steel of known composition, including samples of cast iron, malleable cast iron, wrought iron, ordinary steels, manganese, chromium, tungsten, and silicon steels. The electrical resistance and the magnetic properties are determined in absolute measure. Amongst the electrical resistances the most noteworthy fact is the very high resistance of cast iron, as much as ten times that of wrought iron. The fact that manganese steel is almost non-magnetic is verified, and its actual permeability measured. The action of manganese appears to be to reduce the maximum magnetisation of steel, and in a still greater ratio the residual magnetism, but not to affect the coercive force materially. It is shown that the observed permeability of manganese steel containing 12 per cent. of manganese would be accounted for by assuming that this material consists of a perfectly non-magnetic material, in which are scattered about one-tenth part of isolated particles of pure iron. Some practical applications of the results are discussed.

April 30.—"Further Observations on Enterochlorophyll and Allied Pigments." By C. A. MacMunn, M.A., M.D.

In a paper read before the Royal Society in 1883, the writer described the spectroscopic and other characters of enterochlorophyll which was obtained from the liver or other appendage of the *enteron* of various invertebrates (hence the name). It is now shown that this pigment is *not* due to the presence of symbiotic algæ, or *immediate* food-products, but is built up by the animal containing it.

Taking the six bands[1] of vegetable chlorophyll in alcoholic solution described by Kraus, the first two and the fourth are coincident with those of enterochlorophyll in a similar solution; the third band is, however, frequently missing from the latter. The fifth and sixth bands belong to the yellow constituent, which Hansen shows to be a lipochrome; the corresponding bands in the case of enterochlorophyll also belong to a lipochrome, and are not always coincident with the lipochrome bands of plant-chlorophyll. This was proved by saponifying enterochlorophyll by Hansen's method (as described in NATURE, vol. xxx. p. 224). But saponification of vegetable chlorophpll changes it considerably, as bands of a solution, before saponifying, do not correspond with those of a similar solution after saponifying. Hansen's results were confirmed as far as the separation of "chlorophyll green" and "chlorophyll yellow" are concerned, and the crystals described by him obtained.

While the dominant band of "chlorophyll green" in solutions of plant-chlorophyll is moved much nearer the violet by saponifying, or split up into two in some cases, the corresponding band of enterochlorophyll disappears *in toto*, or remains in the same place. Another difference was also noted in the case of enterochlorophyll and in the case of *Spongilla* chlorophyll, namely, that it is impossible to bring about a *complete* separation of the constituents in most cases by saponifying and treating as Hansen directs.

All the bands of a solution of *Spongilla* chlorophyll are coincident with those of a similar solution of plant chlorophyll, as already proved by Prof. Lankester and Mr. Sorby.

From the enterochlorophyll of *Uraster rubens* crystals of "chlorophyll yellow" and "chlorophyll green" were obtained by saponifying.

Morphologically, enterochlorophyll occurs—as proved by the examination of fresh-frozen sections—in oil-globules, granules, and dissolved in the protoplasm of the liver cells; no starch or cellulose could be found in such sections after adopting the usual botanical precautions.

Hence enterochlorophyll is an animal product, and a chlorophyll, of which there are probably several occurring in animals.

[1] The five bands in a leaf, as described by Kraus, can be seen by using a micro-spectroscope of small dispersion and good substage achromatic condenser.

Geological Society, April 29.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the chair.—James Backhouse, Percy Bosworth Smith, and James Shipman were elected Fellows of the Society.—The following communications were read:—On the structure of the ambulacra of some fossil genera and species of regular Echinoidea, by Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., V.P. Linn. Soc. After noticing the general knowledge which exists about the structure of the ambulacra in the Cidaridæ and the elaborate investigations of Lovén on the Triplechinidæ, the author brought before the Society the results of his own work with and without the cooperation of his fellow-worker in the description of the Echinoidea of Sind, Mr. Percy Sladen, F.G.S., and which referred to the Diadematidæ and the Arbaciadæ of the recent faunas. Starting with the knowledge of the construction of the modern Diadematidæ, the author investigated the genera *Hemipedina*, *Pseudodiadema*, *Pedina*, *Hemicidaris*, *Diplopodia*, and *Cyphosoma*. The necessity for the re-establishment of the genus *Diplopodia* was shown, and a new genus, *Plesiodiadema*, was founded. *Pseudodiadema*, shorn of the forms included in these genera, remains and differs more from *Diadema* than has been believed. The method of the growth of the great plates of *Hemicidaris* was explained, and the comparison between the peristomial plates of some of the Diadematidæ and the universal structure of the ambulacral plates in *Pedina* was made. The author considered that there are six types of ambulacra in the regular Echinoidea, so far as the group has been investigated, there still remaining much to be done. These types are the Cidaroid, Diadematoid, Arbacioid, Echinoid, Cyphosomoid, and Diplopodous. In conclusion the succession in time of the structures which characterise these types was considered.—The Glacial period in Australia, by R. von Lendenfeld, Ph.D. Communicated by W. T. Blanford, LL.D., F.R.S., Sec.G.S. Although several previous writers have suggested that boulders and gravels found in different parts of Australia are of glacial origin, the evidence is vague, and no clear proof of glaciation has been brought forward. During a recent ascent of the highest ranges in Australia, parts of the Australian Alps, the author succeeded in discovering a peak which he named "Mount Clarke," 7256 feet high, and in finding traces of glaciation in the form of *roches moutonnées* throughout an area of about 100 square miles. The best-preserved of the ice-worn surfaces were found in a valley named by the author the "Wilkinson Valley," running from north-east to south-west, immediately south of Müller's Peak and the Abbot Range. No traces of ice-action were found at less than 5800 feet above the sea. The rocks showing ice-action are all granitic, and the fact that the surfaces have been polished by glaciers is said to be proved by the great size of such surfaces, by their occurrence on spurs and projecting points, by many of them being worn down to the same general level, and by their not coinciding in direction with the joints that traverse the rock. In conclusion the author briefly compared the evidence of glacial action in Australia with that in New Zealand.—The physical conditions involved in the injection, extrusion, and cooling of igneous matter, by H. J. Johnston-Lavis, M.D., F.G.S., &c. The great disproportion between the displays of volcanic activity in the same volcano at different times, and between the eruptions of different volcanoes, is a subject deserving the most attentive consideration. The violence of a volcanic outburst does not bear any relation to the quantity of material ejected. The union of water with lavas may be compared with the solution of a gas in water; but there is reason to believe that in their deep-seated sources lavas contain little or no water. If igneous matter be extruded through dry strata the eruption might take place without explosive manifestations. But if igneous matter be extruded through water-bearing beds, a kind of dialysis would take place between the igneous and aqueous masses. In this way the tension of the steam in the fluid rock may at last become so great that a fissure will be formed at the surface and volcanic action will follow. In this way the violence of a volcanic eruption will be determined by the quantity of water contained in the strata through which the lava passes in its passage to the surface, and by the temperature at which it reaches the surface. This theory explains the acknowledged sequence of volcanic outbursts of different degrees of violence, and the intervals which occur between them. It also explains the differences between the central and lateral eruptions of a great volcano and the phenomena attending its extinction. The structures of the igneous rocks, whether of basic or acid composition, are greatly modified by the presence in them of volatile ingredients. The succession of events indicated by the structure of Monte Somma and Vesuvius, Roccamonfina, Monte Vulture, and Monte Nuovo show that after a long cessation of volcanic activity we have an extensive production of fragmentary and scoriaceous material, and that this is gradually succeeded by the eruption of lava-streams. The water and other volatile substances, such as sulphates and chlorides, which are given off abundantly in volcanic eruptions, may act as solvents for the various minerals which constitute lavas.

Physical Society, May 9.—The meeting was held in the Physics Theatre of Clifton College, Bristol, in consequence of an invitation from the British Naturalists' Society, Prof. Guthrie, President, in the chair.—Messrs. E. Cleminshaw, E. F. Herrom, and A. L. Selby were elected members of the Society.—The following communications were read:—On evaporation and dissociation, by Prof. W. Ramsay and Dr. S. Young. The authors gave the results of a series of investigations undertaken with the view of determining how far the passage of a liquid into a gas resembled the dissociation of a chemical compound. For this purpose the relation between the pressure and temperature of several dissociating substances such as ammonic carbonate, chloral hydrate, and phthalic acid had been examined. The authors hope shortly to publish the full details of these experiments and the conclusions arrived at.—On a model illustrating the propagation of the electro-magnetic wave, by Dr. S. P. Thompson. The model consists of two sets of beads. Each set is composed of a number of beads fixed to the extremities of wires, and by a suitable mechanical contrivance each executes an approximately harmonic motion at right angles to the wires and the mean plane of the set. The phase of each bead differing by a certain small amount from the succeeding, the whole represents a wave-propagation. The two sets are coloured differently and are so placed that their harmonic motions are executed at right angles about the same axis which represents the direction of propagation of an electro-magnetic disturbance, one wave being the electrostatic and the other the electro-magnetic displacement.—On a self-recording stress and strain indicator, by Prof. H. S. H. Shaw. This instrument was designed for one of Wicksteed's 50-ton single lever machines lately erected in the Engineering Laboratory of University College, Bristol, and has been found very simple and effective. In this testing machine the stress is applied by moving a mass of 1 ton along a lever; this mass is connected by a cord with a vertical cylinder upon the indicator. This cylinder carries a paper wound around it, and turns upon its axis as the mass is moved towards the end of the lever. A pencil capable of a vertical motion bears against this, and thus horizontal distances upon the paper are measures of stress. The strain is measured by the vertical motion of the pencil, the position of which is controlled by a wire attached to the rim of a wheel above, upon the same axis of which are other smaller wheels, any one of which can be connected to a fine wire which is carried horizontally to the upper end of the test-piece passing over a pulley fixed to it, and is fixed to the lower end. Any extension of the test-piece can be multiplied at pleasure on the diagram by attaching the wire to a larger or smaller wheel.—Note on the so-called silent discharge of ozone generators, by Mr. W. A. Shenstone. Mr. Shenstone had arranged some apparatus by which this could be viewed. It seemed to have the characteristics of the Brush discharge.

EDINBURGH

Royal Society, April 20.—Robert Gray, Vice-President, in the chair.—In a paper on the effect of pressure on the temperature of minimum compressibility of water, Prof. Tait showed that the various results obtained admitted of easy deduction from theory.—A note on the variation by pressure of the melting-point of paraffin, &c., by Mr. W. Peddie; and a note on the thermal effects of tension in water, by Mr. G. N. Stewart, were submitted by Prof. Tait.—Mr. Hugh Robert Mill read a paper on the temperature of the water in the Firth of Forth, describing the work done at the Scottish Marine Station in this direction. The annual range of temperature, from summer maximum to winter minimum, was found to vary from nearly 40° F. at Alloa, where the river is fresh at low tide, to 20° at Queensferry, twenty miles seaward, and 10° at the mouth of the Firth thirty-five miles further on. The mean temperature of the water appeared to be the same—47°·5—at all parts of the estuary. From June to September the river was warmer than the sea, from October to May it was colder, the average rise or fall in temperature at any time along the Firth being 0°·07 per mile. During the summer period the surface-water had a higher, and during winter a lower, temperature than that beneath. The annual minimum was reached in February, the maximum in August, and there were indications of the period being delayed toward the open sea. Materials are unfortunately wanting for discussing the variations of temperature in the North Sea beyond the influence of land. Mr. Mill showed curves of the monthly mean temperatures of the water plotted by the use of polar coordinates. Each month was represented by an angle of 30°; the temperature being measured on the radius, equal values were shown as concentric circles. Temperatures so plotted appear as closed curves, and in several cases those for the water resembled a circle placed eccentrically to the circles of reference. This method of curve-drawing has several advantages over that by the use of rectangular coordinates where periodic phenomena are to be represented.—Mr. J. T. Cunningham, of the Marine Station, read a paper on the relations of the yolk to the gastrula in teleosteans and in other types.

Mathematical Society, May 8.—Mr. A. T. G. Barclay, President, in the chair.—Prof. Chrystal read papers on repeated differentiation, and on a process for finding the differential equation of an algebraic curve. Dr. Thomas Muir made a communication on integration formulæ, and gave a historical note on the so-called Simson line.—Mr. J. S. Mackay contributed several mnemonics for certain mathematical constants.

SYDNEY

Linnean Society of New South Wales, Feb. 25.—Prof. W. J. Stephens, M.A., F.G.S., President, in the chair.—The following papers were read:—On some reptiles from the Herbert River district, Queensland, by William Macleay, F.L.S., &c. Five new species are here described, *Hinulia picta*, and *Tetradactylus guttulatus* of the family Scincidæ, and of Ophidians *Nardoa crassa*, *Tropidonotus ater*, and *Hoplocephalus assimilis*.—Notes on certain Ceylonese Coleoptera, described by the late Francis Walker, by A. Sydney Olliff. In these notes Mr. Olliff, who had examined Mr. Walker's types in the British Museum, endeavours to clear up the synonymy of the Clavicorn families. The name *Asana* was proposed for the *Trogosita rhyzophagoides* of Walker, which cannot be referred to any known genus. In form it resembles *Lipaspis*, but is characterised by the presence of a scutellum.—On the flight of birds, by R. von Lendenfeld, Ph.D.

PARIS

Academy of Sciences, May 11.—M. Bouley, President, in the chair.—Remarks on the application of photography to the mapping of the stars by means of MM. P. and Pr. Henry's new objectives, by M. Mouchez. The first essays with an objective of 0·16 m. and a provisionary apparatus proved so successful, that a new instrument has been constructed with two objectives of 0·24 m. and 0·34 m. respectively. Although not yet completely regulated, this instrument has already yielded some remarkable results, fully justifying, if not exceeding, the hopes entertained by astronomers. It appears to have once for all solved the problem how to apply photography to the construction of a map of the heavenly bodies which shall include stars of the 14th and 15th magnitudes.—On the spontaneously reversible spectral rays, and on the analogy between the laws of their distribution and intensity with those of the hydrogen rays, by M. A. Cornu.—On the electric conductibility of solid mercury and of pure metals at low temperatures, by MM. Cailletet and Bouty. From numerous experiments made with mercury, silver, tin, aluminium, magnesium, copper, iron, and platina, the authors conclude that the electric resistance of most pure metals decreases regularly when the temperature is lowered from 0° to – 123°, and that the coefficient of variation is apparently much the same for all. It seems probable that the resistance would become extremely slight at temperatures lower than – 200°, although this point has not yet been practically tested.—Note on the action of aluminium on the chloride of aluminium, by MM. C. Friedel and L. Roux.—An inquiry into the reason which renders mechanical exciters incapable of bringing into play the excito-motor regions of the brain proper, by M. Vulpian.—Remarks on MM. A. F. Marion and G. de Saporta's "Evolution of the Vegetable Kingdom," by M. Duchartre.—On a method of reconnoitring the enemy's position at great distances with a description of the telemetrograph, an instrument invented for carrying out these operations (one illustration), by M. A. Laussédat.—On the cure of progressive myopy by the processes of iridectomy and sclerotomy, with remarks on the theory of this ophthalmic affection, by M. H. Dransart.—Note on the theory of the figure of the earth, by M. O. Callandreau.—Remarks on a new and accurate method of astronomic observation by means of a fixed lunette attached to the meridian, by M. Ch. von Zenger. By this simple process the angle of position and the distance of the double stars may be determined and measurements taken of the parallax of the sun or the stars. For simple observations a precision of 0"·02 may be relied upon which is considerably greater than that hitherto obtained by the use of the most accurate and powerful meridian lunettes.—Results of experiments undertaken at the national powder mills of Pont-du-Buis with the regulating apparatus of two turbines for the purpose of testing the conclusions deduced from M. Léauté's memoir on oscillations at long intervals in machinery set in motion by hydraulic agency, by M. A. Bérard.—On the polarisation of the metallic capillary tubes by the flow of fluids under high pressure, by M. Krouchkoll. When a conducting fluid is driven through a capillary metallic tube at a pressure of less than fifteen atmospheres, the tube and the fluid being placed in communication with the mercury of a capillary electrometer, no polarisation of the tube takes place. But if the pressure be raised, the author shows that the tube begins to become polarised, the polarisation increasing with the pressure.—Description of a new electric pile, at once simple and cheap, which has been named the "self-accumulator" by the inventor, M. Jablochkoff. For this pile it is claimed that it emits no odour, that it utilises the local currents which are so troublesome in ordinary piles, and especially that it supplies electric power at a very low price, for in it filings, cuttings, and other waste forms of metals may be employed.—On the tensions and critical points of some vapours, by MM. C. Vincent and J. Chappuis. The author's observations are here confined to hydrochloric acid and the chloride of methyl, the object being to show how the maxima tensions of a series of liquefied gases vary with the temperature, to determine the critical points of these products, and to compare the results obtained for the purpose of verifying the hypotheses advanced by MM. Nadejine and Pawlowsky. — Note on the oxychlorides of aluminium, by MM. P. Hautefeuille and A. Perrey.—On the apparent volatilisation of silicum at a temperature of 440°, by MM. P. Hautefeuille and A. Perrey.—Note on a method of preparing arsenical acid, and on the existence of combinations of arsenious and arsenical acids, by M. A. Joly.—On the limit of combination for the bicarbonates of magnesium and potassium, by M. R. Engel.—On a hydrochlorate of protochloride of chromium, by M. Berthelot.—A calorimetric study on the effects of the tempering and cold-hammering of cast steel, by M. Osmond.—Remarks on the mineralogical constitution of the Sierra Nevada of the Iberian Peninsula, by M. Guillemin-Tarayre.—On the liberation of carbonic acid and the absorption of oxygen by leaves kept in dark places, by MM. P. P. Dehérain and L. Maguenne.—Note on a new gutta-percha plant, by M. E. Heckel. As a substitute for the Isonandra gatta, Hooker, which is threatening to disappear, the author proposes the *Butyrospermum Parkii*, Kotschy, which possesses similar properties, and which is widely diffused throughout equatorial Africa, between Upper Senegal and the Nile basin.—A fresh contribution to the question of the origin of boric acid: analysis of the Montecatini waters between Florence and Pistoja, by M. Dieulafait.—On an arrangement enabling the observer to follow with the eye the phenomena presented by aquatic animals subjected to a pressure of 600 atmospheres, by M. P. Régnard.—On a new apparatus intended to detect infinitesimal quantities of blood wherever present in fluids or on solid substances, and named the "hema-spectroscope" by the inventor, M. M. de Thierry.—On pathological urines, by M. A. Villiers.—Note on a method for measuring the intensity of sensations, and especially those of colour, by M. Aug. Charpentier.—On the formation and development of the spores in *Cladothrix dichotoma*, by M. A. Billet.—A study of the Bacterium ureæ, by M. A. Billet.—Remarks on the cause of a new epidemic recently prevalent amongst the domestic ducks in the neighbourhood of Castres, Tarn, by M. A. Caraven-Cachin. This disease, which at one time raged with great violence, was ultimately traced to the leaves of the *Ailantus grandulosa*, Desf., or varnish of Japan, growing in the district and eaten by these birds.

Berlin

Physiological Society, April 17.—Prof. Busch spoke on anomalies in human teeth, and illustrated his observations in part by preparations laid before the Society, in part by plaster casts. In the first place he treated of anomalies of situations he had observed in teeth—the horizontal position of a wisdom tooth, which, pressing against the third molar, produced inflammation in the latter; the projection of teeth through the aveolar wall of the maxilla on the anterior or posterior side, an occurrence happening mostly in the case of permanent canine teeth which pushed their way through at a late period, when there was no place left for them in the jaw; the exchange of situation between the canine tooth and the first bicuspid in the order of the teeth. Another kind of anomalies respected the number of the teeth, especially of the incisors. Instead of the normal number of four in each jaw, five were now and again observed, and in a few, very rare, cases, as many as six. On the other hand, there were cases of only two incisors with a correspondingly large lacuna. The failure of the wisdom tooth was not a rare occurrence. Anomalies of dental structure the speaker illustrated by pieces of ivory, which presented very remarkable deviations from the normal course of their fibres. In human teeth there had to be considered under this head enamel pearls, that is, smaller or larger round drops of enamel adhering to the roots, and having no connection with the crown. Anomalies of size were very rare. The breadth of the physiological variations amounted to about 3 to 5 mm. Now and again, however, enlargements were observed as high as 10 mm., and diminutions as low as to 0·9 cm. In the latter case crown and root had each transformed itself into the shape of a cone. Enlargements affected the root more frequently than the crown. Anomalies of the root were sometimes seen in curves shaped like an S or hook, but more frequently in the increase or diminution of the number of the roots. More than five outspread roots, more or less perfect, had never been observed. Molars of the lower maxilla were not unfrequently found with three, and bicuspids with two separate roots. In incisors and canine teeth divisions of the tips of the roots were occasionally found with two pulps, or more or less deep segmentations. A diminution, as well as an increase in the number of the roots had also been observed; yet was the coalescence of separate roots of rarer occurrence than their increase by splitting. The frequency of the anomalies referred to was not great. Out of nearly 11,000 teeth examined, only about 100 anomalous specimens had been found. Still more seldom did swellings occur on the teeth. These were sometimes soft, and consisting of connective tissue; sometimes completely calcified without containing one of the tooth tissues differentiated; sometimes situated on the crown, sometimes on the root. These Odontoma, like the teeth themselves, were always to be found in particular grooves of the maxilla. No osseous coalescence of the teeth and maxilla had ever been observed. At the close the speaker produced casts of gums which showed very considerable variations in their curves, ranging from an entirely flat up to a highly arched form.—Prof. Christiani communicated briefly the results of experiments carried out by Herr Gnezda on the poison of the cobra di capello (*Naja tripudians*). The poison was obtainedin India by causing the snakes to bite into snails or mussels wrapped in gutta-percha and filled with water. The watery solution thus obtained was reduced by evaporation. Of its physical and chemical qualities it was to be remarked that the poison belonged to the class of propeptons. Experiments were instituted with representatives of all the vertebrata. They were all susceptible of the poison, and died when the dose of the poison amounted to 3mg. per kilogramme animal. The time when death followed a full dose of the poison was very various. Rabbits died after half an hour, pickerels after an hour, frogs later, then cats, and lastly pigeons. Stronger doses hastened death. Dilutions and the introduction of artificial respiration delayed death. The physiological effect extended principally to the central nervous system. The muscles and the peripherical nerves continued irritable, although paralysis set in very soon. Seldom were spasms and compulsory movements observed. The poison appeared to have hardly any effect at all on the heart.

Physical Society, April 24.—Dr. Kayser reported on a recent paper of Prof. Bunsen (*Wiedemann's Annalen*, 1885, Heft 3) in which the differences between the results of the speaker's experiments regarding the absorption of carbonic acid on smooth glass surfaces and those published by Prof. Bunsen two years ago received their explanation. While, namely, Dr. Kayser had found that the absorption of carbonic acid proceeded according to definite laws formulated by him, Prof. Bunsen had observed that this process of absorption did not terminate even after as long a period as three years, but still continued, even though at a reduced rate. In his most recent work Prof. Bunsen had now established that the glass threads, even after a current of dry air had been for a considerable time directed over them, still retained a layer of water which was thin in proportion as the temperature was high, but did not become entirely dissipated till the temperature reached as high as about 500° C. This layer of water it was which absorbed the carbonic acid, and all the more powerfully the denser was the layer of water. The density of the water, however, stood in inverse relation to its thickness. From these experiments Dr. Kayser concluded that the absorption of carbonic acid on the glass threads which Prof. Bunsen had observed continuing for so long a period was only an absorption of the gas by the adhering water and no absorption on the smooth glass surface, whereas in the speaker's experiments, in which the glass threads had in boiling oil been freed from all adhering matters, the carbonic acid had been absorbed by the smooth glass.—Dr. Less spoke of two curves placed before the Society, as markings of the barograph on April 22 and 23 during the time of the brief thunderstorm in Berlin. The two curves presented in general an analogous course, concurring, moreover, with curves which Dr. Less had observed last year during the severe July storm. Before the outburst of the thunderstorm the curves sank slowly, next rose steeply to a considerable height; with the attainment of the maximum of pressure coincided the stroke of lightning; the curve then maintained itself at a level for some time, throughout which the thunder-shower or hail was wont to fall; on the cessation of rain the curve of atmospheric pressure sank steeply to beneath the former minimum. In the two April curves a further sudden rise preceded the second weaker stroke of lightning, and there then followed several smaller jerkings of the curves coinciding with the time of the formation of clouds consequent on the short thunder-storm. In the curves of the July of last year during the severe storms so copiously charged with lightning, the apex of the curves after the sudden ascent was not straight, but consisted wholly of short indentations each of which appeared to correspond with an individual lightning stroke, so far as it was possible to fix the precise times. The sudden steep ascent of the curve on April 22 and 23 coincided with a sudden increase in the force of the wind, which soon, however, fell weaker, and at last sank almost to complete stillness. The speaker also reported the corresponding numerical values for the variations of atmospheric pressure marked by the barograph.

VIENNA

Imperial Academy of Sciences, March 5.—Contribution to a knowledge of Coniopterigidæ, by F. Löwe.—On a new morphological element of peripheric nerves, by A. Adamkiewicz.—On the sensibility to light and colours of some marine animals, by V. Graber.—On some propagatory organs of the fruits of Compositæ, by M. Kronfeld.—On the fauna of the Jurassic deposits of Hohenstein, Saxony, by G. Bruder.—On mannite lead-nitrate, by A. Smolka.—Note on Löwe's lead-nitrate and on Morawski's penta-plumbonitrate, by the same.—On the temperature of Vienna and its environs, with a study on the action of local influences on the mean temperature, by T. Hann.—On camphoronic acid, by T. Kachler and F. V. Spitzer.—On the daily and yearly course, and on the period of disturbances of magnetic declination at Vienna, by T. Liznar.

March 12.—On nerve-corpuscles, by A. Adamkiewicz.—On the use of boiling oxygen, nitrogen, carbon oxide, and atmospheric air as a freezing-agent, by S. von Wroblewski.—Contribution to a knowledge of the texture of hyaline cartilage, by E. Zuckerkandl.—On the Upper Italic flora of the Lunz strata and of the bituminous slate of Raibl, by Dr. Stur.

March 19.—Crystallographic researches on camphor derivates, by V. von Zepharovich.—Experimental studies on the determination of the constant of dielectricity of some gases and vapours, by T. Klemencie.—On the planes of solution of calcareous spar and arragonite, by V. von Ebner.—On figures obtained by corroding arragonite, by the same.—On a meteoric explosion observed at a distance of 1000 metres by R. Spitaler on March 15, by E. Weiss.

UPSALA

Society of Science, April 17.—The following paper, by Dr. K. B. J. Forssell, was accepted for insertion in the Society's *Journal*:—"Beiträge zur Kenntniss der Anatomie und Systematik der Gloeolichenen." Prof. Lilljeborg described a *Metridia armata* (Boeck) taken in the Antarctie Ocean (lat. 54°–5° S.), and suggests that it was probably found near both poles. It was taken by Capt. Schéele, of the Swedish barque *Monark*, an amateur scientist to whom the Society had lent instruments, vessels, and apparatus for deep-sea researches. He further exhibited *Pluroma abdominale* (Lubbock), also taken by Capt. Schéele in the South Atlantic. It was remarkable as having an appendicular eye on the side of the head.—Prof. Hildebrandsson spoke about the twilight phenomenon, specially with reference to some observations of the purple glimmer then prevailing, made by Dr. Gyllenskjöld.—Prof. Clason gave a lecture on the functions of certain parts of the brain.

CONTENTS

THURSDAY, MAY 28, 1885

PRACTICAL INSTRUCTION IN BOTANY

A Course of Practical Instruction in Botany. By F. O. Bower, M.A., F.L.S., Lecturer on Botany at the Normal School of Science, South Kensington, and Sidney H. Vines, M.A., D.Sc., F.L.S., Fellow and Lecturer of Christ's College, Cambridge, and Reader in Botany in the University; with a Preface by W. T. Thiselton Dyer, M.A., C.M.G., F.R.S., F.L.S., Assistant Director of the Royal Gardens, Kew. Part I. Phanerogamæ-Pteridophyta. (London: Macmillan and Co., 1885.)

IT is with more than ordinary satisfaction that we welcome this volume. Apart altogether from consideration of its intrinsic excellency, its appearance is gratifying as a first product of the younger school of botanists in this country—a school which for some years past has been doing good work in oral teaching, though up till now it has not contributed to teaching literature—and it is time that its methods were put in a more permanent form and made more generally accessible. The inconsistencies and inaccuracies characterising, with few exceptions, our endemic botanical text-books and our dependence for reasonably safe handbooks with information up to date upon translated works, mostly of German authors, are a reproach for which every botanist would gladly see the cause removed. At last we have a prospect of this, and the volume now before us is an instalment of a work which will in great part do so. The names of Thiselton Dyer, Bower, and Vines on the title-page are a guarantee of its thoroughness and accuracy, and the book certainly bears out their reputation.

The book took origin, as Mr. Thiselton Dyer informs us in the preface, in the work initiated by him at South Kensington in 1873. It is no small merit to have started at that time a system of instruction which embraced the examination by every student of the leading morphological facts of every important type in the vegetable kingdom. And this programme, which Mr. Thiselton Dyer set himself and successfully carried out, has not only eventuated in what, with him, we hope will be permanent—the institution, in what is now the Normal School of Science, at South Kensington, of a lectureship on botany, but also, in what concerns us here—this volume.

"I had always," says Mr. Thiselton Dyer, "hoped to put together the results of the experience in teaching methods acquired at South Kensington in the form of a handbook, which should save teachers who wished to follow our example from much of the trouble and difficulty which I, and those who at different times have taught in this way, have had to face. But, in the meanwhile, I had been drawn off to administrative duties which left a steadily decreasing leisure for purely scientific work. Fortunately, my friend Mr. Bower was willing—and with far greater competence—to take up the task which I was unable to perform, and to him are entirely due the laboratory instructions for studying the different types selected. Dr. Vines has very kindly supplied the chapters on methods and on the morphology of the cell. But besides this he has at every step given the assistance of his own extensive experience in practical teaching." With this book before us we can understand the motive of success of the South Kensington course, for it is the most thorough introduction to the practical study of plant morphology which has yet appeared; the only book to be mentioned along with it is the recently published "Practicum" of Strasburger—(of which of course the inevitable translation is promised)—and that is laid down on somewhat different lines.

In the first chapter Dr. Vines gives an excellent account of methods and reagents, delightful in the clearness and conciseness of its language and bearing throughout evidence of the hand of one who is no mere compiler of instruction but who has himself tested and had experience of all that is explained. The manner of setting to work, of making preparation, of making cultures, of preparing reagents, is all set forth in such a way that any intelligent tyro may readily equip himself and do good work. And we must congratulate Dr. Vines on the wise selection of methods and reagents he has made for notice, and on their arrangement. The multiplicity of new methods—many with but questionable advantage to recommend them—and their technicalities even in connection with botanical work is, at the present time, somewhat appalling and it is satisfactory to have these sifted by so competent an authority.

Dr. Vines's second chapter, on the Structure and Properties of the Cell, is a very prominent and commendable feature in the book, and will prove an extremely valuable one to all practical students—the micro-chemical portion of it especially, which gives in summarised and terse form the fundamental reactions exhibited by the various elements in the plant body, which are the basis of all further laboratory work. The student finds here at once a guide for testing the dictums of the earlier chapter as well as a graphic code for reference in his future studies. A synoptical arrangement such as this, and so happily worked out, has not been attempted in any previous book.

Mr. Bower's more especial work, the morphology of the various types dealt with, is no less excellent. The examples selected for illustration appear to us particularly well chosen, being readily obtainable in any locality, and their characteristics, macroscopic and microscopic, are explained with precision and in great detail. We shall not dwell at any length upon illustration of the admirable character of this part of the book, but in evidence of its completeness will refer to the section on the vegetative organs of Dicotyledons. *Sunflower* is selected as the chief type for examination, and we have first of all a brief description of the embryo and germination; then its stem in the mature and young condition are gone over, macroscopically and microscopically; but as it shows only the herbaceous type, the arboreous type as seen in *Elm* is explained, and further, the aquatic type, as in *Mare's-tail*. Sections are next added on the stem of *Cucumber* and *Lime-tree* with a view to special illustration of the sieve-tube elements, and upon *Dandelion* and *Spurge* for laticiferous elements. In like manner the leaf is treated of, to that of *Sunflower*, which is the chief type, descriptions of *Cherry-laurel* and *Stone-crop* being appended. Again, in the case of the root, *Scarlet-runner* as well as *Sunflower* is described. Besides these forms we have mentioned, which are dealt with in detail, frequent references are made to other examples in which equally good or further illustration of special features may be obtained. Similar thoroughness runs through the accounts of all the types.

Every one perusing the volume must be impressed with the high standard of its educational value. Teacher and student in this country are alike to be congratulated upon its publication. The former has now a thoroughly trustworthy laboratory guide to place in the hands of pupils, and the latter has a handbook in his own language to which he can refer with confidence in his search after a sound knowledge of plant-morphology.

This is only the first part of the work, and deals with Phanerogams and Pteridophytes. May the succeeding portion not be long in appearing! It is regrettable that the original intention of the authors "to preface the directions for the study of each type with a short account . . . of its salient morphological facts" has not been carried out in this part; Mr. Thiselton Dyer assigns in the preface the reason for its postponement. We are convinced that the want of such brief epitomes will be universally felt. But as the book is certain of a full measure of success, we look forward, with the authors, to the realisation of their hope that "the original scheme upon which the work was planned" may be "carried out in a future edition."

We conclude as we began by heartily welcoming the volume. We envy a student commencing to work with such a guide, and we are greatly mistaken if its effect is not very rapidly felt in the botanical teaching of the country.

THE PENNATULIDA OF THE NORWEGIAN NORTH ATLANTIC EXPEDITION

Den Norske Nordhavs Expedition, 1876-1878. *Zoologie Pennatulida.* Ved D. C. Danielssen og Johan Koren. (Christiania: Grondahl and Sons, 1884.)

THIS is the twelfth part of the series of monographs contained in this fine work, the first part of which was published in 1880. The former parts have dealt with, besides the chemistry and physics of the expedition, the fishes, a part of the Mollusca, the Gephyrea, Annelida, Asteroidea, and Holothuroidea, the monographs on the last four animal groups being by the same indefatigable naturalists who have produced the present memoir on the Pennatulida. The work is a highly creditable one to all concerned.

The present part is illustrated by twelve excellent plates, two of which are coloured, and which are in the same style as those already published by the same authors in their well-known memoir on new Alcyonians belonging to the Norwegian fauna published two years ago.[1] Thirteen species of Pennatulida belonging to eight genera were obtained during the expedition, and of these eleven species and two genera were new. One of the new genera is Svava, a small sea-pen with rudimentary fins and devoid of spicules on the sarcosome, cells and polyps. There is a stripe of zooids on either side of the stem, and in the two lateral canals of the stem are developed the zonads on the mesenteries of these zooids. The zooids alone produce gonads, the fully-developed polyps being barren. They are viviparous, the larvæ escaping from their mouths, as in Corallium. The other new genus, Gunneria, is founded on a fragment of a single specimen, but it is characterised by the presence of an immense quantity of spicules on the bodies of the polyps, their tentacles, and the sarcosoma, which latter forms a regular calcareous crust on the walls of the cells; the spicules are so closely packed in several layers that it is difficult to separate them, even with caustic potash. In this respect Gunneria approaches the Gorgonidæ; yet it is, nevertheless, a true Pennatulid.

The main feature of the memoir is, however, the part which relates to the now famous deep-sea Pennatulid, *Umbellula encrinus*, to which more than half the letterpress and seven of the five plates are devoted.

The Norwegian Expedition obtained twelve specimens of *Umbellula encrinus* from different localities. Kolliker described eight species of the genus from the *Challenger* collection, but one of these, *U. magniflora*, is considered by the authors as referable to the old historical *U. encrinus*, as are also Lindahl's new species from the Swedish Expedition of 1871, viz. *U. miniacea* and *U. pallida*. The whole of the twelve specimens obtained by the Norwegian Expedition are here carefully described in all details. All of them differ from one another, displaying peculiarities in various ages and stages of development which might, were the series less complete, easily lead to the establishment of separate species. The largest specimen obtained was dredged from a depth of 763 metres. It is a giant indeed. The rachis and the polyps, of which there are forty in the bunch, are twice figured on the last two plates, of actual size, coloured and uncoloured. The bunch of polyps occupies with its breadth nearly the entire length of the folio plate. The plates are far the finest representation of Umbellula yet published. There are eight prominent lanceolate areas occupied by zooids which extend up between the lateral polyps on the calicle-like part of the rachis, and spread themselves inferiorly over the rachis generally. The zooids are described as having each a single protusible tentacle, the tentacle when not retracted looking like a pendent papilla. These tentacles sometimes, but not always, bear short lateral pinnules, which are hollow, their cavities communicating with those of the tentacles, and which can be retracted with them. Kölliker, in his account of the *Challenger* Pennatulids, described similar zooids each bearing a single tentacle as existing in *Umbellula Huxleyi* and *U. Carpenteri*, and in the latter species found the single tentacles branched. He figures them, but only on a very small scale. On looking at the figures here given of these zooids (Tab. X., Figs. 56, 57) it is very difficult to understand their structure: the position of the mouth is not shown in any one, and they are drawn as elongate and flask-like in form when expanded, squat and rounded when retracted. The tentacle seems when protruded to be a direct narrow prolongation of the entire body of the zooid, and it appears as if on retraction this prolongation were telescoped into the basal region of the body. The base of the single tentacle should abut on one side of the mouth, but no such mouth-opening is figured. In the enlarged view of a zooid (Fig. 57) the mouth is neither definitely indicated nor referred to in the description. The text is not at all clear on the point.

[1] "Bergens Museum. Nye Alcyonider, Gorgonider og Pannatulider tilhorende Norges Fauna." (Bergen, 1883.)

The polyps bear the gonads, and are apparently viviparous. Very interesting conclusions are arrived at by the authors by comparison of the various stages at their disposal as to the mode of growth and successive additions of fresh polyps to the colony around the terminal primary polyp, and these are at variance with those of Lindahl. A couple of lateral polyps appear on each side of the terminal polyp, then another pair of laterals are formed, and the rachis expands in breadth. The centrodorsal polyp is formed, and then the dorso-lateral are developed, whilst the lateral polyps become more numerous.

H. N. MOSELEY

OUR BOOK SHELF

A Flora of the English Lake District. By J. G. Baker, F.R.S., F.L.S. (London: George Bell and Sons, York Street, Covent Garden, 1885.)

IT is perhaps surprising that a "Flora" of the Lake district has not before been issued, considering the large number of botanists who have yearly rambled over its fells and dales. It has been left to Mr. J. G. Baker to do so, and with modesty he says "it does not seem likely at present to stand in the way of anything more complete." The limits of the "Flora" embrace parts of Cumberland, Westmoreland, and the whole of what is botanically called Lake Lancashire; but excludes "the northern half of Cumberland and the western slope of the Pennine Chain, through Cumberland and Westmoreland;" the exact boundaries are, however, not very clearly defined

One cannot help feeling, directly the book is opened, that it is the work of one used to generalise and deal with facts in a broad way: in no part more so than in the first fourteen pages, where, accepting Mr. H. C. Watson's definitions, he describes the distributive types, zones of altitude, temperature, &c., with a clearness coming of long and practical acquaintance with the subject, giving comparative tables of the types, &c., with those of Northern Yorkshire, Northumberland and Durham, and Britain, and making the Lake Flora about 900 species. It should, however, be remembered that this number is based on Mr. H. C. Watson's estimate of 1425 species for Britain as a whole.

Had that estimate to be made *now* by Mr. Watson, the result would probably be the accepting of a larger number, not alone by the discovery of species since made, but by a decided feeling on his part "that there were some species that would eventually have to be divided." It may well be asked *why* is there this comparatively large amount of difference demanded among our native plants to constitute a "species," and the little often accepted among newly-discovered "species" from distant countries; doubtless knowledge is progressive in the latter case, but still theories and generalisations are built up on them with as much apparent certainty as on floras long known and studied. Mr. Baker then enumerates the species constituting the flora, running up to 234 pages, numbering them according to the sixth edition of the "London Catalogue," showing also (but not numbering) the large number of doubtful plants that have at various times been reported from the district.

Perhaps the most striking fact brought out by this "Flora" is the scarcity of aquatic species compared with the numerous lakes and tarns, of which there must be between sixty and seventy, large and small. Whether in this particular district this is from the want of investigation, or from a real paucity of species or specimens, is difficult to say; but certainly our lakes and waters have not been sufficiently systematically searched, whether from the botanical, zoological, or chemical point of view. In this we should do well to emulate the Swedish naturalists; but in *our* case it may well be asked, "Where are we to look for help?"

How little we know of the life-histories of our aquatic plants! and it may well be suggested as a study for those botanists, who, while not being able to take up botany in the way so ably advocated lately by Prof. Bower in NATURE, still have some leisure from other occupations and duties, and could really advance the knowledge of our flora beyond mere collecting. It is only necessary to turn over the plates of Dr. T. Irmisch's work on them to understand what is meant and required.

AR. B.

The Fallacy of the Present Theory of Sound. By Henry A. Mott, jun., Ph.D., E.M., &c., Professor of Chemistry and Physics in the New York Medical College and Hospital for Women; Author of "The Chemist's Manual," "Was Man Created?" "Adulteration of Milk," "Testing the Value of Rifles by Firing under Water," "The Laws of Nature," "The Air We Breathe and Ventilations," &c. 12mo. (New York: Printed for the Author, 1885.)

THIS is a very curious book. Its author appends to his name recognised scientific titles, and seems to hold a responsible position as a teacher; but he has been led into a hopeless and inextricable muddle about wave-motion; and, starting with a misconception, he naturally obtains results so utterly at variance with common sense and experience, that it is remarkable he cannot see his error.

He begins by admitting that "to attack a theory which has been upheld for 2500 years, and which has been and is sustained by the greatest living scientists, is certainly a very bold undertaking." But he feels bound, nevertheless, "to come to the front and join Dr. A. Wilford Hall in exposing the fallacy." He fulminates, moreover, the following withering defiance at false prophets: "If Profs. Helmholtz, Tyndall, Lord Rayleigh, Sir William Thomson in Europe, and Profs. Rood and Mayer in this country, wish to retain the respect and confidence of thinking people, they will at once endeavour either to defend the theory of sound, or, like men, come boldly to the front and acknowledge that it is fallacious."

There can be no doubt that these various noblemen and gentlemen will at once proceed to adopt humbly the latter and safer alternative; because it is obvious that if they do not do so speedily, creation and nature will come to a premature end. This rather serious occurrence is thus predicted: "The lowest tone of an organ is stated by Prof. Blaserna to have sixteen vibrations to the second, and a consequent wave-length of 70 feet. It thus follows, says Dr. Hall, that in the sound of such an organ-pipe the air-particles (as a whole) are obliged to travel 35 feet and back sixteen times each second in order to pass from the space occupied by the centre of rarefaction to the centre of condensation and back. They would thus move with a velocity in one direction of 560 feet a second, or at the rate of 381 miles an hour, which would produce a tornado of more than double the velocity necessary to sweep a village into ruins. If there was the least truth in the wave-theory, the sound of a church-organ should get up a cyclone which would blow a cathedral into atoms."

This is truly very horrible! far worse than dynamite. Saddened by these reflections, we can bear with comparative equanimity the revelation that "the prong of a tuning-fork moves at the rate of only about one inch in four years," and "instead of swiftly advancing, as Tyndall says, sounds audibly when moving more than 25,000 times slower than the hour hand of a family clock, and more than 300,000,000 times slower than any clock-pendulum ever constructed, instead of very much faster, as Helmholtz teaches."

One more quotation is irresistible: "Imagine," says our author, who seems to have recovered wonderfully from the terrestrial cataclysm which he and the evil-doers above named have all but provoked, "imagine a locust stridulating in the centre of a mass of iron one mile in all directions" (*sic*). The idea is charming, countrified, bucolic, but perhaps rather cold for the poor insect! "It is admitted he could be heard, and about sixteen times quicker than in the air. . . ." (the steps of this grand calculation must perforce be omitted). "The mass of iron thus displaced" (*i.e.* by said locust) "would weigh not less than 729,749,050,612 tons, and would be so moved by the strength of the locust."

The thought is too tremendous! so, locust-like, I must cease to "stridulate," lest I bring down the solar system in ruins on the heads of innocent humanity.

W. H. STONE

Kryptogamen-Flora von Schlesien. Vol. III.: *Pilze.* Bearbeitet von Dr. J. Schröter. (Breslau: J. U. Kern.)

DR. COHN'S "Cryptogamic Flora" is already so favourably known by the portions which have appeared, that the announcement of any subsequent part is sure to be received with satisfaction. The first part of the Fungi, by Dr. J. Schröter, is just issued, and consists almost entirely of an introduction of nearly 100 pages, carefully digested and summarised, concluding with the order of classification adopted. The three groups or primary divisions are:—(1) Myxomycetes; (2) Schizomycetes; and (3) Eumycetes. The latter embraces the Chytridiei, Zygomycetes, Oomycetes, Protomycetes, Ustilaginei, Uredinei, Auriculariei, Basidiomycetes, and Ascomycetes, with an appendix for the incomplete Hyphomycetes, Tuberculariei, and Sphæropsidei. As the present part contains only a portion of the Myxomycetes, no opinion can be formed of the manner in which the foregoing skeleton will be filled up; but, as this portion is based upon Rostafinski's monograph, no exception can be taken thereto. The real difficulty lies further ahead, and whether the knot is to be untied or cut cannot be predicted.

LETTERS TO THE EDITOR

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

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On the Terminology of the Mathematical Theory of Elasticity

I HAVE been greatly interested by the letters on this subject from Prof. K. Pearson (NATURE, vol. xxxi. p. 456) and Prof. A. B. W. Kennedy (vol. xxxi. p. 504), and I have looked forward with pleasure to further communications from other eminent "elasticians." As, however, no better qualified person seems disposed to continue the correspondence, and as I am practically interested in a definite settlement of elastic terminology, I venture to offer a few remarks on the subject.

(1) Nothing could be better than Prof. Pearson's term *state of ease* for the condition of an elastic body when capable of enduring a certain amount of stress, without showing permanent set on its removal. This is worthy of Clifford, and is sure to make its way.

Prof. Kennedy has extended this term by applying "maximum state of ease" to the condition in which the body may be strained to its elastic limit without set. Perhaps *ultimate state of ease* would be more significant, and *limited state of ease* might be employed to denote the intermediate stages. The ultimate state of ease of course corresponds to the "natural state" of the ideal perfectly elastic solid.

At the point B in Prof. Kennedy's figure we reach the *limit of perfect elasticity*, and enter the stage b of *elastic instability*. Prof. Kennedy's suggestion of "limit of stability" for the point C is inconsistent with the last. I would suggest *elastic crisis* as an alternative for "breaking-down point." We evidently here pass the critical point in the static equilibrium of the molecules.

Perhaps c' might be called the stage of *thermal inversion*.

At C_1 the bar enters the *plastic state*—divided by Prof. Kennedy into the *stage of uniform flow* from C_1 to the point D of *maximum load* and the *stage of local flow* from D to the point E of *terminal load* or (apparently) of *maximum stress*.

(2) I observe that Prof. Kennedy uses "load" and "external stress," apparently as alternative terms, and that Prof. Pearson speaks of "stress per unit area." Would it not be advisable to settle, once for all, that *stress* shall always, when it stands alone, mean a force per unit area? "Stress" and "intensity of stress" would then be identical terms, while the *force* across a given area due to stress would be known as the "total" or "resultant stress" across the area. This is all that is required to bring the terminology of *perfect* elasticity into exact correspondence with that of hydromechanics, in which pressure and total or resultant pressure have always stood in this relation to one another.

(3) Next as to "tension." The word was originally adopted from the theory of strings, and of bars used like strings to support weights, and was, I believe, invariably used (as it still is in the case of strings) to denote the load, or *total* longitudinal stress endured. Nowadays, however, it seems to be employed indifferently in this sense and in that of intensity of tensile stress. I would suggest that the term *traction*, which the modern French writers have freely adopted, should be invariably used to denote intensity of tensile stress, and that *tension* should be restored to its original signification of total or resultant traction.

"Traction" and "pressure" would then (according to the ordinary convention as to sign) be synonymous with "positive" and "negative" stress. Perhaps some elastician would suggest a convenient abbreviation for "total pressure" or "negative tension."

(4) Is it too late to protest on behalf of that much-abused term *viscosity* as applied to solids? The thoroughly-established sense of the word, as applied to fluids, implies—*not* the property in virtue of which they undergo permanent or continued change of shape under continued distorting stress (*i.e.* their *fluidity*); but that other property in virtue of which they are able to offer more or less resistance, by means of molecular friction, to instantaneous changes of shape under stress which is not continued. In this case, therefore, viscosity is a property distinctly opposed to fluidity, and, indeed, described in terms as a falling short of "perfect fluidity."

It is thus obviously false analogy to describe a metal in the state of plastic flow as *viscous*, or to "appropriate this name to that permanent set which may be produced by the application for a long period of a stress well within the limits of elasticity." The latter sense—at least as applied to ice (NATURE, vol. xxxii. p. 16)—has, no doubt, a classical authority in the great memoir of Forbes; but Sir W. Thomson has pointed out ("Enc. Brit.," Art. "Elasticity," § 31; and Thomson and Tait's "Natural Philosophy," § 741) that the properties of ice so described are included under the perfectly definite and convenient term *plasticity*, which is really analogous to fluidity.

On the other hand, analogy demands that the term *viscosity*, as applied to solids, shall be strictly confined to that frictional dissipation of energy which is always at work during rapid changes of strain, and which was first discovered during small vibrations within the elastic limit by Sir W. Thomson (*Proc. Roy. Soc.*, May 18, 1865, or the passages above cited).

That the viscosity of a ductile material is very greatly increased in the plastic stage is of course beyond a doubt, the amount of energy absorbed by it on sudden increase of the stress being so much in excess of that required to provide for the increased potential energy of the accompanying strain that the temperature rises to a sensible extent. But what I wish to make clear is that the true viscosity is not essential to or characteristic of the truly plastic state, but that, on the contrary, the viscosity of a ductile solid renders it *imperfectly plastic* in just the same sense as a viscous fluid is *imperfectly fluid*.

(5) Finally, I may perhaps be permitted to add that, next to the importance to all concerned of a definite and universal terminology, comes the importance to mathematicians at least of a uniform *notation*.

The effect of reading through, for purposes of comparison or historical record, the 100 odd *really important* treatises on this subject—in each of which a perfectly independent and generally quite different notation is employed—is simply infuriating! I would urge upon Prof. Pearson that he has now an unrivalled opportunity of fixing in the language of English (and perhaps foreign) mathematicians a really serviceable and significant system of notation.

The double-suffix notation for strain and stress, which is developed to perfection in St. Venant's French translation of Clebsch, has many advantages, but seems to be too cumbrous for English taste. Nothing perhaps could be more unmeaning than Thomson and Tait's notation for "stresses," independent as it is of all reference to the strain-symbols. Still I must confess (in common, I dare say, with most men who have derived their first inspirations from that mathematical epic) that it has secured too firm a place in my mental machinery to be lightly cast out, even in favour of a better. W. J. IBBETSON

Cambridge, May 12

The Colours of Arctic and Alpine Animals

MR. R. MELDOLA has maintained, in NATURE, vol. xxxi. p. 505, the idea that the white colour of some animals, Arctic mammals and birds, must be ascribed to the absorbent and radiating power of the same colorations in relation to the rays of the sun. He maintains also that to a similar cause we owe the seasonal polychromism of several mammals and birds of the Alps, and what would be for these animals a partial return to the characters of the Glacial epoch.

By an analogous theory the author explains the contrary phenomenon that is observed in many insects—that is, the darkening of the coloration, and he speaks principally on this point of the Lepidoptera.

Now I beg to make the following observations, and to indicate the following facts:—

(1) That a seasonal mutation of colour is observable in many mammals, now more, now less distinctly, and generally it concurs with the change of coat. Also not seldom in mammals strictly belonging to the Alps, as, for example, in the *Rupicapra europea*, and in the *Capra ibex*, the colour changes very little in the summer and in the winter, although the length, the thickness, and also the coarseness of the hairs were very different. In other cases, as, for example, in the *Cervus mandarinus*,[1] the coat is, in summer, light reddish yellow, with many round white spots, while in winter it is dark brown, and the round spots are less numerous and are light brown.

(2) As to the insects, it is observed that in *Coleoptera* the colours of the Alpine species are brighter than those of the warmer plains, as in the genera of *Carabus*, *Pterostichus*, &c. In several species of *Harpalus*, *Amara*, *Cicindelis*, &c., the individuals that we find at the greatest elevations of the Alps have often lighter colours.

(3) A darker colour and sometimes a whole melanism is observed in general in the insects of the deserts—for example, in that of Sahara. On the contrary, the mammals of these countries present in general a very light colour. It seems to me that this fact cannot be explained by the theory of radiation.

(4) A very remarkable melanism is also observed in several mammals, the Reptilia and Coleoptera that are in little islands, or upon rocks in the warmest regions, for example the *L. muralis*, &c., *Cicindela campestris*, in the island of St. Peter in Sardinia.[2]

(5) In the reptiles and in the Alpine amphibia we sometimes meet with some cases of darkening, but the cases of a remarkable brightening are not very rare, as, for example, in the *tadpoles* of *Rana muta*.

(6) A sensible difference is observed in the coloration between the Arctic birds and the Antarctic. In these last black is much more abundant.

Indeed, Australia, New Zealand, &c., are countries known for a remarkable darkening in the colours of many sorts of animals.

In the Carnivora, which are the mammals that chiefly present seasonal polychromism and white colour, is observed a tendency to this colour in several forms that, however, do not live either in Polar regions or in very cold places. As to this fact the colour of the genera *Zorilla*, *Meles*, &c., and also the very curious *Ailurus melanoleucus* of Thibet,[3] should be observed.

[1] Milne-Edwards, "Recherches pour servir à l'Histoire Naturelle des Mammifères," tav. 22, 22a. Paris: Masson.

[2] Si consulti L. Camerano, "Richerche interno alla Distribuzione dei Colori nel Regno animale." *Mem. R. Accad. Scienze di Torino.*

[3] Milne-Edwards.

The causes, I would say in conclusion, that intervene to modify the colour of animals, are very complicated; climate has amongst these a certain importance, but it does not seem to me that, although it be very attractive, Mr. Meldola's theory of radiation is sufficient. LORENZO CAMERANO

Zoological Museum of Turin

On Certain Stages of Ocular After-Images

IN a short note in the *Phil. Mag.*, 1872, vol. xliii. p. 343, Prof. C. A. Young has recorded a curious instance of "after-image," which seems to me to be of the same order as that observed by Mr. Shelford Bidwell, and recorded in NATURE, (vol. xxxii. p. 30). I quote from Prof. Young's note, which is named "Note on Recurrent Vision," a few lines, which will show what his observation was:—

"In the course of some experiments with a new double-plate Holtz machine belonging to the College (Dartmouth, America), I have come upon a very curious phenomenon, which I do not remember ever to have seen noticed. The machine gives easily intense Leyden-jar sparks from 7 to 9 inches in length, and of most dazzling brilliance, at the rate of seventy a minute. When, in a darkened room, the eye is screened from the direct light of the spark, the illumination produced is sufficient to render everything in the apartment perfectly visible; and, what is remarkable, every conspicuous object is seen *twice* at least, with an interval of a trifle less than a quarter of a second—the first time vividly, the second time faintly; often it is seen a third, and sometimes (but only with great difficulty) even a fourth time."

Prof. Young shows that it is a subjective phenomenon, and measures the interval between the first and second seeing of an object, giving as the mean of twelve experiments the interval 0·22 second for the case of his own eyes, and 0·24 second for that of another observer.

Five or six years ago I observed another instance of what I believe to be the same kind of "after-image," though at first I was inclined, being engaged upon experiments with a view to finding the cause of certain ocular "ghosts" due to multiple reflection inside the eye (*Proc. Roy. Soc.*, No. 223, 1883), to ascribe it to a different cause. It was seen in a room lighted only by the bright glow of coals in the grate. Whenever the eyes were suddenly flashed across the fireplace, and then fixed on some object 50° or 60° from it, there appeared a faint blue light, which seemed to flash from the object to the glow. This phenomenon was much more strongly marked at some times than others, and varied with some cause which I never further investigated. Later I came upon another instance of the same thing; and as this is the easiest to reproduce, and one by which one may best study the phenomena, I will describe it.

Let a match or a splinter of wood be made to glow, as for testing oxygen, and let it be observed in a dark room; the eyes should be fixed, and the glowing match moved about. I found that for purposes of rough measurement a most convenient curve of motion is a figure of 8 on its side in a vertical plane (∞). Also it is convenient to keep the period of the movement the same, and to vary the size of the curve if change of velocity is required. There are difficulties to be overcome in regulating the brilliancy of the light (Mr. Bidwell has pointed out the necessity of a certain degree of brilliancy in the case of the vacuum tubes), if a systematic investigation were undertaken; a glowing match becomes brighter the quicker the movement; the reverse is the case with a platinum wire carrying a strong current of electricity; and a small incandescent lamp is objectionable on account of reflection from its glass case.

I shall consider the "after-images" of the glowing-point as forming a trail, in which all the changes are set out at the same moment, and proceed to describe the trail for two cases. I should state that following descriptions refer to the trails as seen by me *in the evening*; for there are very considerable variations in the phenomena according as the eye is likely to be wearied or fresh. I may also repeat Mr. Bidwell's caution that it is by no means certain that a person new to the subject will at first be able to see the appearances described.

I arrange a metronome beating seconds, and move the glowing-point so as to describe the curve completely in two seconds. First, let the figure of eight be only as large as can be got into a rectangle 3 inches by 1½. In this case there comes after the glowing-point a dark interval in the trail, about an inch long; then a distinct blue-green ghost, about the same size as the glowing-point; again a dark interval follows, shorter than the first, and behind it a long strip with a dark core and very faintly bright edges; as one traces backwards, the edges appear to close in together gradually, so that, after about two inches, the dark core has collapsed, as it were, and the edges have come together to form a narrow and well-defined thread of a mauve tinge; this gradually dies away as we go further back along the trail, and by the time that the glowing-point has travelled over the whole curve once, it has nearly disappeared.

Secondly, let the figure of eight be as large as can be described in a rectangle 8 inches by 4. Here the phenomena are quite different. It now seems as if the dark intervals at either end of the ghost as described above were absent, and the ghost itself were drawn out into a streak which follows *immediately* upon the glowing-point. Its colour is now yellow-green. This gardually narrows to extinction as one traces the trail backwards, and is the positive after-image in its various stages. More probably this streak has no connection with the true *ghost*; but is quite distinct from it, whilst the ghost no longer appears, when the point moves with greater velocity. In fact, there is probably a limiting velocity of the glowing-point, beyond which the ghost is not formed. This coincides with Mr. Bidwell's observations as to the rate of rotation of the vacuum-tube. As the yellow streak disappears narrowing, one sees a faint blue haze on either side, separated from it by an interval of darkness. When one has traced backwards so far that the streak has vanished, one sees what was above described as a strip with dark core and faint blue or mauve edges. The edges close in and form a distinct mauve thread, which gradually dies out.

It is very beautiful to see the ghostly trail hanging before one; and, by suitable movement of the glowing point, one may fill the space, as it were, with a maze of wreathing lines. Perhaps the most striking part of the phenomenon, regarded from an æsthetical standpoint, is the *depth* of the figures so produced: one realises in the form of the trail that the glowing-point has been moving, not in one plane, but in space; and one sees that some parts are nearer than others. After a time the glowing-point seems to be forgotten, and the trail is the only thing observed. The position of the trail appears to change with any change in the state of accommodation of the eye; if the trail goes away from one the eye attempts to follow it, and exaggerates the movement. If there is any irregularity in the curve, as may often be the case from want of proper co-ordination of muscles—especially if the moving arm is at all subject to rheumatism—it is revealed in a terribly truthful manner by the trail.

A systematic investigation of the subject would, I think, be very valuable as throwing light upon the processes in the retina.

Both Prof. Young ("whatever the true explanation may turn out to be, the phenomenon at least suggests the idea of a *reflection of the nervous impulse* at the nerve extremities, as if the intense impression upon the retina, after being the first time propagated to the brain, were then reflected, returned to the retina, and, travelling again from the retina to the brain, renewed the sensation") and Mr. Bidwell ("the series of phenomena seem to be due to an affection of the optic nerve which is of an oscillatory character," &c) appear to incline to what I may call a *physical* view of the phenomena. The phenomena appear to me to point to some *chemical* action on the retina, and to depend in a great measure on the *rate* at which this action goes on. It would be of great interest to consider the phenomena in connection with Hering's theory of colour sensation; according to it these sensations are due to changes in a certain substance, in such a way that changes of a destructive or dissimilative character give rise to the sensations of white, red, and yellow, whilst those of a constructive or assimilative kind produce the sensations of black, green, and blue ("Zur Lehre vom Lichtsinne," Wien, 1878). It may be that this work has been already done; if so I must crave the indulgence of those who have made the subject a special study.

H. FRANK NEWALL

Crowthorne, Wokingham, May 18

"Speed" and "Velocity"

SOME of your "general" readers, like myself, may wish to see the distinction between "velocity" and "speed" more easily defined than by a reference to the calculus of quaternions, to which I believe the term "tensor" appertains.

"Speed" is not in the index to the new edition of Part II. of Thomson and Tait. Maxwell, at p. 26 of "Matter and Motion," says, "The rate or speed of the motion is called the velocity of the particle." Tate, in his "Properties of Matter," p. 52, writes about "water of motion; *i.e. Speeds.*" It seems thus:—

(1) Rate of motion is velocity (Maxwell)
(2) Speed of motion is velocity ,,
(3) Rate of motion is speed (Tate).

From (1) and (3) it appears as if velocity and speed must be the same, as indeed (2) seems to assert. But we are told this is not the case. Cannot the distinction between the two be made more generally intelligible than by saying that "speed" is the "tensor" of velocity.

SENEX

[When Maxwell introduced to junior students the *Diagram of Velocities*, he made velocity include the *direction* of motion as well as the mere *rate* of motion (*i.e.* speed).—ED.]

The Male Sole is not Unknown

IN last week's issue of NATURE is what is said to be an abstract of a paper read at the Society of Arts by Prof. Ray Lankester, in aid of a proposed marine laboratory, and, passing over what he stated generally requires elucidation, he gives one example of *what is not known among fishes*, and which in the first instance will be investigated at Plymouth. He is made to say "at present absolutely nothing is known as to the spawning of the sole—the male fish is not even recognised."

In times gone by the plaice was asserted to have ascended from a shrimp, but this, I think, is the first time that the existence of the male sole has been declined recognition. Omitting references to others, I will merely draw attention to the fact that in my collection of British fishes in spirit at the "Great International Fisheries Exhibition," and which is now deposited in the Economic Museum at South Kensington, is a fine example of the male sole, with the milt quite ripe.

I must apologise for pointing out the foregoing, but were such an error left unnoticed in a scientific paper, some practical fisherman will possibly direct attention to it, as the comparative rarity of the male to the female sole has been frequently observed upon in our weekly sporting journals during the last few years.

Cheltenham, May 23 FRANCIS DAY

The Aurora of March 15, 1885

NATURE for March 26 (p. 479) contains an account of a fine aurora observed at Christiania, Sweden, on March 15, by Prof. Sophus Tromholt. I would call attention to the fact that an aurora (a very unusual phenomenon at this place) was visible here on the evening of March 15. It was first seen at about 7 p.m.

At the above time several streamers were noticed ascending somewhat east of north: after a short interval these died leaving a white nebulous cloud of light at an altitude of about 10° near a point some 10° or 15° east of north. Shortly afterwards streamers appeared ascending some 10° or 15° west of north; these presently disappeared, leaving a mass of light similar to that left in the east of north. Several times feebler streamers made their appearance west of north. The rays did not attain a greater height than some 20°, and by 8½h. all was quiet, save an auroral glow along the horizon some few degrees east of north, which remained throughout the night. I have thought this might be interesting in connection with the Christiania aurora.

Longitude west of Washington = 0h. 39m. 0·68s.
Latitude ... ... = +36h. 8m. 58 25s.

E. E. BARNARD

Vanderbilt University Observatory, Nashville, Tenn., U.S.A.

Catalogue of Fossil Mammalia in the British Museum. Part I.

IN reply to Mr. Lydekker's comments on the review of his work (NATURE, vol. xxxi. p. 597) I am glad to find that the author repudiates the Owenian system and its errors, though his recognition of the three upper premolars in *Vespertilio* as corresponding, respectively, to *pms.* 2, 3, and 4 of the typical series of four, and the minute anterior upper premolar of *Rhinolophus* as *p.* 3, added to the strange absence of any note on the presence of exceptions to the supposed rule that the premolars decrease in number by reduction from the anterior extremity of the series would certainly lead any one acquainted with the subject to believe that he had acted on it. The only clues afforded by the work which indicate that the Owenian system was not adopted in its entirety, now pointed out by Mr. Lydekker as existing at pp. 152, 174, would certainly escape the notice of any one who had not actually spelled through the work, as I feel sure whoever will take the trouble to refer to will agree with me.

There is no evidence whatever to support Mr. Lydekker's assumption that the two anterior premolars in *Vespertilio* and the anterior premolar in *Rhinolophus* correspond, respectively, to *pms.* 2 and 3 and to *p.* 3 of the typical series. On the contrary, the small size of the second premolar in *Vespertilio* points to reduction by loss from the middle of the series, as we find in the greater number of species of the closely-allied order, Insectivora, and, as we know, takes place in the mandible of several species of Chiroptera.

With reference to the wish expressed in the review that, instead of writing a mere catalogue of the fossil mammals in the British Museum, Mr. Lydekker had undertaken one of all the known species, and his objection, while regretting that the intended friendly estimate of his capability for such a work has been so hostilely received, I maintain that such should have been undertaken; but Mr. Lydekker's remarks show how necessary it is, and that the objection that new genera and species are being made almost daily (it is probable that they will continue to be be made to the end of time) might be applied with equal force on behalf of the birds by Mr. Sharpe, who nevertheless continues his excellent catalogue. It is only by the publication of such a work that we can hope to limit the manufacture of "empty names," such as Mr. Lydekker objects to, and to reduce to order the vast amount of scattered information and contesting opinions which encumber the study of the subject.

THE REVIEWER

THE ORCHID EXHIBITION

THE Exhibition held in the Conservatory at South Kensington on the 12th and 13th inst. in connection with the Orchid Conference of the Royal Horticultural Society, must have furnished to the least observant visitor some explanation of the fascination exercised by orchids over their cultivators. The beauty, the variety, the strangeness of the flowers of the Orchideæ attract and interest the least enthusiastic even of the lovers of nature. But the variation in flower, compatible with botanical inclusion in one family, is not more marked than is the difference in mode of flowering and of growth. Could there be in one natural order a stronger contrast than between the mode of growth and the gorgeous flowers of the genus Cattleya—essentially "flaunting flowers"—and those of the genus Masdevallia, where the conspicuous part of the flower consists of the three sepals, drawn out in many species into thread-like tails many inches long, and ranging in colour through every shade of orange, scarlet, and purple, down to an almost inky black!

While a larger array of specimen plants has often been seen than was shown at the Conference, there has never been gathered together in any country so varied and interesting a collection, nor one containing so many rare and curious plants. Great as was the interest for the cultivator, it was no less great for the botanist. Mr. Ridley, of the Natural History Museum, who, in conjunction with Mr. Burbidge, of the Dublin Botanic Gardens, has undertaken to draw up a report on the Conference Exhibition, found that sixty-one genera of orchids were represented. For the first time in the history of flower-shows there was a numerous collection of hybrid orchids, raised by artificial fertilisation, in flower. For the first time was there a large collection of orchids in fruit. The progress of hybridisation, greatly due to the energy and skill of Messrs. Veitch and Sons and their intelligent foremen, Mr. Dominy and Mr. Seden, has already been fertile in valuable results for the cultivator. An excellent little book lately published,[1] gives a list of eighty-nine hybrids already in cultivation, distributed among twelve genera, but thirty-seven of them belonging to the genus Cypripedium. Those who are privileged to enter the penetralia at Chelsea know that there are there and elsewhere great numbers and varieties of hybrids, which are slowly surmounting the dangers and delicacy of infancy and childhood.

But the labours of the hybridiser promise to be of great value to the botanist. Mr. Harry Veitch, in his very suggestive and interesting paper on the "Hybridisation of Orchids," read at the Conference, says: "How will these bigeneric crosses affect the stability of the genera as at present circumscribed?" It is well established already that the genera Lœlia and Cattleya cross freely with one another, and Mr. Veitch refers in his paper to two other bigeneric hybrids, which have already flowered, and to others which have been raised, but have not yet flowered.

Unfortunately it must be a long time before orchid cultivators generally can enjoy the results of hybridisation. Mr. Veitch gives the time the hybridist must wait to see the result of his labours, as follows:—

Genus.	Time from Germination to Flowering
Dendrobium	3 to 4 years.
Phaius	About the same.
Calanthe	
Masdevallia	4 to 5 years.
Chysis	
Zygopetalum	5 to 9 years.
Lycaste	7 to 8 years.
Lœlia	10 to 12 years.
Cattleya	

With the exception of the genera Dendrobium and Cypripedium, it is a long time before sufficient plants of a hybrid can be obtained for distribution, even under the most skilful cultivation. For this reason many of the more beautiful hybrids will probably remain scarce and valuable for years. The high prices paid by collectors for orchids in some cases have been a source of merriment to the uninitiated. Speaking generally, orchids were never so cheap or so plentiful. But if a collector must have a hybrid which has been raised by skilful hands and nursed into vigour by years of patient care—or, on the other hand, must have a beautiful natural variety which has been picked out of millions of plants—if he must have them, he must pay for them.

The Royal Horticultural Society is to be congratulated both on the botanical and the horticultural results of the late Conference. The Conference was a new idea, a new departure. It has demonstrated the great, widespread, and, better still, the intelligent interest taken in a singular and beautiful natural order, and the skill brought to bear on its cultivation.

The short scientific contributions of Prof. Reichenbach, whose absence was universally regretted; the paper on "Hybridisation," by Mr. Veitch, and the brief discussion which ensued, were listened to by a large and appreciative conference. The paper on "Cultivation," by Mr. O'Brien, was also interesting and valuable. The very difficult question of nomenclature, which is in so confused and unsatisfactory a state as to ill brook delay, was postponed. It could not be discussed with advantage at the tail of a long meeting, and will be referred, it is to be hoped, to a a scientific committee selected from botanists in and out of the Royal Horticultural Society. T. L.

WHEAT-PRODUCTION IN INDIA[1]

INDIA has recently exhibited her extraordinary powers as a wheat-producing area of vast extent. Up to the year 1877 the British wheat-grower looked upon the exhaustless prairies of the far West as his most formid-

[1] "Orchids: a Review of their Structure and History." Illustrated. By Lewis Castle. (*Journal of Horticulture* Office, 171, Fleet Street, E.C.)

[1] The Wheat-Production and Trade of India. Calcutta. Being a collection of correspondence in continuation of papers published in 1879.

able rival in the matter of wheat-growing. A short seven years has greatly altered his feelings in this respect, and we are probably right in considering that the far East is destined to do its part in forcing down the price of wheat to as great a degree as the land of the setting sun. The *brochure* before us is a thoroughly dry statement of facts composed of numbered despatches, letters, and tables, all bearing upon the capabilities of India as a wheat-producing country. The reader will not, however, obtain information as to extent or area, except in a more or less incidental manner. The principal matters dealt with are (1) the quality and comparative values of the various wheats grown; (2) the modes of cultivation pursued; (3) the nature of the soils on which wheat is grown; (4) the average yield per acre; (5) the effects of continuous wheat-growing in diminishing yield; and also other matters relating to the details of wheat-cultivation in India.

With regard to the quality of Indian wheats there is no room for doubt. The conclusions arrived at are based upon actual weight per bushel, value upon the Corn Exchange at Mark Lane, and an elaborate report upon milling and bread-making results furnished by Messrs. McDougall Brothers of 10, Mark Lane, London. From whichever of the above points of view we test the quality of the Indian wheat, the result is equally satisfactory, and the more so when we find that from year to year the samples and bulk continue to improve. Messrs. McDougall Brothers go so far as to sum up their experience by saying, "glancing at all the facts, it is evident that these wheats afford a larger margin of profit both to the miller and baker than any other."

The modes of cultivation adopted are of great interest. They usually exhibit vast pains, and are in this respect superior to the system of wheat-cultivation employed at home. Such elaborate cultivation would indeed astonish an English farmer accustomed to plough his lea land or turnip land once for wheat. The comparison is less fair if we take into consideration the fact that one thorough English ploughing may be worth half-a-dozen of those "ticklings" of the soil which, under Indian skies, are sufficient to make it "laugh." Under the head of Systems of Cultivation we read:—"Ploughed in July, and again six or seven times until October. Watered in November. Again ploughed twice, rolled, ploughed again, and the seed sown through a tube attached to a plough-handle. After twenty-five or thirty days, again watered; and this is repeated until the plants appear fortnightly where irrigation is by lift, and every twenty-five days where it is by flow. In February, when the ears have appeared, water is given weekly until the ears begin to mature." In Armritsar;—"Six months before sowing, the land is ploughed five to ten times. After sowing, the crops are watered not less than six or more than nine or or ten times." In Gujrat:—"Land is broken up and ploughed many times between May and September, manured and ploughed and levelled." The average produce per acre after this system of cultivation varies from seven to fourteen or even twenty maunds (nine to twenty-seven bushels of 61 lbs.), and yet it is calculated that it is grown at from 8*s.* to 11*s.* per quarter! Wheat-growing appears to be carried on upon all sorts of soils. Upon stiff loams, sandy loams, hard clay, and "every kind of soil." In reply to the question, Has the productive power of the soil begun to fail? the answers are usually in the negative, or that it is not apparent. Still, as might be expected, better crops are grown upon manured and irrigated soils and upon those newly broken up from pasturage.

After reading the details of wheat-cultivation in India and compared its results with those obtained in England with a fifth part of the labour, we are inclined to wonder greatly that this remote field should be able to compete with us. Why do they plough five to ten times? How is it that in that sunny land, and after all this expenditure of labour and irrigation, twenty-seven bushels should be a maximum return, while in some cases seven bushels is all that is reaped? A painstaking farmer in England hopes for from thirty-two to forty bushels per acre after once ploughing and pressing his clover leys, and yet he cannot make both ends meet, nor yet compete with the Indian Ryot.

JOHN WRIGHTSON

THE REPORTS OF THE UNITED STATES COMMISSION OF FISH AND FISHERIES FOR 1881 *AND* 1882[1]

THE Report for 1881 was presented to the Senate and Congress of the United States on March 17, 1882; it is to be regretted that so long an interval was allowed to elapse before its publication. The volume is a large one, three inches in thickness, and containing nearly 1200 pages. Scarcely any of this large quantity of letterpress is without interest and value, and we here give an account of the work described in it.

The Commission began the second decade of its existence in 1881, and the present report shows how greatly the organisation has extended itself, and what large results it has achieved in its first ten years. The central offices of the Commission are at Washington, and up to the year 1881 were confined to the private residence of its public-spirited chief, Mr. Spencer Baird, who devoted the greater part of his house to the State service without remuneration. In 1881 a building was erected next to the Commissioner's residence, at the public expense, to provide space for the increased administrative work. The stations where the varied operations of the Commission are carried on are scattered throughout the United States territory. These operations fall naturally under three heads: (1) Economical statistics and historical data concerning the fishing industries; (2) the applied science of regulating fish supply and distribution; (3) the pure science of marine zoology. The part of the work belonging to the first of these divisions is conducted partly at the central offices, partly at the seats of the industries in question. The two other fields of work are, of course, not always distinctly separate. Since 1878 buildings at Fort Wharf, Gloucester, Mass., had been occupied for hatching operations, but in 1881 they passed into the possession of a private firm, since which time only reports on the fisheries and records of ocean and atmospheric temperatures have been obtained from Gloucester. The principal site of the purely scientific work during the summer season was Wood's Holl, Mass., where the Commission possessed a sea-side laboratory. Researches on the artificial propagation of oysters, &c., were carried on at St. Jerome, Md., near the mouth of the Potomac. Cultivation of the land-locked or Schoodic salmon was practised on the Grand Lake Stream, near Calais, Me. The Penobscot or Atlantic salmon (*Salmo salar*) similarly received attention at Buckport, Me. Another station, where lake trout, brook trout, California trout, &c., were hatched, was at Northville. The principal hatchery for the Californian salmon was on the McCloud River, a branch of the Sacramento. Shad eggs were hatched at Battery Island, Md., at North-East River, Md., near the mouth of the Susquehanna, at the Central Station, Armory Buildings, Washington, at Washington Navy Yard, on the Potomac river-barges, and at Avoca, N.C. Carp ponds were maintained at Monument Lot and at the Arsenal, Washington. The Commission acknowledges valuable assistance received from almost all departments of the Government, but especially from the Navy Office, which, in compliance with decrees of Congress, has detailed steamers fully manned and equipped, lent launches, and executed work and repairs at the navy yards. Steam-

[1] Washington, 1884.

ship and telegraph companies have also aided in the work of the Commission.

Up till 1879 the Commission was not in possession of any vessel of considerable size: its explorations at sea were carried on by means of boats either hired or lent by the navy. In 1879 Congress voted money for the building of a steamer to be entirely devoted to the work of the organisation. This vessel was designed as a floating hatching station capable of being moved from place to place according to the season and the opportunities afforded, but she was not intended to go to sea in all weathers or to any great distance. She was named the *Fish-Hawk*, and was built at Wilmington, Del., from the designs of Chas. W. Copeland, consulting engineer of the Lighthouse Board. A very complete and interesting report is presented in the volume before us on the construction of the *Fish-Hawk* and the work performed by her in 1880; and another on her services in 1881. The *Fish-Hawk* is 156 feet long over all, 27 feet in the beam, and 7 feet 2 inches in draught at the stern. Her ordinary speed is about 9 knots an hour. The hull below the main deck is of iron, sheathed with yellow pine; above the main deck she is of wood. The hatching apparatus and machinery for working it are placed on the main deck immediately abaft the forecastle; the space thus set apart is 47 feet in length. On the after part of the main deck is the principal cabin, which contains the Commissioner's office. Above the main deck, extending from stem to stern, is a promenade deck, on which are the hoisting and reeling engine, the dredging boom, its heel attached to the foremast, and at the after end the naturalists' laboratory. The vessel is rigged as a fore and aft schooner, carrying a fore-staysail, a foresail and mainsail; she has four boats, the largest of which is a steam-cutter.

The *Fish-Hawk* has been found to fulfil admirably the purpose for which she was designed, viz. the economical and effective hatching of shad. But it had long been evident that the Commission required also a sea-going steamer to investigate the conditions and extent of the known, and to discover new, fishing-grounds, to ascertain the complete history of the migrations of food-fishes, to add, if possible, to the list of species available as food, and to study marine phenomena in general. The reward to be expected from this kind of work was indicated by the history of the discovery of the tile-fish, an entirely new species of which some specimens were brought in by a fishing-vessel in 1879. The *Fish-Hawk* made a trip to the place where the tile-fish was found, at the western edge of the Gulf Stream, and found that it was as abundant over a large extent of ground, as the cod is in other places. The area dredged over was found to be also in other respects a valuable fishing-ground, and extremely rich in all forms of life, many new and interesting species being discovered. The tile-fish has been found to be of great value as food when fresh, and to be as easily salted and preserved as the cod. In consideration of these facts Congress voted 103,000 dollars for the building of an ocean steamer for the work of the Commission, to be called the *Albatross*.

In 1881 the Commission began the publication of another annual volume in addition to its Report. It is called the Fish Commission Bulletin, and the first issue contained a memoir on the development of food-fishes, by John A. Ryder; one on the life-history of the eel, by G. Brown Goode; one on the salmon disease in English waters, by Prof. Huxley and S. Walpole; and other papers on fish-hatching and fisheries. Besides this were published in 1881 four census bulletins, and a volume of tables containing statistics of American fisheries, all prepared under the supervision of members of the Commission. In the latter part of the year a monograph on the oyster industry was issued by Mr. Ernest Ingersoll.

The results of the year's work in the three several departments already defined are given in three separate appendices to the Commissioner's report. Those belonging to the first department are contained in Appendix B, which consists of six memoirs, only two of which refer to American fisheries. The first of these is on the history of the mackerel fishery, by Messrs. Brown Goode, Collins, Earll, and Clarke, and occupies nearly a third of the whole volume. It begins with an account of the natural history of the fish, and of its geographical distribution, by Mr. Brown Goode. He finds that the species (*Scomber scombrus*) is confined to the North Atlantic. Its southern limit on the American coast is Cape Hatteras, lat. 35°; its northern limit, the Straits of Belle Isle, lat. 52°, though stragglers may occur further north. Its northern limit on the European coast is North Cape, lat. 71°; its southern, the Mediterranean. The mackerel appears in large shoals on the American coast every summer; as yet it has not been ascertained where it passes the winter. Prof. Hind, who is a Canadian, believes that the fish hibernates in the mud, near shore. Mr. Brown Goode, with much greater probability, argues that the shoals move out to the deep ocean in autumn. He distinguishes between the littoral and bathic migrations of this and other species, and concludes that this fish, like others of similar habits, is influenced in its movements chiefly by temperature, food, and breeding instincts. The mackerel only remains near shore while the temperature of the water is above 40° F. Off Cape Hatteras mackerel first appear about March 20; in the Gulf of St. Lawrence they are not abundant till June. The shoals disappear in October, though occasionally some are caught in December. The mackerel spawn in water of 15 fathoms and less, and while spawning do not take bait, or rise to the surface. The eggs are pelagic, and the young fish grow to 6½ or 7 inches in the first season, probably reaching full size in four years. The mackerel's food consists chiefly of pelagic forms, but not so exclusively as in the case of the herring. A great deal of space is given in this account to the evidence of fishermen as to the food of the mackerel, but as no scientific interpretation is given of their somewhat vague descriptions, the reader does not learn much from the discussion. We conclude that the food consists largely of copepoda, crustacean larvæ, schizopoda, and pteropoda. One paragraph dealing with the food question is, to an English reader, somewhat amusing. The author says that the food of the mackerel is called in England the "mackerel-mint," and consists of "sand-lants [*sic*] and five other species of fish." We are not sure, but we think "mackerel-mint" is a mistake for "mackerel-midge," which is the young of various species of rockling, but especially of *Motella tricirrata*. In the same paragraph it is said that mackerel have been seen to devour the swimming larvæ of tape-worms. The first chapter of the essay can only be regarded as a preliminary inquiry to serve as a basis for accurate investigation. It seems strange that Prof. Brown Goode and Mr. Baird should mention a mysterious membrane over the eye of the mackerel without giving the anatomical meaning of the membrane; and it is equally unsatisfactory to read an account of the dissection of a mackerel, quoted from Bernard Gilpin, in which the air-bladder and the aorta are mixed up. Next follows a history of the mackerel-fishery in the United States, from which we learn that since 1880 the purse-seine has come into general use for mackerel-catching. The mackerel fleet consists of 468 vessels, mostly of 60 to 80 tons, schooner rigged, and very fast sailers. The old method of hook-fishing is described fully in a historical chapter. Besides the purse-seine, gill-nets are also used in mackerel fishing at the end of the season, off the New England coast. The total catch of mackerel in 1881 off the United States coast is estimated at 294,667,000 fish.

Chapter III. of the essay contains an account of the legislation affecting the mackerel fishery. Even at the time of printing the Report in 1881, on account of the clamours of the inshore fishermen against the purse-seine, a Committee of Senate was appointed, which was likely to result in additional regulative enactments. The rest of the essay contains an account of mackerel-canning, statistics of the fishery in 1880, the inspection laws, a chronology of the history of the fishing, a list of vessels engaged in the industry, and a table of the catch by American vessels in Canadian waters.

A paper by Mr. Harrison Wright relates the history of the shad fishery in the Vale of Wyoming, on the north branch of the Susquehanna. The Indians caught shad there before white settlers came, about 100 years ago. The white people used shad seines with great success until 1830, when the construction of dams for a canal put an end to the fishery altogether. There were about forty permanent fisheries, some of which had an annual catch of 10,000 fish, weighing three to nine pounds each. It is suggested that the fishery might be restored by the construction of ladder-ways over the dams, and other improvements, together with a restocking of the river with young shad.

A translation is given of a report on the Loffoden fishery in 1880 by Lieut. Niels Juel, the chief of the police administration, which has charge of public order, &c., at the fishery. This report is very interesting, but we have scarcely space to summarise it: we can only give a few of the prominent facts. The number of boats engaged varied from 1000 to 5000; the total number of fishermen was about 27,000, of whom about 13,000 fished with gill-nets, 10,000 with long lines, and 3000 with hand-lines. The author believes that the water-temperature most suitable for cod is between 3½° C. and 4½° C. The total yield of the fishery in 1879 was 25,000,000 fish, valued at 5,000,000 crowns. In 1880 the yield was still greater, being only surpassed by that of 1877.

Another paper in this appendix gives extracts from the official statistics of the Norwegian fisheries in general, and another is a transcript, from the London *Quarterly Review*, of an article on "The Fish-Supply of London." In the latter the opinion of very high authorities is quoted that the fisheries of the North Sea, small as its area is, are practically inexhaustible, and that trawling does not tend to exterminate any species of food-fish.

Appendix D deals with the propagation of food-fishes. It contains twelve papers, which are, with one exception, reports on the work of the various stations of the Commission during the year. The exception is a paper on the "Repopulation of the Water-Courses of Belgium," by Baron de Selys Longchamps. This essay shows how the waters of the Meuse and Scheldt have been rendered barren by the construction of dams and the pollution from factories; and that it will be a matter of great difficulty to remedy this state of things by the construction of fish-ways and the purification of the rivers.

The whole work of the Commission, from its institution in 1871 to 1880, is reviewed in a number of statistical tables prepared by Chas. W. Smiley. In the period in question 43,000,000 shad were artificially hatched and released on the spot, 53,000,000 successfully transported; 15,000,000 of Californian salmon have been hatched and released on the Pacific coast, 31,000,000 transported to other States, and 4,000,000 sent abroad. Of the 31,000,000 transported, about 50 per cent. were successfully introduced into distant waters. In 1879 and 1880 61,000 carp were distributed.

Then follow seven reports on the work of the various hatching-stations, in which occur, here and there, interesting accounts of experiments and inventions connected with the hatching apparatus. At Wood's Holl experiments were made with a view to arranging an apparatus suitable for hatching cods' eggs; the experiments were only partially successful. It was at Wood's Holl that Prof. Ryder carried on his researches into the embryology of the cod. Experiments on the artificial hatching of the Spanish mackerel were made at Cherrystone, Va.

Lastly, we have to notice Appendix C, on Natural History and Biological Research. First, we have an account of the Annelida Chætopoda collected on the Massachusetts coast by the summer expedition of Union College. Three genera and sixteen species are described here as new to science. Of these Thaumastoma is said not to belong apparently to any known family. As far as we can judge from the figure of the head given, the genus is allied to the Nereidæ; but all the figures in the plates to this paper are rough and unsatisfactory.

Mr. Coutance records some experiments on the effect of saline solutions of the same strength as sea-water, but of different composition, on marine molluscs. In all cases the solutions were ultimately fatal; but it would be interesting to have these experiments repeated with some alterations: viz. the solution to be substituted for the sea-water gradually, instead of suddenly, and the natural conditions to be more nearly realised in all other respects save the composition of the medium.

Prof. J. A. Ryder contributes a paper on "The Importance of the Protozoa and Protophytes as the Primary Source of the Food of Fishes." He might have said simply Protophytes, since Protozoa are fed by these; and it is obvious, since a small proportion only of marine animals feed on littoral algæ, that marine life depends largely on pelagic Protophyta. The author reviews the evidence that most Entomostraca feed on Protozoa, and that these feed on diatoms, &c., while the Entomostraca constitute the food of vast numbers of fish. He gives evidence to show that the adult shad feeds while spawning, in fresh water, and that the newly hatched shad feed on exceedingly small and young Entomostraca. The paper is rather a popular essay than an original memoir.

S. A. Forbes finds that the earliest food of the young of *Coregonus albus* in Lake Michigan consists almost entirely of Copepoda of the species *Cyclops Thomasi* and *Diatomus sicilis*.

Prof. Ryder, in another paper, describes some successful experiments in retarding the development of shad ova. It was found impossible to develop them at 38° F. or at 45° F. Ova kept moist on flannel trays at 52° F. were killed by fungus, but the development proceeded at the rate of nine days for the embryonic period. In an experiment in which glass McDonald jars were used with water from the Potomac when the river was at the temperature of 51° F. to 57° F., development took place normally, and hatching was retarded till the thirteenth to the sixteenth day. The embryos were lost by accident, but the author thinks it would require about twenty-five days at this temperature to absorb the yolk, and thus, if the same success could be insured on board ship, there would be ample time to transport embryos to Europe.

Prof. Ryder's remarks at the end of this paper, on "The Rationale of Retardation" somewhat neutralise the satisfaction experienced in reading the account of his practical work. In the present state of science it is scarcely allowable to talk of the nucleus as a "directive dynamic centre," because the phrase has little definite meaning. It is not true that the division of a nucleus has been described by Flemming under the terms "systole" and "diastole"; that author's use of those words referred to certain alternating movements in a nucleus previous to its division. The division of the nucleus does not give us a complete explanation of the phenomena of retardation. It is a truism that retardation of development means diminution in the rapidity of the rate at which cell-divisions take place; but to talk of the *vis essentialis* of segmentation residing in the nucleus is about as instructive as an attempt to localise the horologity of a clock, the *vis essentialis* of a steam-engine, or the situponability of a chair.

The Report for the year 1882 was published at the end of last year, only a few months after the issue of the volume for 1881. In some respects this, the most recent annual Report, is the most interesting of the whole series, the year 1882 having been unusually eventful for the Commission. During that year the new ocean steamer *Albatross* was constructed, steps were taken towards founding a permanent station at Wood's Holl, the Armory Building at Washington was fitted up as the central station of the Commission, and the surprising fact came to light that the tile-fish, investigated a short time previously by the Commission, had been practically exterminated by unknown natural causes. Besides the history of these events the Report contains a long and elaborate memoir, by John A. Ryder, on "The Development of the Cod," which forms one of the most conspicuous features of the volume, and some interesting papers on the artificial propagation of the oyster: the rest of the volume is chiefly made up by the usual separate Reports of the various hatching-stations, and papers on American fishing industries.

The appropriation made by Congress for the *Albatross* in 1881 was too small, and it was not till March, 1882, that an additional grant was obtained, and the contract for her construction was signed. On November 11 the vessel was put into commission with Lieut. Z. L. Tanner, formerly commander of the *Fish Hawk*, as captain. On December 30 the *Albatross* left Wilmington, where she was built, for Washington, on a trial trip. Her total displacement is 1000 tons. A description of the vessel and of her equipment is promised in a subsequent Report. The arrangements for establishing the principal permanent seaside station of the Commission at Wood's Holl made some progress during the year, but were not completed. An agreement was made upon the conditions of the purchase of the requisite land, and all the necessary technical formalities arranged; but it was essential that there should be constructed within the great harbour of Wood's Holl an inner harbour, which would serve for a harbour of refuge as well as for the purposes of the Commission. An appropriation of 52,000*l.* for the new harbour was granted by Congress, but the President decided to defer action upon this and other new items in the harbour bill, and, consequently, the establishing of the Station was delayed for a time. Nevertheless, Wood's Holl was made the head-quarters of the general summer work of the Commission, and a large party were engaged there during July and August working at marine zoology and exploration. The *Fish Hawk* was stationed there during this time.

The central station at Washington was fitted up with shad-hatching apparatus, and was used as the centre from which all young shad hatched on the rivers Potomac and Susquehanna were distributed: the extreme limit of distribution was the Colorado river in Texas. The number of shad fry distributed was over 20,000,000.

The curious history of the tile-fish (*Lopholatilus chamæleonticeps*), into the distribution of which researches were made in 1881, is related in a report by Capt. Collins in Appendix B. At the beginning of Capt. Collins's paper an account of the fish itself is given, from which we learn that it belongs to the family Latilidæ, Gill, the representatives of which are mostly inhabitants of tropical seas and of shallow water. The ground where the tile-fish had been found lies between the latitudes of Hatteras and Nantucket, in long. 70° to 71°, about 100 miles off shore, at a depth of 90 to 125 fathoms. In March and April, 1882, vessels arriving at the principal Atlantic sea-ports reported the extraordinary occurrence of vast numbers of large dead and dying fish floating on the surface of the sea over the region where the tile-fish had been found. It was ascertained that a large proportion of these dead fish were tile-fish. In order to determine the extent of the destruction, a steamer was chartered by the Fish Commission, and sent out to the tile-fish ground in September. Not a single Lopholatilus could be obtained, but a new fish belonging to the genus Setarches was discovered, which promised to be of importance as a food-fish. An account of this exploring cruise was published in the Fish Commission *Bulletin* for 1882.

Prof. Ryder's memoir on the development of the cod is founded on researches made at Wood's Holl, Mass., in June, 1881, and at Fulton Market, New York, in February, 1882. On the former occasion an apparatus devised by Marshall MacDonald was used, and about 5000 young fry were set free at Wood's Holl, and 25,000 sent to Chesapeake Bay and liberated there; these were all the fry obtained from several millions of eggs artificially fertilised. The memoir is a long one, extending to more than 100 pages, and is illustrated by twelve plates of woodcuts. This is the first publication in which the development of the cod has been described in detail and figured; the description given by Sars in his report to the Norwegian Government some years ago having been rather general, and not illustrated. The facts are given in Prof. Ryder's paper for the most part with great accuracy and fidelity, although the appearance of the woodcuts is not very pleasing, and the more complicated of the figures are a little wanting in clearness. The theoretical part of the paper will not commend itself to those who have accepted the generalisations of embryology at present prevalent. For example, it is stated that in Teleosteans, at an early stage, the body-cavity and segmentation-cavity are continuous; but the evidence produced in support of this revolutionary proposition is not by any means conclusive. It cannot be said that the obscurities of Teleostean embryology, such as the invagination of the gastrula, or the development of the genital ducts, are much illuminated by Prof. Ryder's memoir: on the latter point no information is given.

Two other interesting papers are included in the Appendix for Natural History and Biological Research: one by Sidney J. Smith on the Decapod Crustacea from the dredgings of the *Albatross* in 1883, and the other by Prof. Verrill on the fauna of the tile-fish ground at the western edge of the Gulf Stream. The former of these is an extremely elaborate memoir, accompanied by ten plates of clear and well-executed woodcuts, illustrating species and structures which had not before been sufficiently figured. The paper contains a great number of new species and several new genera: each new species is described with wonderful minuteness, and, a long table of measurements being added to each description, no one having occasion to use this memoir will be able to complain of inexactness or incompleteness in the characterisation of specific distinctions.

The paper of Prof. Verrill is short, being simply intended to indicate the most interesting features of the peculiar area investigated. It was found in the operations of 1882 that the invertebrate fauna, discovered to be so unusually abundant in 1881, had, like the tile-fish, suffered great destruction in the interval between the two seasons. This was especially the case among the Crustacea, some species, which had been taken in thousands at a single haul, having become extremely scarce. Prof. Verrill believes the remarkable destruction of life had been caused by a very severe storm which occurred in the spring of 1882, and which probably forced out the cold coast water over the Gulf Stream slope.

The whole of Appendix D has reference to oyster culture. It contains six memoirs, two of which describe experiments on the artificial propagation of the American oyster, *Ostrea virginica*. Lieut. Francis Winslow studied the subject at Beaufort, N.C., and at Fair Haven, Con.; Prof. Ryder at St. James's Creek, Md. In both cases, though a fair amount of success was obtained in impregnating the ova and keeping the embryos alive in the free-swimming stage, no satisfactory method was discovered of obtaining a supply of attached spat with any certainty. Prof. Ryder and Col. MacDonald on one or two occasions found that their embryos had fixed themselves to the sides of their aquaria in large numbers, but they could not keep them alive more than a day or two after the attachment had taken place.

The growing extent of the piscicultural operations of the Commission, as indicated by the Reports in Appendix E, is marvellous. Statistics of the distribution of shad-fry during 1882 are given in a paper by Chas. W. Smiley; the total number distributed was over 30 millions. The total number of carp distributed was 259,000, of Penebscot salmon 1,716,000, of Schoodic salmon 1,482,000.

It would be extremely interesting to have some information as to the result of all this work, as to the effect produced on the supply of fish in the rivers, and on the productiveness of the fisheries. The Commissioner points out that it is of little use to put anadromous fish into rivers if the waters are obstructed by dams or made uninhabitable by pollution, and a new fish-way to remedy the former difficulty is described by Col. M. MacDonald in Appendix A. But all who are acquainted with the labours of the American Commission would be grateful if Mr. Chas. Smiley would apply his great power of handling statistics to exhibiting the economical results of the piscicultural work. J. T. CUNNINGHAM

NOTES

THE statue of Darwin will be unveiled in the great hall of the Natural History Museum, Cromwell Road, on Tuesday, June 9, at 12 o'clock, when Prof. Huxley, President of the Royal Society, on behalf of the memorial committee, will formally transfer it to the care of the Masters of the Museum, who will be represented by His Royal Highness the Prince of Wales. Places will be reserved for the committee and subscribers to the memorial, but the greater part of the hall will be open to the public during the ceremony. The statue, which has been executed by Mr. Boehm, R.A., is of marble, and seated, rather larger than life-size; it is pronounced by those who have seen it to be an admirable likeness as well as a fine work of art.

IT is now twenty-one years since the *Geological Magazine* was first issued. During all that time Dr. H. Woodward, F.R.S., has been an editor, and for almost the whole of it the principal editor, on whom the main burden and chief responsibility of the work has fallen. It has been a work which has not only cost him much time and labour but also has been practically unremunerative. His friends among geologists accordingly purpose to celebrate the "majority" of the *Magazine* by presenting to him a testimonial in appreciation of his services to science. A meeting was held last week, at which an influential committee was formed, a list of which will shortly be circulated. The treasurer and secretary is Dr. Hinde, F.G.S.

WE greatly regret to record the death of the Rev. Thomas W. Webb, Vicar of Hardwick, near Hay, Brecon, well-known for his writings on astronomical subjects. We hope next week to refer to the work he has done in astronomy.

THE death is announced of Mr. Peter William Barlow, F.R.S., the well-known engineer.

A CONGRESS on hydrology and climatology will, it is stated, be held at Biarritz during October next. The French Government has brought the matter to the notice of foreign Governments, in order that the latter may take the necessary steps to be represented at the congress.

ON April 13 the Leander McCormick Observatory attached to the University of Virginia was opened by public ceremony. The buildings are situated on a hill called "Observatory Mountain," because in 1825 Thomas Jefferson erected a small observatory there, which gradually fell into decay. They consist of residences for the director and assistant, offices, a small observatory for minor observations, and a large building for the dome. The observatory proper consists of a cylindrical building surmounted by a hemispherical dome forty-five feet in diameter, and a rectangular building used as a library and computing office. The walls are of brick, the circular portion being heavily buttressed, and bearing at the top a coping of Ohio stone. On this rests cast-iron rails, on which the dome revolves. The latter weighs 25,000 lbs., and is composed of a framework of steel covered with galvanised iron and lined with painted canvas, having three openings covered by shutters when not in use. It takes five seconds to open one of these, and a minute and a quarter to revolve the dome quite round. The telescope, which is mounted on a brick pier under the centre of the dome, is similar at the Washington Observatory. The clear aperture of the object-glass is twenty-six inches. Like so many other important scientific and educational institutions in the United States, this observatory is due to the generosity of a wealthy native of the State, Mr. Leander McCormick, from whom it takes its name. This gentleman presented both telescope and building to the University. The cost is stated to have been about 13,000*l.*, the telescope costing over 9000*l.* The directorship of the observatory, to which post Mr. Ormond Stone, director of the Cincinnati Observatory, has been elected, is endowed with a sum of 10,000*l.*, collected by public subscription; while Mr. W. H. Vanderbilt has given the University a further sum of 5000*l.* as an endowment to pay the salary of an assistant observer, the expenses of publication, &c. According to the founder's plan the observatory is not to be confined to purposes of the University alone, but for general scientific research, so that students from any part of the United States who desire to become professional astronomers may receive a thorough training there. In accordance with this plan the Professorship of Astronomy in the University is a wholly distinct post from that of Director of the Observatory. Prof. A. Hall. of the National Observatory at Washington, delivered the opening address, taking for his theme "The Instruments and Work of Astronomy."

FROM various publications which we have recently received from the Government of Hong Kong Dr. Doberck, the astronomer, appears to have lost no time in employing the new observatory. The last batch of observatory papers include observations on lunar transits across the meridian of Hong Kong, and on the height of Victoria Peak. As this eminence is the most important in the east (with the possible exception of Fuji-yama) in one sense—the sense in which Richmond Hill is more interesting than Mount Everest—it may be added that the mean height of the peak is 1710·6 feet above the Observatory, or 1818 feet above the mean sea-level. There is also a report on five-day means of the principal meteorological elements for 1884, constructed according to the recommendations of the International Meteorological Congress, and a complete weather report for the same year. With four well-equipped observatories (Tokio, Shanghai, Hong Kong, and Manila) at work, the meteorolgy of the China Seas will soon cease from being the sealed book which it practically is at present.

LAST year was a tolerably productive one for the collectors of prehistoric remains in Switzerland. The water of the lakes was almost constantly below the highest level, which is the most favourable state of things for explorations around the lake-dwellings. The remains discovered belong mostly to the Bronze period, and the chief localities in which they were found were Lake Neuchâtel and the settlement of Wallishofen near Zürich, the latter of which is the only station of the Bronze period yet know in Eastern Switzerland. Among the most remarkable articles discovered at this settlement in 1884 were a splendidly preserved bronze sword, several dozens of bronze hatchets, bracelets, &c. Of the remains of the Stone period discovered in the same year the most notable are those obtained at Robenhausen, including several pretty knife-handles made of yew, some excellent specimens of mechanical industry, such as thread, woven fabrics, fishing-nets, &c., and ears of barley and wheat, one being a specimen of the rare *Triticum turgidum*.

THE Zoological Society of Philadelphia, according to the Thirteenth Report of the Board of Directors, appears to have suffered during the past year, like many other institutions dependent on the public for support, from the general depression of trade. The financial balance shows a large reduction; nevertheless the Superintendent is able to report that the collection "presents to-day a greater and more typical variety of animal forms, in furtherance of the educational facilities which have been one of the chief aims of the Society, than at any previous period of the history of the garden." Among the principal additions during the year was a hippopotamus, the first obtained by the Society, a collection of European water-fowl, and a brush-turkey (*Tallegalla lathami*) of New South Wales. The specimen procured is a female, but it is hoped that a male may also be obtained, and that its extraordinary habit of hatching its eggs, by covering them with decomposing vegetable matter, may be shown in the garden.

IT seems that the experiments of Dr. Ferran in inoculation for cholera have been stopped by the Spanish Government.

THE Sanitary Congress at Rome has been engaged during the past week mainly in discussing quarantine regulations.

WE have received Prof. Theodore Gill's "Account of the Progress in Zoology" for 1883, from the Smithsonian Report—a substantial pamphlet of over fifty pages. The special discoveries recorded have been selected either on account of the modifications which the forms considered force on the system, or because they are or have been deemed of high taxonomic importance, or the animals *per se* are of general interest; or, finally, they are of special interest to the American naturalist. The arrangement of the account is as follows:—General Zoology, Protozoans, Porifers, Cœlenterates, Echinoderms, Worms, Arthropoids, Molluscoids, Mollusks and Vertebrates. Each of these divisions is sub-divided according to the discoveries to be noted. At the end, a brief bibliography of noteworthy memoirs and works relating to different classes is appended. "The statement," Prof. Gill says, "is not intended for the advanced scientific student so much as for those who entertain a general interest in zoology, or in some of the better-known classes. It is compiled for the many rather than the few, and hence, perhaps, zoologists cultivating limited fields of research may find omissions, as well as notices of discoveries of minor importance."

ON May 20 a terrific storm raged in Paris; a stupendous peal of thunder was heard at 11 a.m. It seems the lightning struck the top of a high furnace at St. Ouens, near Montmartre. It is supposed that it was attracted by a mass of lead which was placed at this elevated situation for some purpose. The peculiarity is that no trace of the lead was afterwards found

THE centennial celebration of Blanchard and Jeffries crossing the Channel in a balloon was celebrated on Sunday at Guine, Pas de Calais, where the two travellers landed.

SHOCKS of earthquake were felt at Wartberg and Kindberg, Austria, on May 20 towards 1.30 a.m. A sharp shock was felt at Smyrna at 7.15 p.m. on May 26.

PROF. DEWAR, F.R.S., will give a discourse on "Liquid Air and the Zero of Absolute Temperature" at the last Friday evening meeting of the season on June 5, at the Royal Institution.

A FEW years since the German Anthropological Society initiated an exhaustive investigation among German school children as to the proportion of those with dark and with fair complexions. This has been followed by similar investigations in Belgium, Switzerland, and Cislethian Austria, and these have supplied gaps in the German inquiry. The result was, according to *Die Natur*, laid before a recent meeting of the Berlin Academy of Sciences by Herr Virchow. In all, 10,077,635 children were examined as to the colour of the skin, hair, and eyes; 6,758,827 in Germany, 608,678 in Belgium, 505,609 in Switzerland, and 2,304,501 in Austria. The geographical boundaries were the Pregel and Dniester on the east to the Vosges on the west; the Baltic and German Ocean on the north, to the Adriatic and the Alps on the south. The following is the result:—Of pure blondes there were found in Germany 2,149,027; in Austria, 456,260; in Switzerland, 44,865; a total of 2,650,152, which, on a total of 9,468,557 (Belgium being omitted here) children examined, is rather more than one-fourth. The number of brunettes was: in Germany, 949,822; Austria, 534,091; in Belgium, 167,401; in Switzerland, 104,410; a total of 1,755,724, or about one-sixth of a total of 10,077,635. Hence more than half the school children of Central Europe are of the mixed type. The distribution of the pure types is very different. In Germany 31·80 per cent. is fair and 14·05 per cent. dark; in Austria the dark predominate, being 23·17 per cent., while the fair amount only to 19·79; in Switzerland the disparity is still greater, for the blondes are only 11·10 per cent., while the brunettes are 25·7; and in Belgium the blondes are 27·50 per cent. In Germany, therefore, the fair complexions predominate; but even here the proportions vary greatly, getting less and less as we go towards the south. In North Germany the proportion is between 43·35 and 33·5 per cent.; in Central Germany, about 25·29; and in the south, only 18·44; while, on the contrary, the proportion of dark children diminishes from 25 per cent. in South Germany, to 7 per cent. in the north. This appears to show the incorrectness of the theory of the French anthropologist that we must seek the real Germans in South Germany, and that North Germans are a dark race, a mixture of Finns and Slavs. The fair people are most numerous in Sleswick-Holstein, Oldenburg, Pomerania, Mecklenburg, Brunswick, and Hanover. That this should be the case in Mecklenburg—formerly a Slav district—is due, according to Herr Virchow, to a return-emigration of the Germans. Middle and Western Germany were especially the cradle of this emigration. Flemings, Dutch, and Frisians thus reached Holstein, Westphalia, Brunswick, Mecklenburg, and Pomerania. Saxony, Silesia, and Northern Bohemia were colonised through Eastern Franconia, Austria from Bavaria. The emigration of the German tribes took place at two different periods: the first, a movement from south to west, which ended with the foundation of the Frankish monarchy; the other a return to the last, which began with the Karolingian period, and is not yet concluded. The latter has led to a permanent colonisation, and to the formation of a new pure German people. The deep brown colour of the south and middle Germans, as well as of the Swiss, is traced by Herr Virchow to the Romans, Rhetians, and Illyrians, and especially to the remnants of the Celtic or pre-Celtic inhabitants, which have now become mixed with the Germans.

THE experiment of acclimatising the American Whitefish (*Coregonus albus*), lately tried by the National Fish Culture Association, has met with great success. Until now the attempts made were unsatisfactory, the utmost difficulty being experienced in finding suitable lakes for the reception of this valuable edible fish. The whitefish in question were incubated at South Kensington in March, and afterwards transferred to ponds at Delaford where they have thrived well ever since.

THE Naturalists' Societies in the East of Scotland have advanced an important stage. They have been established, have worked, and now have formed a union, the first report of which we have now before us. The union embraces the societies in the counties of Aberdeen, Fife, Forfar, Kincardine, Kinross, and Perth, and now consists of ten societies. The president, Dr. Buchanan White, of Perth, explained in his inaugural address the functions of the union as distinguished from those of the individual societies. Its main object of course is to carry on more effectually the work for which each of the societies that compose it has been formed, that work being the promotion of the study of natural science, especially of local natural science. Rivalry begotten of communication and connection, he argues, is as valuable to societies as to individuals; and while each society was isolated and worked independently in its own district, the sum total of the work done was necessarily imperfect because of want of uniformity in the matter of details; one subject has been thoroughly worked while another has been untouched, certain districts have been investigated, while others have been neglected, and the relations of one district to another have not been considered. Each society has toiled in a quarry in its own district, and has brought forth good stones, but they lie in an unsorted heap. The union undertakes the task of sorting and utilising them. On this broad principle the union started, and the president laid down in the opening address the programme of its work for the immediate future. The first step was to ascertain the present state of knowledge of the zoology, botany, geology, and meteorology of the six counties included in the union. For this purpose a uniform method of treatment was adopted. Each reporter in his own special subject states how far the subject has been investigated, what parts of it especially require investigation, both as regards the district and the subject, what the probable richness of the district is, what important works, if any, have been published on the subject and district, and, finally, what work should be taken in hand at once. These statements make up the bulk of this first report, and there are in all nineteen, covering almost every department of natural history. The union, it thus appears, directs and organises the work of its affiliated societies, and prevents waste of power.

THE additions to the Zoological Society's Gardens during the past week include a White-bellied Beaver-Rat (*Hydromys leucogaster*), a White-bellied Sea Eagle (*Haliaetus leucogaster*), two Stump-tailed Lizards (*Trachydosaurus rugosus*), a Great Cyclodus (*Cyclodus gigas*), a Diamond Snake (*Morelia spilotes*) from Australia, presented by Mr. E. P. Ramsay, C.M.Z.S.; an Australian Cassowary (*Casuarius australis*) from Australia, presented by Mr. T. H. Bowyer Bower; four Pucheran's Guinea Fowls (*Numida pucherani*) from East Africa, presented by Commander C. E. Gissing, R.N.; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. C. A. Marriott; seven Striped Snakes (*Tropidonotus sirtalis*) from North America, presented by Mrs. A. H. Jamrach; a Common Viper (*Vipera berus*), from Epping Forest, presented by Mr. F. W. Elliott; two Lions (*Felis leo*) from Africa, two Pumas (*Felis concolor*) from South America, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), four Upland Geese (*Bernicla magellanica*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

DOUBLE-STAR MEASURES.—Nos. 2662–63 of the *Astronomische Nachrichten* contain the first division of a series of measures of double stars made by Herr R. Engelmann during the years 1882–84, preceded by a comparison of the differences between the observer's positions and distances of a number of stars, with those measured by Dembowski and Asaph Hall, and other particulars bearing upon his own results. For several of the more interesting binaries, the following epochs are given:—

		°	"
Castor	1882·88	234·3	5·56
ζ Cancri	1884·28	67·0	0·94
ω Leonis	1884·23	91·4	0·66
ξ Ursæ Majoris	1884·41	249·6	1·92
γ Virginis	1883·07	155·6	5·22
42 Comæ Beren.	1882·93	192·1	0·56
ξ Bootis	1884·45	266·6	3·65

MINIMA OF ALGOL.—The following Greenwich mean times of geocentric minima of Algol have been obtained after applying a small correction to the period given by Prof. Schönfeld in his second catalogue of variable stars, so as to satisfy more nearly the observations of the late Prof. Schmidt in 1882 and 1883:—

	h. m.		h. m.		h. m.
July 25	13 10	Sept. 3	16 29	Sept. 29	11 46
28	9 58	6	13 17	Oct. 2	8 34
Aug. 14	14 49	9	10 6	19	13 26
17	11 38	12	6 54	22	10 15
20	8 26	26	14 57	25	7 3

CENTRAL SOLAR ECLIPSES IN NEW ZEALAND.—It is well known to those who are interested in astronomical matters that the track of the central line in the total eclipse of the sun on September 9 next is almost entirely over the Southern Ocean, and that the total phase will only be observable on land on the shores of Cook's Straits, New Zealand. It would appear that no central eclipse has traversed those islands during the present century; an examination of the various ephemerides points to the annular eclipse of December 29, 1796, as the last which was there central. An annular, though nearly total, eclipse will take place near the north extremity of the North Island on January 3, 1927, while, on May 30, 1965, when the sun is barely risen to an altitude of 5°, he will be totally eclipsed on the east coast of the North Island, near its north extremity for about 2m. 20s.

It is true that in an old catalogue of eclipses which has been transcribed into several of our popular astronomical treatises those of December 12, 1890, and September 29, 1894, are mentioned as being central in New Zealand, but an examination of these eclipses upon more recent data shows that neither will reach that country. In the eclipse of 1890 the central line ends in about longitude 143° W., latitude 36½° S., totality with the sun on the meridian taking place in longitude 129½° E., latitude 54° south, and the line thus running south of New Zealand. In the eclipse of 1894 it ends not far from longitude 163° E., latitude 56° S.

THE DAYLIGHT-OCCULTATION OF ALDEBARAN ON MAY 22, 1868.—Mr. H. Sadler reminds us that the occultation of Aldebaran to which reference was lately made in this column, as having been pointed out by Mr. Newall in 1868, when the star was only some eight degrees from the sun's place, was observed by Prof. Asaph Hall. The observation is to be found in the "Washington Astronomical and Meteorological Observations" for 1868, p. 327.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, MAY 31 TO JUNE 6

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 31

Sun rises, 3h. 51m.; souths, 11h. 57m. 25·7s.; sets, 20h. 4m.; decl. on meridian, 21° 59′ N.: Sidereal Time at Sunset, 12h. 42m.

Moon (at Last Quarter June 6, 0h.) rises, 21h. 16m.*; souths, 1h. 43m.; sets, 6h. 10m.; decl. on meridian, 18° 21′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	3 7	10 22	17 38	13 43 N.
Venus	4 14	12 28	20 42	23 8 N.
Mars	2 50	10 21	17 52	16 31 N.
Jupiter	10 13	17 25	0 37*	13 10 N.
Saturn	4 54	13 3	21 12	22 24 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Phenomena of Jupiter's Satellites

June	h. m.		June	h. m.	
2	22 50	II. tr. ing.	5	22 43	I. occ. disap.
4	23 14	II. ecl. reap.	6	22 22	I. tr. egr.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

CHEMICAL NOTES

In a paper communicated by Prof. Mendeléeff to the last issue of the *Journal* of the Russian Chemical Society, being a reply to M. Avenarius, the Professor makes a very interesting comparison between his own formula of dilatation of liquids and the logarithmic formula of Waterston, supported in Russia by his opponent, M. Avenarius. He shows by analysis why both formulas express with sufficient approximation the expansion of ether within the limits of 0° and 104°, the observations beyond that limit having to be left aside until we have a more accurate knowledge of the laws of expansion of this substance at higher temperatures and under higher pressures. He demonstrates, moreover, that the logarithmic formula is as inapplicable to water as his own; and, developing both formulas into series, he shows why his own simpler formula ought to be considered as a first approximation to the law of dilatation of liquids until the true law is discovered. Though polemic in its first part, the paper is a masterly piece of scientific treatment of the controversy about so important a question.

Following on the lines laid down by Mr. H. B. Dixon in his experiments on the combustion of carbonic oxide in dry and in moist oxygen, Mr. H. Brereton Baker has recently described some very interesting results regarding the combustion of phosphorus and carbon in oxygen. When the elements in question were heated in oxygen which had been kept in contact with phosphorus pentoxide for some weeks, combustion occurred only to a very limited extent. The presence of a small quantity of water-vapour seems to be needed in order to start the combustion (*C. S. Journal*, *Trans.*, 1885, 349).

The influence of the relative masses of the reacting bodies on chemical changes has of late years received a good deal of attention. Urech has discussed the well-established data regarding the influence of dilution, and of the presence of excess of one or other ingredient, on chemical reactions (*Ber.*, xviii. 94). He points out that the diluent may act both physically and chemically. When it acts altogether as a diluent it does not, according to Urech, affect the rate of the chemical operation. Excess of either reacting body appears always to exert an influence on the rate of change. The causes of the variations in the rate of chemical change are probably very complicated; even the shape and character of the containing vessel may exert an appreciable effect.

Experiments are described by M. J. Thoulet (*Compt. Rend.*, xcix. 1072) on the effect of immersing various solid bodies in saline solutions, *e.g.* marble, quartz, &c., in aqueous solutions of sodium or barium chloride. In each case a portion of the dissolved salt was precipitated on the surface of the immersed solid. The conclusion is drawn that there is an attraction between the dissolved salt and the solid immersed, and that the amount of attraction is proportional to the surface of the solid.

Some time ago Mr. Bayley showed that when drops of various solutions are allowed to fall on to filter-paper, the salt which was in solution in many cases remains in the centre, and a water-ring extends around it. Mr. J. U. Lloyd has extended these observations (*Chem. News*, li. 51). He has observed the distances to which various substances in aqueous solutions extend on pieces of blotting paper, dipped into the solutions, before they are left behind by the water. Great differences were noticed in the length to which different salts thus travelled. Mixtures of salts were also examined; in some cases one salt passes on, leaving the other completely behind. Thus a solution of quinine and berberine sulphates was separated by the method described; the former salt passed on through the paper after the progress of the latter had quite ceased. Dilute sulphuric acid behaved similarly; pure water alone passed onwards. In the case of simple salts dissolved in water, the rule appears to be that the more dilute the solution, the quicker is the separation into salt and water.

Chemists are beginning to realise that the structural formulæ they have so long regarded as final expressions are, after all, very imperfect representations of chemical operations. The molecule of a compound has been treated as a structure built up of atoms; in their anxiety to learn the relations of these atoms chemists have almost forgotten that the molecule is itself a whole. Attention has of late been recalled to this aspect of molecular formulæ. Hartley's researches on "the relation between the molecular structure of carbon compounds and their absorption spectra" have led to results of much interest in this direction. In a paper communicated to the Chemical Society on May 7, Hartley brought forward a series of facts which lead to the conclusion that "molecules vibrate as wholes or units, and the fundamental vibrations give rise to secondary vibrations which stand in no obvious relation to the chemical constituents of the molecule, whether these be atoms or smaller molecules. Hence it appears that a molecule is a distinct and individual particle which cannot be truly represented by our usual chemical formulæ, since those only symbolise certain chemical reactions and physical properties, and fail to express any relations between physical and chemical properties."

Nasini (*Atti d. Acc. d. Lincei Rdct.*, 1885, 74) has been pursuing his inquiries regarding the "atomic refraction" of sulphur in various compounds, and has obtained results which lead him to conclude that the variations in the refraction-equivalents of sulphur compounds cannot be explained by the ordinary structural formulæ employed in chemistry. These variations appear to be connected neither with the valency of the sulphur-atom in the different molecules, nor with the nature of the other atoms which are associated with the atoms of sulphur. Changes in the structure of sulphur-containing molecules seem to be accompanied by changes in the refraction-equivalents of these molecules, but these changes cannot be regarded as due to variations in the valency, or arrangement, of the atom of sulphur they must rather be attributed to some cause which affects the molecule as a whole.

We notice a very interesting and important discussion raised in the *Journal* of the Russian Chemical Society (vol. xvii. 3) by Prof. A. Butleroff, with regard to Prof. Menshutkin's explanation of isomerism by "substitution." M. Butleroff very ably advocates the theory of "structure," *i.e.* of a combination of molecules, instead of atoms, and of compound molecules with atoms. The chief principles advocated by the author appear as follow:—We are right in speaking, as of a real thing, about mutual chemical relations between atoms and molecules; and it is only by admitting some differences in these relations (some differences in the manner of their "union") that we can explain the phenomena of isomerism. These differences are constant, permanent to the molecules; they are their inseparable characteristic attributes. These principles being admitted, the author deduces from them the following conclusions:—"(1) The scheme of substitution (advocated by Prof. Menshutkin) permits rightly to foresee and formulate isomerides only when the structure is supposed known; (2) it requires auxiliary hypotheses, and it is devoid of simplicity and lucidity; (3) the fundamental ideas, both of the theory of substitution as applied to organic bodies and of that of chemical structure, are the same; therefore the former gives nothing new which is not given by the latter; (4) being narrower and more one-sided, when applied to isomerism in organic bodies, the former—if it be applied alone—does not in many instances foretell certain phenomena which are simply and easily foreseen by the theory of chemical structure."

GEOGRAPHICAL NOTES

A British Mission from India is being sent to Cashmere in charge of Col. Lockhart, who is accompanied by Major Woodthorpe, Capt. Barrow, and Dr. Giles, and an escort consisting of two non-commissioned officers and twenty men. The chief object of the Mission is to obtain further geographical information concerning the countries on the northern and western frontiers of Cashmere. It will visit Chitral and the neighbourhood of that place, and will be absent for several months.

M. Leonardo Féa, of the Museum of Natural History at Genoa, has been despatched by the Italian Government on a scientific journey to Burmah. He is to make zoological collections, and also to make various scientific observations. He was provided with letters to the Burmese Government at Mandalay. The Geographical Society of Rome has received from Capt. Molinari reports of two journeys which he has recently made in the Shan States.

At the usual meeting of the Dutch Aardrijkskundig Genootschap on April 18, a general view of those parts of New Guinea was given to which the Society wishes to send an expedition. The Government has promised a grant not exceeding 10,000 florins a year, and under such circumstances the expedition is to be confined to geographical investigations. Particulars could not yet be given, since the proposals of the Society were still under consideration with the Government in the Dutch Indies. It was mentioned, however, that the expedition would probably go to Doreh or to Onin; many offers to accompany it have been made to the Society.

AT a recent meeting of the Paris Geographical Society, M. Romanet du Caillaud described the life and travels of Ordoñez de Cevallos, who was born at Jaen towards the middle of the sixteenth century, and who commenced his journeys all over the world at the age of seventeen. He visited various countries in Europe, and travelled several times to both Americas. He then became a priest, without, however, renouncing his dominant passion. He went as missionary to the Philippines, thence to Canton and Japan. From Japan he set sail for China again, but a storm drove him on the coasts of Tonquin. Having received permission to land, he went to the Court in 1590, and visited various parts of the Indo-Chinese peninsula, Malacca and India. He started then for Buenos Ayres, touching at the Cape of Good Hope, and endeavoured to go to the west coast of South America by the Straits of Magellan, but was prevented by an English fleet, which barred the Straits. He returned to Buenos Ayres, and in 1595 undertook a journey, similar to that in which Crévaux lost his life, by Tucuman, the Paraguay, Potosi, &c., preaching by the way to the savage tribes, whom he calls the Quixos, Omaguas, &c. He fought also agains the black Indian cannibals, called by the Spaniards the Gimarrons or Caribs. Ultimately he returned to Seville and became a canon. In 1607 the Bishop of Macao gave him a message from the King of Tonquin desiring him to return to that country, but he could not do so. The works of this indefatigable traveller are: (1) "Historia y Viage del Mundo"; (2) "Relaciones verdaderas de los Reynos de la China, Cochinchina, y Champaa" (Jaen, 1628); (3) "Triunfos de la Santissima Cruz"; (4) "Descriptio Indiæ Occidentalis," in the "Novus Orbis sive descriptio Indiæ Occidentalis" of Antonio de Herrera (Amsterdam, 1622).

A BLUE-BOOK just issued by the Foreign Office contains five maps referring to the Russo-Afghan boundaries. The first is a chart of the routes followed by members of the Boundary Commission from Kushan to Bala Murghab; the second is a reproduction in English of a Russian military map of the frontier; No. 3 is a copy of a map of South-Western Turcomania, produced in Russia; No. 4, which was prepared by M. Lessar, shows his explorations; while the last is a sketch map to illustrate the various zones and lines of frontier proposed at one time or other recently by Russia and England.

The Austrian Tourist Club has appointed a committee with the view of making experiments for the improvement of the natural drainage of certain parts of the Karst which are liable to periodical inundation. This celebrated region in the north of the Adriatic is remarkable for its underground rivers, which communicate with the surface here and there by vertical shafts. Through these openings the surplus waters escape to the surface when the underground channels are filled to overflowing, and in that way considerable tracts are periodically converted into temporary lakes. The well-known Lake Zirknitz is only one of dozens of such lakes that are formed in this district every year. The practicability of preventing these inundations by enlarging the underground channels has been discussed on several occasions in the Tourist Club, and now the first attempt to carry this scheme into effect is about to be made with the Pinka Jama, a natural shaft leading down to an underground channel about a mile and a half from the Adelsberg Cavern.

HERR GLASER, the Austrian explorer, is about to undertake a new journey in Southern Arabia. He will go first from Sanaa to Marib, and will then visit in succession Wadi-Davassir, Nedjd, Omaun, and Hadramant. In a similar journey which he made some time ago he brought back 276 inscriptions of the Sabeans, who were regarded in the time of the Ptolemys as the wealthiest people of Arabia.

CAPT. JENNINGS of the Royal Engineers, has returned to India (according to the *Pioneer*) after a successful exploration of South-eastern Persia, including the hitherto unknown Sarhad country. He carefully examined all the roads and the configuration of the country, and is said to bring back a mass of useful information with regard to this region.

THE last number (xx.) of the *Excursions et Reconnaissances* of Saigon contains, among others, two papers by that indefatigable student of Indo-China, Capt. Aymonier, one on Cambodian epigraphy, the other on a journey in Laos. Dr. Tirant gives the second part of his paper on the reptiles of Cochin China and Cambodia, and M. Hardouin concludes the account of a recent journey in Siam.

Petermann's Mittheilungen (No. 5, 1885) contains a paper, accompanied by an excellent map, on Kaffraria and the eastern boundary lands of the Cape Colony, by Herr Schunke, some observations on the sanitary features of the Upper Amu-Darya, and an account of the Geographical Congress at Hamburg.

A YEARLY AND A DAILY PERIOD IN TELEGRAPHIC PERTURBATIONS

SINCE July 1, 1881, all disturbing currents at forty-four telegraphic stations in Norway and Sweden regarding time, duration, force, direction, &c., have been at my request regularly recorded. These observations will of course first obtain real importance when a longer series is available; still, I believe it would be of interest at present to investigate whether for these telegraphic perturbations a similar yearly and daily period could be established, such as have been proved for the aurora and other terrestrial magnetic phenomena. My time being now rather limited, extensive researches are not possible; of the mentioned forty-four stations I have therefore selected four, and herewith present the results of my investigations.

The four stations are named and located as follows:—

Kistrand	70° 25′ N.	25° 13′ E.G.
Lödingen	68 24 ,,	16 1 ,,
Trondhjem	63 27 ,,	8 5 ,,
Bergen	60 24 ,,	5 20 ,,

My researches have been made for the three years from July, 1881, to June, 1884. As the Norwegian stations do not do night work, the observations could only be taken from 7 o'clock in the morning till midnight.

I have first noted the number of days for each month on which telegraphic perturbations have been observed, excluding those caused by thunderstorms. These numbers besider the totals for each month and year are shown in Tables I. to IV.

TABLE I.—*Kistrand*

Month	1881 to 1882	1882 to 1883	1883 to 1884	Total
July	1	2	8	11
August	0	12	3	15
September	7	12	11	30
October	14	20	6	40
November	10	22	3	35
December	13	8	3	24
January	5	7	0	12
February	7	10	9	26
March	13	16	4	33
April	25	6	12	43
May	19	4	3	26
June	14	5	5	24
Year	128	124	67	319

TABLE II.—*Trondhjem*

Month	1881 to 1882	1882 to 1883	1883 to 1884	Total
July	7	5	10	22
August	4	8	3	15
September	10	6	3	19
October	15	11	6	32
November	11	16	6	33
December	14	6	5	25
January	12	7	1	20
February	16	10	4	30
March	18	8	7	33
April	14	4	2	20
May	17	2	1	20
June	6	6	3	15
Year	144	89	51	284

The monthly totals for the three years are graphically represented in Fig. 1. Both the numbers and the figure show apparently that the yearly period for the telegraphic perturbations is identical with that of the aurora, *i.e.* its maximum coincides with both solstices and its minimum with both equinoxes. Of especial importance is the minimum at the time of the summer solstice, when the aurora, as is well known, ceases, on account of the brightness of the northern nights. The perspicuity with which the yearly course of the period is drawn in the four representations of Fig. 1 may even be called surprising, considering the material of observation only embraces three years.

Fig. 1.

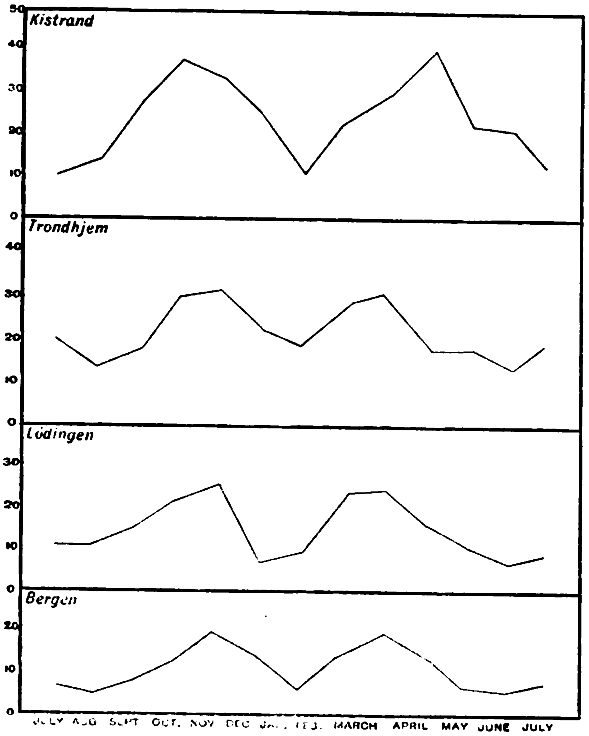


TABLE III.—*Lödingen*

Month	1881 to 1882	1882 to 1883	1883 to 1884	Total
July ...	3	4	3	10
August	6	3	1	10
September ...	9	3	3	14
October	8	11	1	20
November ...	8	14	4	26
December ...	2	5	0	7
January	5	4	0	9
February	10	10	3	23
March...	9	9	6	24
April ..	10	4	3	17
May ...	7	3	2	12
June ...	2	6	0	8
Year	79	75	26	180

TABLE IV.—*Bergen*

Month	1881 to 1882	1882 to 1883	1883 to 1884	Total
July ...	2	1	3	6
August	0	3	2	5
September ..	5	1	1	7
October	5	3	4	12
November ...	6	10	3	19
December ...	6	6	1	13
January	3	1	2	6
February	3	9	0	12
March...	10	4	4	18
April ...	9	3	1	13
May ...	4	2	0	6
June ...	3	1	0	4
Year	56	44	21	121

Tables I. to IV. will show the great frequency of these telegraphic perturbations in Norway compared with those of all other countries in Europe. In the totals of the years a constant decrease for all four stations is visible which decidedly coincides with the diminishing appearance of the aurora during recent years in this country. After some years it will probably be seen how the telegraphic perturbations have the 11-year period in common with the aurora.

In order to determine the daily period, I have investigated how often during the three years in every hour from 7 a.m. till midnight perturbations have been observed (excluding those caused by thunderstorms). Table V. shows the result :—

TABLE V.

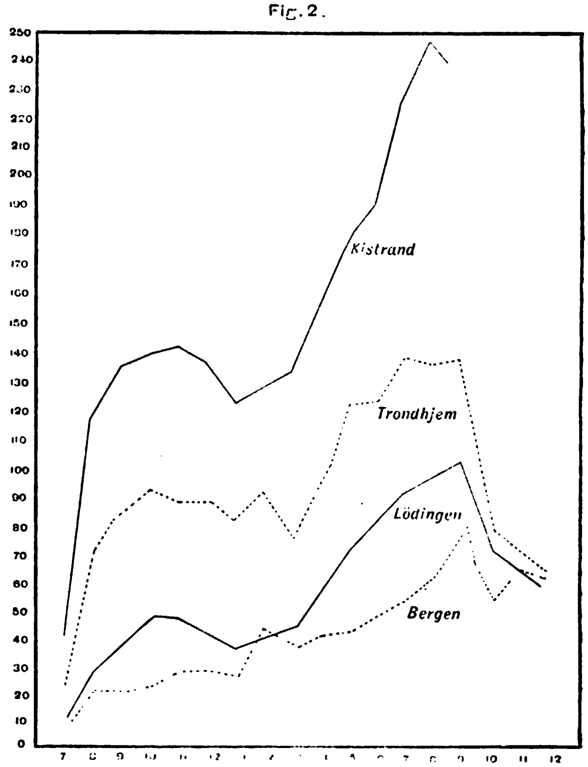
	7	8	9	10	11	12
Kistrand	42	117	135	139	141	137
Trondhjem	24	61	84	91	88	88
Lödingen	11	30	39	48	47	41
Bergen ...	9	23	23	24	28	29

	1	2	3	4	5	6
Kistrand	122	128	133	155	177	191
Trondhjem	81	91	75	93	120	123
Lödingen	36	41	43	57	70	80
Bergen ...	27	43	37	40	42	47

	7	8	9	10	11	12
Kistrand	227	247	238	—	—	—
Trondhjem	137	136	138	77	69	61
Lödingen	91	96	100	70	61	54
Bergen ...	52	61	77	51	61	59

Fig. 2 gives these numbers in graphic representation. It will

Fig. 2.



be seen that the telegraphic perturbations show a very prominent maximum in the evening, 8 till 9 o'clock. Intimations of a trifling maximum (with the exception of Bergen) 10 till 11 a.m., and a succeeding minimum 1 to 2 p.m. are also visible.

Other occupation taking up my time at present a more extensive and detailed investigation must be postponed.

Christiania SOPHUS TROMHOLT

A NOTE RELATING TO THE HISTORY OF THE AURORA BOREALIS

AMONG northern authors none has given the writers on the Aurora Borealis more to trouble than Peder Claussön Friis, 1566-1614, Minister at Undal, near the town of Mandal, in Southern Norway. This, for his time, very productive author, wrote, towards the end of the sixteenth century, a treatise, "About Greenlana." In a second edition (about 1600) he added some extracts from the "Kings-mirror,"[1] and among these, one about the Aurora Borealis. But here he has inserted a remark, which in a high degree has attracted attention and caused astonishment, and which, till now, has been inexplicable to the investigators of the Aurora Borealis. I give further on a translation of the description of the Aurora Borealis in the "Kings-mirror," and after it the version of Peder Claussön:—

Kings-mirror

"Such a nature and condition has the north-light, that the more obscure the night, the more brilliant it appears, and only in the night is it to be seen, never during the daytime, and especially in profound darkness, but seldom by moonlight. It appears as a large flame from a heavy fire seen from afar. Out of this flame protrudes, apparently up in the air, sharp points of unequal height, and very unsteady, so that now one, then the other is higher, and in such a manner this light is pendent like a luminous blaze. As long as these flashes are most intense and bright, such a keen light radiates from these streams of fire and rays, that outdoor people can find their way, and even go a hunting, if it should be necessary. Also, when people are in houses provided with windows, it is so bright inside that all present can recognise each other. But this light is so fluctuating that it sometimes seems to darken, as if a black smoke or a heavy nebulous cloud had been puffed into it, and then shortly again it seems as if the light were about to be smothered in this smoke, and almost become quite extinct. But as soon as this fog commences to dissolve, then this light brightens, and clears up for the second time, and it happens even that one would believe that heavy sparks emitted from it as from a red-hot iron just taken out of the forge. When the night declines, and with daybreak this light begins to decrease, and when the day has set in it seems entirely to disappear."

Peder Claussön Friis

"In Greenland a meteor and bright light is seen on the sky during the night, which appears in the following manner: the more obscure the night the more brilliant is the light; that is to say, the less the moon shines, *and when she is in her prime or wane, the more this light becomes visible in the sky, however, always towards the north,* AND NEVER SO HIGH IN THE SKY AS TO BE OBSERVED IN OTHER COUNTRIES THAN GREENLAND, ICELAND, AND THE NORTHERN PART OF NORWAY, *and for that reason it is called North-light.*

"It appears as a flame or a *darting fire,* and extends over the sky *like a tall and slender hedge,* and it rushes *up and down in a trice as if many organ pipes were posted one beside the other, and in the twinkling of an eye one shoots up and the other down, and where the flame darts clearest up and down, back and forwards,* it can grow dim and almost leave behind it a smoke; *but the next moment* light up again *on another spot, or catch fire where it just before seemed to be extinguished. Nobody who has not himself seen it, can imagine how quickly this light moves forwards and backwards, as if it were hopping and dancing with much agitation.* And when this light is most intense, people can perceive everything in the houses *as if the moon were shining.* At daybreak this northlight fades away."

The "Kings-mirror" was written about 1250, at all events before 1260, and probably later than 1240. The home of the unknown, but at all events Norwegian, author may be looked for, according to the sagacious reasoning of H. Geelmuyden (Christiania Observatory) between 64° 23′ and 64° 58′ N. lat. (not far from the town of Namsos). This description of the aurora is indeed unparalleled in the aurora literature of the past ages; the noble but unvarnished manner in which he describes the phenomenon has not a counterpart in the same or at a much later period. It is peculiar, however, that the aurora is mentioned in the "Kings-mirror" as a phenomenon chiefly characteristic of Greenland, and not even an intimation is given as to its being visible in Norway. This description indicates, nevertheless, quite plainly that it is based on the author's own observation of the aurora in his native country, and it is therefore beyond doubt that he was familiar with the phenomenon,[1] although he has considered Greenland—the country situated, according to the opinion of past ages, farthest towards the north—the proper home of the aurora.

In Peder Claussön's above quoted version of the aurora description in the "Kings-mirror" I have made the remarks and expressions differing from the "Kings-mirror" conspicuous by italics. It will be seen that his citation is rather free; many of these conspicuous expressions, if not all, point to Peder Claussön's knowledge of the aurora through his own observation. The more striking is the conspicuous remark that the aurora in Greenland does not appear so high in the sky as to be observed in other countries than Greenland, Iceland, and the northern part of Norway.

This remark has been inserted in many other publications, and all historians of the aurora from Mairan to Fritz have occupied themselves with the notable circumstance that, according to this remark, the aurora was not visible during the last half of the sixteenth century in Southern Norway. But nowhere in the whole history of the aurora is it so evident how much caution must be displayed in drawing comprehensive inferences from a single remark of an old author.

Peder Claussön has, in a single copy of his treatise on Greenland in the year 1604 or 1605, with regard to the aurora, added the following important "note," hitherto unknown to the investigators of the aurora:—

"This northlight was, as before said, only seen in past times in northern countries. But in the period of my infancy, about the year 1550, it was first seen by people who live in the southern part of Norway, however not higher on the sky than the Polar Star. But since the year 1570 it ascends to such a height that it appears to us in the south-east and in a southern direction, and I suppose that it is seen at present also in other countries."

Peder Claussön's relation is thus in downright contradiction with the interpretation given to his above-mentioned remark. It remains now to explain how he could write, in the year 1600, that the aurora was only visible in the extreme north of Norway. It may be seen that he had the opinion that the aurora, in "past times," was only visible in "the northern countries"; the silence of the "Kings-mirror" about this phenomenon in Norway has perhaps brought him to this conclusion. The remark "and never so high in the sky as to be observed," &c., therefore, in all probability describes the circumstances which, after his opinion, took place at the time when the "Kings-mirror" was written. The additional clause, "and for that reason it is called northlight," seems at the same time to intimate that he, by the previous remark, would explain why the author of the "Kings-mirror" uses the expression northlight (namely, because it is visible only in the extreme northern countries). SOPHUS TROMHOLT

Christiania

[1] The Kings-mirror (Konungs skuggsjá) is, of its kind, an unparalleled Norwegian work, in which an ingenious and noble man, who must have stood at the height of culture at his time, has expounded his philosophy and especially his views on State administration and ethics, in the form of conversations between a father and son. It is a book on good manners, social intercourse of the highest interest, because of the whole form of culture which it represents, and is written in elevated tone.

[1] The author himself never visited Greenland.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Two studentships have been established at St. John's College on the foundation of the Rev. Mr. Hutchinson, late Senior Fellow. They are of the value of 60*l.* a year for two years and are tenable with a Foundation Scholarship. Any student of the College who shall be *bonâ fide* engaged in the pursuit of some branch or branches of physical or natural science or in the study of Semitic or Indian languages, and shall be of not less than nine and not more than eighteen terms' standing from the commencement of his residence in the University shall be qualified to be a candidate, and if there is no candidate belonging to the College of sufficient merit in these studies, the Council may elect a student engaged in any study, whether a member of the College or not. The Council may impose such conditions on the students as shall encourage genuine study after the best methods—*e.g.* they may require him to present in writing an account of his studies, to deliver lectures, &c. The election will take place in June each year.

It will be seen that a Hutchinson student may be free to work at biology in Naples, to join an Eclipse Expedition, to study Pali in Ceylon or Hebrew in Cambridge. We hope to hear of the Hutchinson students in the future.

The Senate has approved of the erection of a new Chemical

Laboratory according to Mr. Stevenson's design, and tenders are to be obtained as early as possible.

Mr. J. W. L. Glaisher, F.R.S., is to be Additional Examiner in Part III. of the Mathematical Tripos in January, 1886.

Prof, Bonney and Mr. J. J. H. Teall are appointed Examiners for the Sedgwick Prize to be adjudged next year.

Prof. Macalister will take a class in Osteology during the Long Vacation. There will also be an Introductory Practical Course in Anatomy, illustrated by that of the Dog, superintended by the Professor and Mr. Rolleston. The Demonstrator will take a practical class in Histology during the Long Vacation.

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, vol. xix., Part 3, April 1, contains:—On the development of the blood-corpuscles in the embryo of *Perca fluviatilis*, by K. F. Wenckebach (plate 11).—Movements of the ulna in rotation of the fore-arm, by Dr. J. Heiberg.—The nature of ligaments, part iii., by J. B. Sutton (plate 12).—Supernumerary cervico-dorsal vertebra-bearing ribs, with vertebral and costal asymmetry; abnormal articulation in a sternum, by W. A. Lane.—Some points in the histology of the medulla oblongata, pons varolii, and cerebellum, by Dr. W. A. Hollis (plate 13).—The external auditory meatus in the child; the relations of the larynx and trachea to the vertebral column in the fœtus and child; a rare abnormality of the pancreas, by Dr. J. Symington (plate 14).—The existence of a fourth species of the genus Balænoptera, by Dr. G. A. Guldberg.—Some variations in the anatomy of the human liver.—Notes on some unusual variations in human anatomy, by Dr. A. Thomson.—Observations in reference to bilateral asymmetry of form and function, by Dr. F. Tuckerman.—Case of exostosis of the ulna, by Dr. R. J. Anderson.—The mu culus sternalis and its occurrence in (human) Anencephalous monsters, by Dr. F. J. Shepherd (plate 15).—The venous system of the bladder and its surroundings, by E. H. Fenwick (plate 16).

The Journal of Physiology, vol. v., Nos. 4, 5, 6, contains:—Observations of the gastric glands of the pig, by M. Greenwood.—Hæmatin compounds, by V. D. Harris.—Papaïn digestion, by S. H. C. Martin.—The secretion of oxalic acid in the dog under a varying diet, by T. W. Mills.—On the comparison of the concentrations of solutions of different strength of the same absorbing substance, by S. Lea.—On the mutual antagonism between lime and potash salts in toxic doses, by S. Ringer.—The behaviour of the red blood corpuscles, when shaken with indifferent substances, by S. J. Meltzer and W. H. Welch.—On the cardiac rhythm of Invertebrata, by W. B. Ransom.—Some experiments on the liver ferment, by Florence Eves.—An experimental investigation showing that Veratria is similar to lime salts in many respects as regards their action on the ventricle; also showing that veratria and lime salts are reciprocally antagonistic, by S. Ringer.—Some observations on the influence of the vagus and accelerators on the heart of the turtle, by T W. Mills.—On the anatomy of the cardiac nerves in certain cold-blooded vertebrates, by W. H. Gaskell and Hans Gadow.

Vol. vi., Nos. 1 and 2.—Is the nervous impulse delayed in the motor nerve terminations? by A. W. Hoisholt.—Observations on some of the colouring matters of bile and urine, with special reference to their origin; and on an easy method of procuring hæmatin from blood, by C. A. MacMunn.—The edible bird's nest, or nest of the Java swift (*Callocalia nidifica*), by J. R. Green.—The velocity of accommodation, by J. W. Barrett.—On the physiology of the salivary secretion; part 3, the paralytic secretion of saliva, by J. N. Langley.

Gegenbaur's Morphologisches Jahrbuch, Bd. x., Heft 4, contains: On the morphology of nails, by C. Gegenbaur.—On direct nuclear division in the embryonal membranes in the scorpion, by F. Blochmann (plate 22).—On the derivation of the neural system in the nematodes, by O. Butschli (plate 23).—Studies on the developmental history of the cœloms and Cœlom-epithelial in the amphibia, by B. Solger (plates 24 and 25).—Some remarks on the true relations of organisation in the so-called cilio-flagellates, and in the noctiluca, by O. Butschli; with a note by E. Askenasy (plates 26 to 28).—The foramen magendii, and the opening in the recessus laterales of the fourth ventricle, by C. Hess (plate 29).—Reply to Dr. Baur, by Dr. W. Dames.—On the beaks of birds and dinosaurs, by Dr. G. Baur.

Zeitschrift für Wissenschaftliche Zoologie, Band xli., Heft 3, contains:—On the history of the formation and on the morphological value of the ova of *Nepa cinerea* and *Notonecta glauca*, by W. Will (plates 20–22).—On the powers of transformation in the Mexican Axolotl, by Marie von Chauvin.—Contribution to a knowledge of the Trematodes, *Distomum palliatum*, nov. spec., and *D. reticulatum*, nov. spec., by A. Looss (plate 23).—The formation of the radula in the Cephalophorus Mollusca, by R. Rossler (plates 24 and 25).—Studies of the fauna of the larger and smaller ponds in the Riesengebirge, by O. Zacharias (plate 26).—On some common developmental processes in Vertebrates, by J. Kollman.

SOCIETIES AND ACADEMIES

London

Royal Society, April 23.—"The Essential Nature o the Colouring of Phytophagous Larvæ (and their pupæ); with an account of some Experiments upon the Relation between the Colour of such Larvæ and that of their Food-plants," by Edward B. Poulton, M.A., of Jesus and Keble Colleges, Oxford.

Abstract.

The Essential Nature of the Colouring of Phytophagous Larvæ.—Phytophagous larvæ are coloured by pigments derived from the food-plant, pigments proper to the larvæ, and tissues such as fat, which lend incidental aid to the colouring. The altered plant-pigments hitherto detected in larvæ are chlorophyll and xanthophyll, causing the colours green and yellow. The former is termed metachlorophyll, because of the difference between its spectrum and that of unaltered chlorophyll (in the leaf), and because of the chemical differences between its solution in larval blood, &c., and any known solution of plant chlorophyll. The evidence is at present insufficient to warrant the use of a separate name for the derived larval xanthophyll. Other colours hitherto examined are due to true pigments or tissues.

The following table indicates the situations occupied by the different causes of colour, and gives to some extent the historic order of their employment.

I. The internal tissues and organs with ready-made colour	*a.* Digestive tract. *b.* Fat. *c.* Dorsal vessel.
II. The passage of derived pigments through the walls of the digestive tract into	*a.* The blood. *b.* The subcuticular tissues.
III. The appearance of true pigment in	*a.* The hypodermis. *b.* The cuticle.

These causes explain larval and pupal colour, except such instances as the metallic tints of certain pupæ. The different stages of coloration mentioned in the table were not often mutually exclusive, but each new method was an additional resource. The derived pigments more often confer general resemblances, the true pigments special resemblances. In many cases the green colour is due to metachlorophyll in the blood only (many Noctuæ), while in other cases it is also placed in the subcuticular tissues (Sphingidæ). The former larvæ lose their colour locally on slight compression, while the swollen uncompressed part becomes of a deeper tint. When larvæ are dimorphic—green and brown—the colours of the former are mainly due to metachlorophyll, of the latter to true pigments. Such important differences in the causes of colour commonly occur among larvæ from the same batch of eggs, or in the life-history of a green larva, which becomes brown, or *vice versa*. The blood of brown larvæ, with transparent skins, is colourless except in very thick layers; in the brown *Chærocampa elpenor*, the blood becomes brown, but the bands of metachlorophyll and xanthophyll can be faintly seen. Hence these pigments are not destroyed beyond the point at which they cease to interfere with the changed colour. The derived pigments may exist unchanged in the blood after the larva has altered in colour, if the superficial pigments are completely opaque (many geometers). This persistence of the derived pigments may be very important to the organism. Thus the larva of *Ennomos angularia* is an opaque brown geometer, but pupates in a cocoon of loosely-attached leaves through which it can be seen. Before pupation the true pigment disappears, and the larva and pupa are coloured by metachlorophyll. Again, in many instances the derived pigments are retained in the blood of the pupa and segregated in the ova, when these are yellow or green, serving to tinge the newly-hatched larva before the effects of its first meal can become apparent. But after such a long period, and the alternation of solution in blood and deposition in tissue, the colour of the more stable pigment—xanthophyll—preponderates over the green of the metachlorophyll in the newly-hatched larva. The bands of xanthophyll are distinctly seen in an alcoholic extract of crushed ova taken from the bodies of moths which have been preserved for ten years or longer. In blown and dried larvæ the greens soon fade, while the yellows persist and the pigment can be detected after many years. The true pigments are also unaltered. In larvæ preserved in spirit the derived pigments quickly disappear, and the alcohol is yellow with xanthophyll, while the true pigments are unchanged. These facts are also true of phytophagous hymenopterous larvæ, as well as in the lepidoptera. Thus in *Nematus curtispina* the green colour is due to derived pigment, while the broad white dorsal band is due to fat collected on each side of the dorsal vessel (and it can be seen to move with the pulsations of the latter). In *Crœsus Septentrionalis* fat becomes the vehicle for a yellow colour. The few exposed pupæ of moths are coloured in the same manner as the larvæ (*e.g.* the *Ephyridæ* and *E. angularia*). In the Ephyridæ, dimorphic larvæ—green and brown—produce pupæ which follow the colour of their respective larvæ. Larval markings can often be seen upon the pupa immediately after pupation. Thus the pupa of *Sphinx ligustri* is marked by the oblique stripes of the larva. The pupæ of butterflies are nearly always protectively coloured, and often possess the derived pigments. In *Papilio machaon* the derived pigments of the pupa are segregated in a very remarkable chitinised (?) subcuticular layer, which is quite opaque, so that no effect is produced by the bright yellow blood (xanthophyll).

Methods of Investigation and Spectra of derived Pigments.—Zeiss's micro-spectroscope was always employed, with bright sunlight as the means of illumination. The blood is obtained by pricking the pupa or the larva in some situation remote from the digestive tract. Existing under pressure, most of the blood at once emerges as a clear bright green or yellow liquid (when the derived pigments are present). It is received into a tube-section, with one end cemented to a glass slide, and when full a cover glass is placed upon the open end, becoming fixed by the drying of the blood. In most cases the blood so prepared will keep for months. The spectrum of metachlorophyll is as follows (in the case of the bright green fresh blood of the pupa of *Pygæra bucephalus* in a thickness of 23 mm.):—

Chief band in the red, 71·–65·, continuous with a less absorption extending to 58·, darkest from 58·5–59·5; a broad band from 52·–48· with the dimmed blue and violet coming through 48·–42·, from which latter point the violet end is absorbed. There is no absorption of the extreme red. A Zeiss's scale is adopted in which 1· = 1/100,000 mm.

Comparing this spectrum with that of true chlorophyll, as seen in two fresh calceolaria leaves, the whole spectrum is shifted towards the violet end in the latter case, with the exception of the end absorption, which extends to 43·. The chief band in the red is 70·–64·5, and then the continuous absorption of metachlorophyll is replaced by two bands: 61·–63· and 57·5–60·, and if anything the former is the darker. The broad band is 47·5–51·, and the dimmed blue and violet 47·5–43·. The chief difference is the continuity of the three bands of the red end in metachlorophyll, and the fact that their darkness is in the order (1) (3) (2) from the red, instead of (1) (2) (3). A similar spectrum (as far as it could be identified by the use of a paraffin lamp) was observed in a clear green fluid from the digestive tract of the larva of *Phlogophora meticulosa*. In yellowish green blood (pupa of *S. ligustri*) the absorption at the violet end is aided by the xanthophyll present, which gives two bands if the thickness of blood be sufficiently small. In some cases a third band is also present. Thus the blood of *S. ligustri* in a thickness of 3 mm. does not give the band of chlorophyll in the red, but shows three bands in the more refrangible half of the spectrum: 48· 50·, 45·–46·25, and 42·–43· the violet end being absorbed at 41·. Between these areas of absorption the spectrum is dimmed. The three bands become less distinct in the above-mentioned order, and the third can only be seen under favourable conditions of light, and appears to be absent in some cases. Mr. Sorby states that a third band, due to another substance, is sometimes present in the xanthophyll spectrum. While the spectrum of metachlorophyll is very constant over a large number of larvæ and pupæ, in the living green pupa of *Ephyra punctaria*, a form of chlorophyll with a rather different spectrum was met with, in which the second band of true chlorophyll is present instead of the continuous absorption, while the third band could not be seen in the slight thickness obtainable. The term "ephyra-chlorophyll" is given to this pigment, which is dissolved in the blood of the pupa. Metachlorophyll, and probably xanthophyll, are united with a proteid in the blood. The addition of ether to green blood brings down the combined pigment and proteid in the form of a green coagulum, from which the ether does not dissolve the metachlorophyll, but gradually takes up the xanthophyll, becoming bright yellow. Alcohol, on the other hand, decomposes the combined proteid and pigments, the coagulum rapidly becoming decolorised, and the xanthophyll passing at once into solution, while the metachlorophyll disappears. Hence it seems that the latter pigment depends upon its association with the proteid for its extreme stability and permanence under the action of light. This permanence is necessary for the larva, since any colour due to derived pigments implies the penetration of light, and often the complete translucence of the whole organism, and, further, there are long periods (at the ecdyses), during which the pigments cannot be renewed, because no food is taken. Then there are the extreme cases of the green Ephyra pupæ, and the green pupæ of *P. machaon*, freely exposed to daylight during two-thirds of the year. It seems certain that the derived pigments are merely protective, and are of no further importance in the physiology of these organisms. Thus it is not probable that there are any marked differences between the physiological processes of the green and brown larvæ from the same batch of eggs, or in the processes of a green larva which has become brown, or *vice versâ*. The blood of larvæ seems to be always acid (and so with all pupæ examined, except *E. punctaria*, of which the blood was neutral, in the only instance in which the blood of this pupa was tested), but I have as yet been unable to obtain a sufficient quantity of blood to determine what acid is present. The blood forms a solid, black coagulum which is due to oxidation, and does not take place when the blood is preserved in the manner described above. The injured parts of larvæ which have healed are black. It is probable that the darkening of pupæ and of the cuticular pigment of larvæ is also due to oxidation. There is great variability in the amount of clot formed and in the rapidity of the process.

Historical.—Mr. Raphael Meldola, in the *Proc. Zool. Soc.* for 1873, and in the editorial notes to his translation of Weismann's "Studies in the Theory of Descent," Part. II., "On the Origin of the Markings of Caterpillars," &c., argues very convincingly for the use of plant-pigments by green larvæ He points out that internal feeders are never green unless their food contains chlorophyll, and that when this is the case (*Nepticula oxyacanthella*, &c.) they may be green, although the colour cannot be of any advantage to them. Pocklington (confirmed by Dr. MacMunn) found chlorophyll in the elytra of Cantharides, and Chautard seems doubtful about the same pigment in this situation (*Compt. Rend.*, January 13, 1873, and *Ann. Chim. Phys.*, 5, iii., 1-56). Dr. MacMunn found a band in the red which resembled chlorophyll, by concentrating light on the integument of the larva of *Pieris rapæ* and examining with a micro-spectroscope; but both he and Krukenberg refer the pigment to the larval digestive tract. (See *Reports* of British Association at Southport, 1883, and a letter by Dr. MacMunn to NATURE for the week ending January 10, 1885). It is very unlikely that the green colour of so thick and opaque a larva can be due to its digestive tract, and it is probable that the blood, with its dissolved metachlorophyll, was lost in the manipulation. From memory of the appearance of the larva, and from examining a blown specimen, I should certainly infer that there are also derived pigments in the subcuticular tissues.

The Relations between the Colour of Phytophagous Larvæ and that of their Food-Plants.—Entomologists have been long aware of the fact that the colours of many larvæ vary (within the limits of the same species) according to the colour of the plant upon which they are found. Complete references to the observations hitherto recorded upon this point occur in Mr. Meldola's writings (mentioned above). Among the most important of these is a paper by Mr. R. M'Lachlan (*Trans. Ent. Soc.*, 1865, p. 453) in which data are given as to *Eupithecia absynthiata*, which were yellowish when found upon *Senecio jacobæa*, reddish upon *Centaurea nigra*, whitish upon Matricaria. When nearly full grown they were all given *Senecio jacobæa* without altering the colour of the reddish and whitish varieties. From this Mr. M'Lachlan argued (1) that it was necessary for the larvæ to have fed on the one kind of plant from the egg to acquire the resemblance; (2) that the colour is not caused by the food showing through the somewhat transparent integument. Mr. Meldola quotes many instances in which the larva of *S. ligustri* has been observed to vary according to its food-plant (laurustinus, lilac, privet, ash). I have for many years known of the difference between the lilac and privet forms (the latter being of a brighter yellower green than the former, with brighter stripes). In 1884 I bred twelve larvæ from the egg upon privet, and the same number upon lilac. All the privet and six of the lilac larvæ reached maturity, and, without exception, showed the differences indicated above. A more remarkable instance is afforded by *Smerinthus ocellatus.* Mr. Meldola quotes Mr. E. Boscher as finding many yellowish-green varieties of this larva upon *Salix viminalis,* and many bluish-green varieties upon *S. triandra,* similar to those which are well known to occur upon apple. The former varieties possessed the rows of reddish-brown spots which sometimes occur on this variety of the larva. Upon another species of Salix he found instances of both varieties. In 1880 Mr. Boscher conducted some breeding experiments at Mr. Meldola's suggestion, feeding the larvæ from the egg upon *S. triandra, S. viminalis,* and apple, respectively. Only three of the third lot survived, and were all of the bluish-green form. I have also found (*Trans. Ent. Soc.*, Part I., April, 1884) that *S. rubra* and *S. cinerea* produce the yellowish variety, but *S. viminalis* the bluish form, according to my experience. In 1884 I fed five lots of six larvæ each, from the egg, upon apple, crab, *Salix viminalis, S. cinerea,* and *S. rubra,* respectively. On a few occasions *S. babylonica* and *triandra* were substituted for *S. rubra,* and ordinary apple for crab. The eggs were hatched July 15 to 18, and most of the larvæ were full fed by August 23, with the following results:—*Apple*: the five larvæ were typical bluish-green forms. *Crab*: the five larvæ were also typical bluish-green. *S. viminalis*: the four larvæ were not so whitish as the above-mentioned lots, but were almost intermediate. *S. cinerea*: the four larvæ were also intermediate. *S. rubra*: the four larvæ were yellower than any of the others, but were not much beyond intermediate forms. The yellowest was separated on August 14, and fed upon apple, becoming adult August 26, by which time it was rather whiter than any others of the same lot (*S. rubra*).

Thus there was no doubt about the effects produced, but there was a strong tendency all through towards the bluish variety, which the food-plant could only overcome to the extent of producing an intermediate form. The same conclusions were formed by a comparison of larvæ found in the field during 1884. Thus two nearly opposite varieties were found upon the same tree (? *S. ferruginea*, Anderson); an intermediate variety was found upon *S. rubra,* and a bright yellowish variety upon apple. At the same time the great majority of larvæ found were such as I should have anticipated.

Experiments were made upon the younger captured larvæ, which were fed upon food-plants tending towards a different colour. The results were similar to those indicated by the former experiments. Some effect could be produced in an intermediate variety by feeding it for some considerable time upon a food-plant known to have strong tendencies, but no such effect is produced upon a larva with a strongly-marked colour, *i.e.* one with strong tendencies itself, and corresponding with those of the food-plant. But the former experiments show that a very strong larval tendency may be counteracted to the extent of producing an intermediate form by feeding it from the egg upon a food-plant tending strongly in the other direction. When this latter effect has become manifest, it was proved that an appropriate change of the food at a comparatively late period may produce some considerable effect in the direction of the original tendency. The most probable explanation of the above-mentioned facts is that the effects of the food-plant are hereditary, and accumulate when the larvæ of successive generations feed upon plants with the same tendencies. Conversely feeding upon plants with different tendencies, and interbreeding, accounts for the irregularities observed. Thus in the larvæ fed from the egg, it is supposed that the previous generation (or generations) fed upon plants tending towards bluish-green larvæ. The yellowish larva found upon apple must have descended from a line fed upon *S. rubra,* or a plant with the same effects. The localisation of a food-plant would overcome both causes of irregularity, the liability to lay eggs on plants with different tendencies, and the chance of interbreeding between the two varieties.

This explanation is in accordance with the fact that the larvæ are of a very uniform tint upon apple trees in gardens, which are to a certain extent locally separated from the various species of sallow growing by the banks of streams, and in damp lanes and hedgerows. The strong effects produced upon the larvæ by apple, the usual proximity of many trees, and the sluggish flight of the Smerinthi, doubtless all conduce towards the uniformity between the larvæ upon this food-plant. On the other hand, there is the greatest facility for (the observed) irregularity in the results of sallow upon the larvæ, for many so-called species with various tendencies grow close together, so that there must be interbreeding and the deposition of eggs on various species of food-plants, even in the case of very sluggish insects. It is probable that certain conflicting statements as to the effect of the different food-plants upon the larva of *S. ligustri* are to be explained in the same way. As to the structural cause of the variability in these two larvæ, the main factor is a change in the relative amounts of the two derived pigments. Thus there is more xanthophyll in the blood of the pupa of a yellowish *S. ocellatus* than in the other case; and more chlorophyll with less xanthophyll, in the blood of the pupa of *S. ligustri,* from the greener larva fed upon lilac than from one fed upon privet. The result of this adjustment of the relative amounts of derived pigment is to produce a colour which harmonises with the part of the environment imitated—the undersides of the leaves in the case of *S. ocellatus,* the *tout ensemble* of the food-plant in the case of *S. ligustri.* In neither instance can the effects be due to the most direct and simple action of the food itself—the solution of its pigments in their normal proportion showing through the skin. This is disproved by the fact that *S. ocellatus eats* the whole leaf, but *resembles* the underside, and imitates in derived pigments an appearance largely due to texture; further, the effects do not at once follow a change of food, and a strong larval tendency may even cause the rearrangement of the derived pigments, so as to produce an effect *unlike* the leaf. The simple view allows no room for larval tendencies or for delayed effects. It has also been rendered very probable that the effects accumulate during successive generations. In the case of *S. ligustri* there is the additional difficulty that the larval pigment of the oblique stripes is affected by the food-plant as well as the derived pigments. Such effects cannot be explained by any simple theory of phytophagic effects, but it still holds good that phytophagic pigments play a most important part in larval coloration, and afford the chief material which is moulded by some influence—subtler than that which is implied by the term "phytophagic" itself—into likeness to a special part of the environment. The little we know of this influence points towards a nervous circle whose efferent effects are seen in the regulation of the passage of altered plant-pigments through the digestive tract into the blood, and finally the tissues, and in the colour of a certain amount of larval pigment, while the afferent part of the circuit must originate in some surface capable of responding to delicate shades of difference in the colour of the part of the environment imitated This interpretation is rendered unusually difficult by three facts: the gradual working of the process, often incomplete in a single life; the excessively complex and diverse results, and the special character of the stimulus (for it is only the part of the environment imitated which produces any effect —*e.g.* the *undersides* only of the leaves in the case of *S. ocellatus*). During the present year I hope to experiment further upon the subject, and I have a large number of living pupæ of *S. ocellatus,* with the life-histories of their respective larvæ carefully noted.

Chemical Society, May 7.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—On some points in the composition of soils; with results illustrating the sources of fertility of Manitoba prairie soils, by Sir J. B. Lawes, Bart., LL.D., F.R.S., F.C.S., and J. H. Gilbert, Ph.D., LL.D., F.R.S., V.P.C.S.—Researches on the relation between the molecular structure of carbon compounds and their absorption spectra, by Prof. W. N. Hartley, F.R.S. In continuation of the author's previous researches (*Trans.*, 1881, 57-60 and 111-128; 1883, 676-678), measurements have been made of the wave-lengths of the rays absorbed by the following substances:—(1) Aromatic hydrocarbons: benzene, the three xylenes, and naphthalene. (2) Aromatic tertiary bases and their salts: pyridine, picoline, quinoline, and their hydrochlorides. (3) Addition products of tertiary bases and salts: piperidine, tetrahydroquinoline, and its hydrochloride. (4) Primary aromatic bases or amido-derivatives and salts thereof: ortho- and para-toluidine and their hydrochlorides. In the preparation of solutions, a milligram-molecule, that is, the molecular weight in milligrams, was dissolved in 20 c.c. of a diactinic solvent, and made up to a given volume, generally 20 c.c. In this way molecular weights were made to occupy equal volumes. Photographs of the absorption spectra were taken through definite thicknesses of solution. The lines of tin, lead, and cadmium were used as references; the positions of the bands were measured on the photographs by means of an ivory rule divided into hundredths of an inch, and those measurements were reduced by means of two curves to oscillation frequencies and wavelengths. As far as possible, the absorption curves are drawn to a uniform scale. These curves indicate the *molecular actinic absorption* of each substance. The following deductions are drawn:—When an atom of nitrogen is substituted for an atom of carbon in the benzene or naphthalene nucleus, the property of selective absorption is still retained. When the condensation of the carbon and nitrogen in the molecule of a benzenoid compound or tertiary base is modified by the addition of an atom of hydrogen to each atom of carbon and nitrogen, the power of selective absorption is destroyed. When the condensation of the carbon in quinoline is modified by the combination therewith of four atoms of hydrogen, the intensity of the selective absorption is reduced and is not destroyed. A very pure specimen of quinoline from coal-tar gave an absorption curve identical with that of quinoline prepared synthetically by Skraup's method. It may further be added that molecular actinic absorption of a salt is different from that of the organic base which it contains, although the acid exerts no absorptive power by itself. Sometimes the difference is very great, but the area included by the curve of the salt is always less than that of the base. Molecules vibrate as wholes or units, and the fundamental vibrations give rise to secondary vibrations which stand in no obvious relation to the chemical constituents of the molecule, whether these be atoms or smaller molecules. Hence it appears that a molecule is a distinct and individual particle which cannot be truly represented by our usual chemical formulæ, since these only symbolise certain chemical reactions and physical properties, and fail to express any relation between physical and chemical properties.—Researches on the action of the copper-zinc couple on organic bodies; Part x., benzyl bromide, by Dr. J. H. Gladstone, F.R.S., and Alfred Tribe.—On the selective alteration of the constituents of cast iron, by Thomas Turner, Assoc. R.S.M.—On the existence of nitrous anhydride in the gaseous state, by Prof. G. Lunge.—On the reaction between nitric oxide and oxygen under varying conditions, by Prof. G. Lunge. Experimental evidence is given for the following conclusions:—(1) That when nitric oxide is mixed in the dry state with an excess of oxygen they combine exclusively, or nearly so, to form N_2O_4. (2) Dry NO and O_2, with an excess of the former, yield a large proportion of N_2O_3 along with N_2O_4, both in the state of gas. (3) In the presence of water, NO in the presence of an excess of O_2 is altogether converted into HNO_3. (4) If NO and O_2 meet in the presence of concentrated sulphuric acid, neither N_2O_4 nor HNO_3 is formed, even with the greatest excess of oxygen; but the reaction is—

$$4SO_4H_2 + 4NO + O_2 = 4SO_2(OH)(ONO) + 2H_2O.$$

The bearing of these facts on the theory of the vitriol-chamber process is then discussed. The author considers that N_2O_3, and not NO as hitherto assumed, is the carrier of oxygen, and that as long as any appreciable quantity of SO_2 is present, no nitric oxide is formed, the following being the reactions whereby the sulphuric acid is formed:—

$$2SO_2 + N_2O_3 + O_2 + H_2O = 2SO_2(OH)(O_2N)$$
$$2SO_2(OH)(O_2N) + H_2O = 2SO_2(OH)_2 + N_2O_3.$$

Anthropological Institute, May 12.—Francis Galton, F.R.S., President, in the chair.—The election of R. Brudenell Carter, F.R.C.S., was announced.—The Earl of Northesk exhibited a collection of Maori worked jade.—Mr. Sepping Wright exhibited a portrait in oils of King Tawhiao, in native costume.—Mr. J. H. Kerry-Nicholls, F.R.G.S., read a paper on the origin and manners and customs of the Maori race. The origin of the Maoris and the date of their arrival in New Zealand is unknown. The natives refer to Hawaiki as the fatherland of their race, but there is no reliable evidence to show where that land was situated. The lecturer believed that the Maoris emigrated from the Tonga islands to New Zealand, and referred to the resemblance between the two races, and to the affinity of the two languages. The word *tonga* occurred no less than sixteen times in the Maori tongue. The natives of the two countries when they met could converse with but little difficulty. The Maoris are of Malay stock, and came with the gradual spread of that race through the eastern islands of the Pacific to the more southern groups. The race is greatly on the decrease. In Cook's time (1769) the whole native population was estimated to exceed 100,000. In 1859 it only amounted to 56,000. In 1881 the number had decreased to 44,099, of whom 24,370 were males and 19,729 females. Calculating at the same rate of decrease, about the year 2000 the Maori race would be extinct. The principal diseases conducing to this decay were phthisis, chronic asthma, and scrofula, the two first being principally brought about by a half savage, half civilised mode of life, and the latter from maladies contracted since the first contact with Europeans. The native religion still exercises a widespread influence over the people; it consists of a kind of polytheism, a worship of elementary spirits and deified ancestors. They have a vague conception of a Superior Being, and believe in a *Reinga*, or heaven, and a *Po*, or Hades. The Maoris are divided into tribes whose members are bound together by the strictest union. The ownership of the soil is by tribal tenure, and each tribe holds a commercial interest in lands, forests, cultivations, and fisheries. The tribes dwell together in villages, and each *hapu*, or tribal family, cultivates a portion of land sufficient to meet its immediate requirements. The Maoris own about 15,000,000 acres of land in the North Island, not yet alienated to Europeans. The ownership of the soil was secured to the natives under the treaty of Waitangi, made in 1840. The tribes are governed by hereditary chiefs. In 1858 a king was elected by consent of the tribes under the title of Potatau the First. He was succeeded by his son, Matutaera Te Pukepuke Te Paue Tu Karato Te-a-Botatau Te Wherowhero Tawhiao, or Potatau II. This was the king who last year visited this country.

EDINBURGH

Royal Society, May 18.—E. Sang, LL.D., Vice-President, in the chair.—The first instalment of a paper by Prof. Chrystal, on the Hessian, was read. The chief object was to contribute to the theory of the number of intersections of a curve and its Hessian at any one point as depending upon the nature of the singularity at that point.—In a paper on the distribution of potential in a thermo-electric circuit, open or closed, Prof. Tait detailed the various real additions to our knowledge of the subject in their chronological order. He showed what is at present the most probable arrangement of potential in the circuit, and what classes of experiments remain to be made in order to settle the point.—A paper by Mr. Broom gave numerical details of the percentage contraction of volume when a saturated solution of a salt in water is diluted with an equal bulk of pure water.

PARIS

Academy of Sciences, May 18.—M. Bouley, President, in the chair.—On the results of errors caused by defective instruments in the determination of certain astronomical elements, by M. M. Lœwy.—On the radiation of heat during the night in connection with the normal lowering of the temperature during the months of April and May, by M. J. Jamin. This lowering of the temperature, often so destructive to the spring crops, is rightly attributed by meteorologists to nocturnal radiation, which the author finds attains its maximum about the months of April and May.—Note on the prophylactic inoculation recently practised on Rio de Janeiro against yellow fever, by M. Bouley. This experiment, first introduced by Dr. Domingos Freire, has since been carried out on a large scale under the control of the Government. Since the month of March, 1883, as many as 1109 persons of all ages, nationalities and conditions of life have been subjected to sub-cutaneous injections with the attenuated virus cultivated for the purpose. In some cases the injections were administered in houses where the scourge had a few hours before proved fatal to some of the inmates. Yet no misadventure of any kind has followed, and this preventive measure seems so far to have been attended by the best results.—Anatomical study of the fœtus of a spermaceti whale, by M. Pouchet.—Note on the annular protuberance regarded as the prime motor of the cerebral mechanism, the focus or centre of localisation for speech, the reasoning faculty, and the will, by M. Bitot. From his studies in cerebrology the author concludes, against the generally accepted opinion, that the third left frontal convolution is not the seat or centre of speech, which he localises in the annular protuberance. In the same region he also considers that the intelligence and will are localised, so that even slight lesions of the central part of the annular protuberance destroy both the faculty of speech and of reason. He accordingly denies that the strictly psychic faculties are located in the cerebral cortex, which is the seat only of the organs of sense.—Note on the influence of the ship's motions (rolling and pitching) on the observations made at sea with the Renouf mercury level, by M. O. Callandreau.—Remarks on the observations of the planet Saturn made during the present year with the 0·22 refractor of the Meudon Observatory, by M. E. L. Trouvelot.—Note on the verification of the laws of vibration for elastic circular plaques, by M. E. Mercadier.—On the production of induction sparks at high temperatures, and on its application to the study of the spectrum, by M. Eug. Demarçay.—Composition and heat of combustion of a variety of coal from the Altendorf mines of the Ruhr Basin, by M. Scheurer-Kestner.—Note on the buccal membrane characteristic of the cephalopods, by M. L. Vialleton. From a microscopic study of this organ, the use of which has hitherto been unknown, the author infers that it should probably be regarded as a rudimentary arm.—A study of the chlorophyll action of plants as distinct from their respiration, by MM. G. Bonnier and L. Mangin. By "chlorophyll action" the authors understand the decomposition of the carbonic acid of the atmosphere by the green parts of vegetables in the light. This function they claim to have separated from that of respiration hitherto studied in connection with it, and here give the first results of their researches on the two physiological functions studied apart. — Note on the uric acid present in the saliva and in the nasal, pharyngial, bronchial, and vaginal mucus, by M. Boucheron. — On the influence of the lunar declinations on the displacement of the atmospheric currents, by M. H. de Parville.—On the earthquakes and volcanic eruptions which are of such frequent occurrence in Central America, by M. de Montessus. The author here communicates some of the results of a systematic study of these phenomena prosecuted for the last four years at San Salvador and neighbouring districts.—Note on some underground rumblings heard in the Island of San Domingo on August 28, 1883—that is, on the same day as the Krakatoa eruption, by M. Alex. Llenas.—Remarks on M. Gavoy's work on the "Morphology of the Encephalon," presented to the Academy by M. Larrey.

Berlin

Physical Society, March 8.—Dr. Kayser showed a new electro-dynamometer constructed according to the directions of Prof. Bellati. Hitherto dynamometers consisted of two spirals—an external one, fixed, and an internal, movable, with bifilar suspension, which, being both successively traversed by the currents to be measured, produced a deflexion of the movable spiral that was proportional to the square of the strength of the current. The technical difficulties attending the construction of these instruments were very great, and Prof. Bellati had therefore substituted for the inner spiral a bundle of annealed iron wires hanging to a cocoon thread inside the fixed spiral. Seeing the annealed iron wires possessed no residual magnetism, they were at once magnetised by any current and their deviation was likewise proportional to the square of the strength of the current. This dynamometer was highly sensitive with weak currents. An intercalated telephone, the membrane of which was feebly struck, gave deviations of from sixty to eighty parts of the scale—a sensitiveness which till then had been attained by no dynamometer. Dr. Kayser at the same time showed a globular dynamometer, after the design of Fröhlich, in which the inner spiral was coiled up like a ball, and a Siemens torsion dynamometer for strong currents in which the inner spiral was fixed, the outer movable, and the deviation read by a torsion apparatus. In the discussion which followed the speaker stated that the measurements hitherto taken had proved great precision on the part of Prof. Bellati's dynamometer.—Dr. Dieterici reported on the results of an investigation carried out by him in the last session into the electric residuum. The phenomenon had been experimentally examined by Prof. Kohlrausch, and theoretically treated by Riemann; but the formulæ set up by the latter did not correspond with the results of the experiments, and therefore the speaker undertook a new treatment of the subject. The experiments were carried out with a condenser, the lower plate of which was connected with the earth, the upper with a small mercury cup. A metal hoop led from the latter to a second mercury cup which on one side communicated through a metallic wire with one half of a quadrant electrometer, and on the other side through a second hoop with a third mercury cup. The second half of the electrometer and the third mercury cup were in permanent communication with the earth. The two hoops could alternately be raised out of the quicksilver by cords passing over a pulley or let down. If the first hoop were lifted up, the electrometer was conducted to the earth, the upper condenser plate, on the other hand, was isolated, and could now be charged. Thereupon the hoop was let down; the condenser now stood in connection with the earth and discharged itself. Finally, if the second hoop were raised, the condenser was connected with the electrometer, and both isolated. The residuum after the discharge could now be measured. The charge was effected by the highly constant dry Daniell cells (according to Herr v. Beetz), and in the different series of experiments the continuance of the charge was varied between five minutes and twenty-four hours, as the strength of the current was likewise varied. For each duration and strength of charge the residuum was determined in its course in respect of time in a series of individual determinations. The dielectric of the condenser was a paraffin plate and air. The experiments showed that under a charge of short duration—say, five to ten minutes—the residuum rose very rapidly with the time, and soon attained its maximum; so that its curve mounted very steeply and soon ran parallel to the abscissa of the time. Under a charge of long duration, again, the curve rose more slowly indeed; had, however, always greater values, and lay with more flat bend over the curve of short charge. On changing the strength of the current the electric residuum was always in proportion. Dr. Dieterici now treated the theory of the phenomenon, and briefly sketched the course of its theoretic investigation, which, under the assumption that the dielectric was infinitely thick—that is, neglecting the influence of the thickness—led to formulæ which very well explained the experimental results. The formulæ were, however, only empirical: they did not allow the determination of the constants of the phenomenon. In conclusion, the speaker dwelt on the analogy of the electric residuum to the phenomena of heat, which had also under theoretic treatment found its expression by application of heat-formulæ, and to the elastic after-effect which Prof. Kohlrausch had already pointed out.

Rome

Reale Accademia dei Lincei, March 1.—Fossil remains of *Dioplodon* and *Mesoplodon*, found in the Upper Tertiary in Italy.—Signor Capellini made a communication concerning a paper of his, in which he illustrates and describes the fossil remains of Ziphioids with elongated belemnite-shaped beak, found in various places in Italy. These remains belong to the following species:—*Dioplodon longirostris*, *D. gibbus*, *D. tenuirostris*, *D. bononiensis*, *D. medilineatus*, *D. senensis*, *D. laveleyi*, *D. meneghinii*. A few remains are ascribable to the genus *Mesoplodon*. The specimen described by the author add seven species of Ziphioids to the fossil cetaceans found in Italy; four of these being already known in the Upper Tertiary of Belgium and England, while the three others are entirely new. It must be remembered that before 1875 no fossil remains of Ziphioids were known to exist in Italy. From that time till now there have been discovered about ten species, some of the remains belonging to which are of great importance to palæontology and stratigraphical geology.—On the mineral volcanic *ejectamenta* found in the east of the Lake of Bracciano.—Signor Strüver communicated an abstract of a memoir, in which he explains how, after long and fruitless searches, there had been found within the last few years, in the region lying to the east of the Lake of Bracciano, numerous mineral *ejectamenta* similar to the bombs of Monte Somma, and the mineral aggregates of the Monti Albani, of Pitigliano, and of Lake Laach, in Germany. These *ejectamenta* are found between strata of tuff or *lapilli* and fragments of various rocks. Among the numerous minerals composing the aggregates, Prof. Strüver draws special attention to the sarcolite, a mineral hitherto found but rarely, and that only on Monte Somma. The *ejectamenta* in question present, in respect of the extraordinary diversity in their forms, great analogy to the aggregates of a like nature found in the other places mentioned, but nevertheless have a local stamp of their own, and their diversity is in correspondence with the position of the volcanoes from which they were ejected, and the rocks of the regions in which these volcanoes were active. Prof. Strüver draws attention to the fact that these aggregates must at one time have been united together and formed a single deposit, and shows how that excludes the hypotheses that they were formed in the place where they are now found, and that they are derived from deposits anterior to the period of volcanic activity.—On the relations between the maxima and minima of the solar protuberances, and the maxima and minima of the diurnal oscillation of the declination magnet. Prof. Tacchini, after giving an account of his own researches already published, on the maxima and minima of the sunspots and solar protuberances, referred to the observations of Prof. Schiapparelli on the values of the range of diurnal oscillation of the declination needle, and from the comparison of the two sets of observations, it appears that of late years the connection between the solar protuberances and terrestrial magnetism is more strikingly manifest. These and other similar observations, Prof. Tacchini added, corroborate the idea entertained by himself and some others, that electricity plays the chief part in the solar protuberances, and that electricity is able to produce corresponding magnetic disturbances on our globe. It may therefore be inferred with certainty that the phenomena of the sunspots, the solar protuberances, and terrestrial magnetism are closely connected together, and that by means of one of these sets of phenomena it is possible to determine with tolerable precision the epoch of the other two. In dealing, however, with phenomena of rather long period continuous observations for at least half a century are necessary to make our researches complete.—On the spectroscopic observations of the limb of the sun and the solar protuberances made in 1881 and 1884 at the Royal Observatory of the Capitol.—Prof. Respighi laid before the meeting some considerations of his own, based on observations made in his own observatory, and leading him to conclusions different from those of Prof. Tacchini. He maintains that the maximum of solar protuberances occurred towards the end of the third quarter of 1881. Holding that the sun-spots are due to partial cooling of the surface of the sun, and the protuberances to the escape of gases from the interior, Prof. Respighi believes that such perturbations are not of a nature to occur in periods, even though they retain a certain relation among themselves, and still less can he admit any connection between the maxima of the solar protuberances and the elements of terrestrial magnetism.—Meteorological observations made by Signor P. Orlandi, a physician of Rome, during the years 1809–1820. Signor Narducci called attention to a manuscript in the Biblioteca Angelica, containing some interesting medico-meteorological observations made by Signor Orlandi, a medical man belonging to Rome, between the years 1809 and 1820. These observations are copious and complete, having been made daily. They also include notices of movements of the earth's crust and inundations of the Tiber. Signor Narducci mentioned that Dr. Orlandi was a man of science and writer of great renown in his time. Large extracts from the observations of Orlandi are to be published in the *Annals* of the Central Office of Meteorology, and they will thus be able to be compared with those published by distinguished astronomers belonging to the same epoch.—On the last and recent maximum of sun-spots and solar protuberances. Prof. Riccò gave an account of his own observations made at Palermo on the phenomenon of the solar protuberances, which was so important on account of its coincidence in time with very singular manifestations of the solar maculæ. Prof. Riccò deduced from his own observations, harmonising, as they do, with those of Prof. Tacchini, that, starting from the last maximum in the period of eleven years, the number of the protuberances went on increasing till 1881, when a first maximum occurred. It was further verified that the absolute maximum fell between the end of 1803 and the beginning of 1804, and that on that occasion the maximum of protuberances continued beyond that of the sun-spots. Finally, leaving out of account secondary oscillations, Prof. Riccò asserted that a parallelism may be observed between the frequency of sun-spots and protuberances, the principal maxima and minima of both phenomena coinciding with one another.—On the relation between the maxima and minima of the sun-spots and the maxima and minima of the diurnal variations of the declination needle observed at Genoa. Prof. Garibaldi has made a comparison between the normal compensated series of groups of sun-spots observed by Prof. Tacchini during the period 1877–84 and the series of diurnal variations of the declination needle observed at Genoa during the same period. From the mirror-tracings of the author it appears that the two series agree perfectly. Hence, considering that the observation of the sun and its spots depends upon the clearness of the sky, while the magnetic influence of the sun can always act, and observations of magnetic changes can always be easily made, Prof. Garibaldi arrives at the conclusion that the epochs of maxima and minima of the sun-spots may be inferred from the indications of the declination needle when direct observations are not obtainable.—Action of nascent hydrogen on methyl-pyrrol. Drs. Ciamician and Magnaghi having already ascertained by previous researches that *pyrrol* is converted into an alkaloid called *pyrrolin* under the action of nascent hydrogen, communicated a preliminary notice of the experiments commenced by them with the view of increasing the number of bodies belonging to the pyrrolin series, experiments in which they studied the action of nascent hydrogen on other derivatives of pyrrol.—On a method for the electric calibration of a metallic wire. Dr. Ascoli, pointing out that in accurate measurements it cannot be assumed that the length and resistance of a wire stand in a constant relation to one another, described a very simple and easily applied method of his own by means of which a wire can be quickly and perfectly calibrated without the aid of special instruments and without accessory measurements. By the construction of a curve the resistance of the corresponding piece of wire is obtained from the area limited by the curve.—Other communications: Prof. Besso presented a first note on a class of differential linear equations of the fourth order and on the equation of the fifth degree.—Prof. Gomes-Teixeira furnished a paper on the determination of the algebraic part of the integral of rational functions.—Prof. Riccò made a preliminary note on the observations made by him on red glows.—Dr. de Franchis offered various considerations on some relations between the velocities of efflux, the specific heats, and the mean squares of the molecular velocities of gases.

CONTENTS

THURSDAY, JUNE 4, 1885

THE DEINOCERATA OF WYOMING

Dinocerata, a Monograph of an Extinct Order of Gigantic Mammals. By O. C. Marsh. Monographs of the U.S. Geological Survey. Vol. X. (1884.)

ON the high plateau that lies to the west of the Rocky Mountains, along the southern borders of Wyoming Territory, the traveller who is moving westwards begins to enter upon a peculiar scenery. Bare, treeless wastes of naked stone, crumbling into sand and dust, arise here and there into terraced ledges and strange tower-like prominences, and sink into hollows where the water gathers in salt or bitter pools. Under the cloudless sky, and in the dry clear atmosphere, the extraordinary colouring of these landscapes forms, perhaps, their weirdest feature. Bars of deep red alternate with strips of orange, now deepening into sombre browns, now blazing out again into flaming vermilion, with belts of lilac, buff, pale green, and white. And everywhere the colours run in almost horizontal bands, the same band being continuous and traceable from hill to hill, and tower to tower, across hollow and river-gorge for mile after mile through this rocky desert. These parallel strips of colour mark the nearly horizontal stratification of the rocks that cover all this wide plateau country. They are the tints characteristic of an enormous accumulation of sedimentary rocks that mark the site of a vast Eocene lake or succession of lakes on what is now nearly the crest of the continent. These lacustrine sediments, in all somewhere about two miles in vertical thickness, were doubtless laid down during a slow subsidence of the lacustrine area, when the subterranean movements were in progress that finally gave the mountain-ranges and plateaux their present forms and altitudes. They represent a vastly protracted period of quiet sedimentation, in the immediate proximity of an extensive land-surface plentifully clothed with a tropical vegetation, and abounding in varied forms of animal life. They consequently offer to the geologist peculiar facilities for investigating the evolution of a fauna apparently exposed to the minimum of interference from changes in its environment.

It is now about fifteen years since the wonders sealed up within the sediments of these vanished lakes first began to be known. The wandering Indian, indeed, had long been familiar with the skulls and skeletons which, by the decay of the inclosing rock, looked out upon him from the side of *butte* and *cañon*. But he revered them as the bones of his ancestors, and left them untouched, to be disinterred by the ceaseless working of wind and rain. The earliest trappers, squatters, and prospectors brought back news of marvellous monsters grinning from the ledges of rock beneath which they camped. At last these tales attracted the notice of some of the enthusiastic naturalists in the eastern States. Prof. Leidy, of Philadelphia, obtained a number of bones from which he was able to bring to light an entirely novel, and now wholly extinct creature, to which he gave the name of *Uintatherium*. Prof. E. W. Cope likewise described some forms disinterred by him in the same region. But the earliest and most successful investigator of these remains is Prof. O. C. Marsh, who, as far back as 1870, began the search in the Green River basin, and who, after many years of most laborious research, both among the western deserts and in his wonderful collection at Yale College, has at last been able to publish this splendid monograph on the Deinocerata. No trouble or expense has been spared to obtain material for the study of these strange extinct creatures. One expedition after another has been despatched to the West, and many tons of bones have been deposited at Yale, where it is believed there are now represented more than two hundred individuals of the Deinocerata alone. Some of these remains are admirably preserved; indeed, had the animals been still living, the materials for a knowledge of their osteology could hardly have been more perfect than it is.

The Deinocerata form an order established by Prof. Marsh to include some peculiar and well-marked forms found in the lacustrine deposits of the Green River basin—a tributary of the Colorado River of the West. This order belongs to the Ungulates, some of the characters allying it with the Artiodactyls (*Paraxonia*), others with the Perissodactyls (*Mesaxonia*); while in others, again, it is linked with the Proboscidians. The points of resemblance, however, are usually, in the author's opinion, such general characters as seem to point backward to some ancestral ungulate, rather than to any near affinity with existing forms of these groups. The Deinocerata include three genera which occupy three successive stratigraphical horizons. The oldest, Uintatherium, found in the lower strata of the Eocene lake, appears to be the most primitive type; the youngest, *Tinoceras*, found at the highest level, is the most specialised; *Dinoceras* being an intermediate form. The number of species belonging to the order has not been satisfactorily determined, but about thirty forms more or less distinct have been recognised.

Comparing *Dinoceras* with the large living Ungulates, Prof. Marsh points out that in size and proportions it was intermediate between the elephant and rhinoceros, but had also features akin to those of the hippopotamus, while in its stature and movements it probably resembled the elephant as much as any existing animal. It presented certain striking peculiarities which at once marked it off from any form now familiar to us. The skull in particular wore an altogether extraordinary aspect. It was long and narrow, and on its top it supported three separate transverse pairs of high osseous protuberances or horn-cores, which may have been covered with bosses of thick skin, and were no doubt powerful offensive weapons. The canine teeth were enormously developed in the male, forming short, trenchant, decurved tusks, which were protected by a dependent process on the lower jaw. The nasal bones were so elongated as to form nearly half the length of the entire skull, projecting forward and overhanging the premaxillaries. There was probably no proboscis, for the neck was long enough to allow the head to reach the ground without it, but there is some evidence of a thick flexible lip, perhaps like that of the rhinoceros. The brain was proportionately smaller than in any other known mammal, recent or fossil, and even less than in some reptiles. In one species at least it was so diminutive that it apparently could have been drawn through the neural canal of all the pre-sacral vertebræ, certainly through the cervicals and lumbars. The limbs were massive and heavy, the bones, like those of the rest of the skeleton, being nearly or quite solid. The fore-foot was larger than the hind-foot, its component bones being comparatively short and massive, with five well-developed digits, as in Proboscidians, but the carpal bones interlocked with the metacarpals as in Perissodactyls. The feet, as in the modern elephant, were plantigrade, and were doubtless covered below with a thick pad.

We can picture these dull, heavy, slow-moving creatures haunting the forests and palm-jungles around the margin of a great lake. Into the quiet depths of that lake their carcases from time to time found their way, swept down perhaps by river-floods. Among their contemporaries were other forms whose remains have also been more or less abundantly preserved in the same deposits. Of these, two genera next in size to the Dinocerata were Perissodactyl ungulates somewhat larger than a tapir (*Palæosyops* and *Limnohyus*). Another interesting form is *Orohippus* —a four-toed ancestor of the living horse, while additional varieties of the ungulate type were related, though distantly, to the tapir and rhinoceros (*Colonoceras*, *Helaletes*, *Hyrachyus*). Two remarkable genera (*Tillotherium*, *Stylinodon*), nearly as large as a tapir, possessed characters resembling those of the ungulates, carnivores, and rodents, and have been embraced by the author in a new order called by him *Tillodontia*. Among the carnivores there was one (*Limnofelis*) nearly as large as a lion, and another hardly less in size (*Oreocyon*), while *Dromocyon* was somewhat smaller and *Limnocyon* about as large as a fox. There were likewise lemurs having some affinities with South American marmosets; also representatives of the Marsupials, Insectivora, Chiroptera, and Rodentia, but no true Quadrumana or Edentates. Reptiles abounded, especially crocodiles, turtles, lizards, and serpents, while fishes of many kinds swam in the lake.

The structure and history of the Deinocerata with their place and affinities in the animal kingdom are fully discussed in this important monograph. Like his previous work on toothed birds in the same series of memoirs, Prof. Marsh's present volume is an admirably executed and exhaustive research. Every bone is carefully worked out and drawn. Every available fragment of evidence is patiently collected, compared, and tabulated. Whatever may be disputable regarding the conclusions drawn, there can be no variety of opinion as to the actual data. No fewer than fifty-six lithographic plates, and nearly 200 woodcuts depict with singular fidelity every part of the skeleton of the Deinocerata as at present known.

But Prof. Marsh is much more than a comparative anatomist. It is not enough for him to describe the bones he has unearthed, and to point out their analogies in the living world. He is instinctively an evolutionist, and every extinct animal seems to propound to him the problem of its ancestry and its descendants. One of the most suggestive chapters in his present memoir is devoted to the genealogy of ungulate animals, and the place of the Deinocerata among them. He believes that from some primitive form, of generalised type, probably small in size, resembling generally an insectivore, and going back at least as far as Permian time, all the mammalian tribes have descended. Such a genealogical mammal, belonging to Prof. Huxley's group of *Hypotheria*, would possess all the general characters of the subsequently developed mammalian orders. But special characters, acquired in adaptation to conditions of environment, would be developed in the course of time, and would lead to the establishment of different modified types. The general characters would thus alone be a safe guide in tracing a community of ancestry, while those of a special kind need not necessarily indicate affinity, but may have independently arisen from the influence of the same surroundings in groups already quite distinct from each other. In the Cretaceous system, a well-marked group of mammals is found which is represented now by the living Hyrax, along what appears to have been the main stem of ungulate descent. From this stem, after the remarkable waning of reptilian life at the close of the Mesozoic ages, there diverged, in Cretaceous times, a branch which terminated in *Coryphodon*—a tapir-like form which, both in America and in Europe, probably quite equalled if it did not surpass in size and power any of the representatives of the fading reptilian types of an older creation. Another branch which may have been given off about the same time reached its full development in the Deinocerata, which were certainly the monarchs of the region where they lived. But nothing is more striking in the history of these and the other colossal mammals than the rapidity with which they appear and disappear from the scene. *Dinoceras* and its allies, so far as the evidence yet goes, appear to have been restricted to the middle part of the Eocene period. Their remains are not found in the earlier deposits of that period, and cease to occur before we reach the upper parts of the series. The cause of this speedy extinction is to be sought, according to Prof. Marsh, in the small brain of the animals, their highly specialised characters, and huge bulk, whereby they were unfitted for adapting themselves with sufficient rapidity to new conditions; and a change of surroundings brought about their extinction. But this is a point on which the geologist may not unnaturally claim to be heard when he demands some evidence of such change of surroundings. Had the supposed geological vicissitudes been sufficiently serious to cause the extinction of a whole tribe or sub-order of large mammals, they might have been expected to have left some palpable evidence of their passage in a corresponding change in the nature of the deposits accumulated in the lakes. But there is certainly nothing in the nature or succession of these deposits to suggest that any important modifications of topography or climate took place during the time when they were being deposited. On the contrary, they seem to point to protracted uniformity in the conditions of sedimentation. They afford no indication whatever that the successive appearance of *Coryphodon*, *Dinoceras*, and *Diplacodon* was accompanied, far less was determined by, any essential change of physical conditions. That such change actually took place is of course quite conceivable, but when it is demanded as an essential factor in mammalian evolution, some admissible proof may very fairly be demanded.

Like Prof. Marsh's previous memoir on "Odontornithes," the present volume may be regarded as a model monograph. It is complete without being overloaded, exhaustive and yet lucid and interesting from beginning to end. After reading it one feels that the Deinocerata are no longer extinct, vanished forms, but familiar acquaintances which one could not fail to recognise anywhere. Every part of their structure is methodically presented to view, and restorations are given showing the relations of the parts to each other and what is the author's conception of the general form of the animals. It has hardly ever been possible in the Old World to reconstruct the mammalia of so early a period from such ample materials as are now amassed at Yale College. Hence the restorations attempted have often been little more than more or less probable conjectures which might be conformed but were more usually corrected or even effaced by the progress of discovery. So full, however, is the evidence for Prof. Marsh's restorations, that there remains very little room for future emendation. He is still engaged in continuing these remarkable memoirs on the ancient life of the North American continent. A third monograph on the *Sauropoda* is approaching completion, and a fourth, on the *Stegosauria*, is far advanced. These large and profusely illustrated works are issued as part of the work of the United States Geological Survey. They reflect the highest honour on their indefatigable author, and on the Survey which undertakes their publication.

ARCH. GEIKIE

REMSEN'S "ORGANIC CHEMISTRY"

An Introduction to the Study of the Compounds of Carbon; or, Organic Chemistry. By Ira Remsen, Professor of Chemistry in the Johns Hopkins University. Pp. x., 364. (Boston: Ginn, Heath, and Co., 1885.)

THIS is chemistry. Of how few books professing to be books on chemistry can it be said that they teach us anything of the science. The student who begins the study of the carbon compounds has to suffer many things from the text-books. Some of them present him with dry bones in the shape of isolated facts and bold assertions regarding structural formulæ and the linking of atoms. Others lead him into speculations which he is unprepared to follow; he makes little flights into these and comes back fancying he is a chemist. Other books (there are not many of them) proceed on the true scientific lines; but very frequently their pages are encumbered with too many facts about more or less widely separated compounds, or they deal so much with groups of compounds, rather than with typical individual bodies, that the beginner soon loses his way, becomes perplexed, and is ready to abandon the pursuit.

Prof. Remsen has shown us a more excellent way than any of these. He leads the learner by degrees through the early difficulties; he places before him distinct and detailed accounts of a few typical compounds; he shows him how these compounds are mutually related; and then he takes him back to the beginning again and teaches him how each compound he has learned to know represents a group, and how, when he knows the properties of one member of the group he also knows much about all the members.

At the outset Prof. Remsen makes a few wise and pregnant remarks on the meaning of structural formulæ. These "enable the chemist who *understands* the language in which they are written to see relations which might easily escape his attention without their aid. In order to *understand* them, however, the student must have a knowledge of the reactions upon which they are based; and he is warned not to accept any chemical formula unless he can see the reasons for accepting it." The whole book is a practical sermon on this text.

In no other elementary book in the English language will the student find so many admirably chosen examples of the formation of structural formulæ. The important facts are noted; then the inference is drawn; then the hypothesis is ventured upon; analogous facts are recalled; the hypothesis is strengthened or weakened; suggestions are made; experiments are conducted; and all is finally summarised in the formula. But the book i more than a selection of examples showing ho.. ..ructural formulæ ought to be gained. It is a systematic although elementary treatise on organic chemistry. The student is first taught about the two paraffins, methane and ethane; then he learns how the halogen derivatives of these are prepared, and what relations they bear to the parent hydrocarbons. By this time he has had his first taste of isomerism. Then he proceeds to the oxygen derivatives of methane and ethane; he learns what an alcohol is; he becomes acquainted with ether, aldehyde, formic and acetic acids, some ethereal salts, and acetone. This method of studying a few simple compounds in detail is pursued until the student is more or less familiar with representatives of all the principal groups of compounds derived from the paraffins. He is now in a position to study these hydrocarbons as a group, and to deal in some detail with the questions of isomerism. When the paraffins and their derivatives have been thus studied, the more difficult subject of the benzenes and their compounds is approached. And here the author shows an admirable power of dealing with facts as facts, and with theories as theories. What could be better than the following remarks regarding saturated and unsaturated compounds?

"In the aldehydes and ketones, carbon is in combination with oxygen in the carbonyl condition. When they unite with hydrogen and some compounds, such as hydrocyanic acid, the relation between the carbon and oxygen is probably changed, the latter being in the hydroxyl condition. The changes are usually represented by formulas such as the following:—

$$CH_3.C\begin{cases}O\\H\end{cases} + H_2 = CH_3.C\begin{cases}OH\\H_2\end{cases},$$

$$\begin{matrix}H_3C\\H_3C\end{matrix}\!\!>C = O + HCN = \begin{matrix}H_3C\\H_3C\end{matrix}\!\!>C\!<\!\begin{matrix}CN\\OH\end{matrix}.$$

In the carbonyl group the oxygen is represented as held by two bonds to the carbon atom, while in the hydroxyl condition it is represented as held by one bond. The signs may be used if care is taken to avoid a too literal interpretation of them. There are undoubtedly two relations which carbon and oxygen bear to each other in carbon compounds. These relations may be called *the hydroxyl relation*, represented by the sign C—O—, and *the carbonyl relation*, represented by the sign C=O" (pp. 209-10).

How different this is to the crude, glaring statements that annoy the reader of the commonplace text-book written by the Philistine.

The fact that structural formulæ help us to understand the relations existing between the parts of specified molecules is strongly insisted on throughout this book. When we know nothing of these relations the author does not hesitate to tell us so. Thus, regarding the formula of benzene, as commonly written with successive double and single bonds, he says (p. 239):—"This formula, however, expresses something about which we know nothing, and concerning which it is difficult at present to form any conception. The simpler formula [*i.e.* the hexagon without any double bonds] leaves the question as to the relation between the carbon atoms entirely open, as it is in fact." And again, speaking of the structure of the molecule of ethylene, Prof. Remsen remarks (p. 213):—"As regards the relations between the two carbon atoms of ethylene we know nothing, save that it is probably different from that which exists between the carbon atoms of et[illegible]."

A most instructive example of the methods pursued in organic chemistry, and at the same time of the scientific method of inquiry, is to be found on pp. 318-321, where the reactions of phenol-phthaleïn are discussed. The facts are given, but they seem only facts until some light is shed on them by the appearance in one reaction of triphenylmethane, a substance already familiar to the student. The student is shown how "this suggests that all the substances [he has been examining] are derivatives of this fundamental hydrocarbon." And he is asked to note how easily, when this conception has once been formed, the interpretation of all the reactions follows.

Many other admirable illustrations of the scientific method of inquiry are to be found throughout the book. I would especially draw attention to the simple but thoroughgoing treatment of the "equivalency of the hydrogen atoms" in the molecule CH_4 (pp. 28-29), and in the molecule C_6H_6 (pp. 234-236). It is on subjects such as are discussed in the pages referred to that the chemical student so frequently suffers shipwreck. If he will use this little book by Prof. Remsen as his pilot, and will keep a good look out as he proceeds, he may hope to pass the shoals of the hexagon-formula, and the shallows of the ortho-, meta-, and para-derivatives of benzene.

The author of this book deserves the thanks of all chemical teachers who have tried to teach organic chemistry to beginners for the clear and short directions which he gives for preparing the more important compounds of carbon. The book may well be used as a laboratory guide, no less than as an introduction to the science of organic chemistry.

Prof. Remsen has already done good service to the science of which he is a student, by publishing his "Principles of Theoretical Chemistry;" he has now given us a book which must be of great use in advancing the study of organic chemistry; could he not supplement these by an elementary but scientific treatise on inorganic chemistry?

M. M. PATTISON MUIR

MINERALOGY IN CALIFORNIA

Fourth Annual Report of the State Mineralogist of California. By H. G. Hanks. 8vo, pp. 410. (Sacramento: State Printer.)

ALTHOUGH a systematic geological investigation of the State of California has been commenced at different times since 1853, the Legislature has generally got tired of providing the funds after a few years' continuance, and the work has been stopped. The most notable effort towards the provision of a complete geological description of the State was that made by Prof. J. D. Whitney, who, with a body of assistants, including men of the highest attainments in every collateral branch of natural science, carried on the survey from 1860 to 1873, when it was suddenly discontinued, to the great regret of scientific men both in America and Europe. No attempt to continue or supplement Prof. Whitney's work was made until 1880, when the author was appointed State mineralogist with the object of investigating questions more particularly connected with mining industry than with geology in the larger sense. The author during his period of office, which appears to be terminable and held for four years only, has founded a valuable mineral museum and library, more than 6000 specimens illustrative of the mineral deposits of the State having been collected and arranged. These do not, however, appear to be very sumptuously housed, as the author calls attention to the danger from fire, "as well as other inconveniences, such as the prevalence of ammoniacal and hippuric odours, and the disturbance of arranged specimens in the cases by the jarring made by the hoisting of hay by tackles attached to the underside of the museum floor. The California State Museum is well worthy of a good and thoroughly fireproof building." With the latter opinion our readers will no doubt heartily agree.

Besides the work of organising the museum the author has published annually a report upon some branch of mineral industry as carried out in the State—for instance, that for 1883 was largely devoted to the borax deposits of the mud lakes in the interior of the State. The present volume, described as the fourth and last report of the State mineralogist, is mainly devoted to a catalogue and description of the minerals of California as far as they are yet known. This is alphabetically arranged, and contains descriptions of the composition physical properties and uses of the different species, together with detailed information as to localities, and methods of working in the more important ones. Altogether 161 different species are described as having been found in California, but this number will no doubt be considerably increased by future explorers. At the present time, in addition to gold; mercury, petroleum, and borax are the chief products of importance, although as regards all of them the prevailing complaints of over-production and unremunerative prices appear to be as prevalent as in less favoured localities in the Old World. The condition of the gold-mining industry appears to be a very healthy one, for although the enormous annual yield, ranging from 10 to 13 millions sterling in 1850-55, has diminished to 3 and 4½ millions in the past four years; the increased facilities for working render it possible to handle at a profit rock not containing more than 12*s.* worth of gold in the ton; while in the earlier days 20 dollar (80*s.*) rock was not considered to be worth removal. The total value of the gold raised in California since 1848 is estimated at above 230,000,000*l.* in value, which if reduced to a single mass would be contained in a cube 14 feet 4 inches in the side.

Although the work is essentially a compilation, it is well arranged, and will be of great use to those interested in Californian minerals. A general introduction on the resources and industries of the State precedes the catalogue of minerals. This, though interesting matter, seems rather out of place. H. B.

ALGÆ

Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz. Zweiter Band. Die Meeresalgen. Bearbeitet von Dr. F. Hauck. Nos. 7, 8, 9, 10. 8vo. (Leipzig: Ed. Kummer, 1883-1885.)

A Monograph of the Algæ of the Firth of Forth. By George William Traill. 4to. (Edinburgh: Printed for the Author, 1855.)

Notes on Marine Algæ. By Edw. Batters, F.L.S. (*Proceedings* of the Berwickshire Naturalist Club, 1884.)

THE concluding numbers of Dr. Hauck's work have recently appeared. To the description of species is added an appendix in which some new species are described. Then follow a comprehensive key to the genera; an index of families, genera, species, and synonyms; lists of illustrations, and of works on algæ, arranged alphabetically, according to the names of the authors; also the title-page, preface, and table of contents—all most useful auxiliaries to a scientific work.

To the favourable opinion of this work, already expressed in the columns of NATURE (vol. xxix. p. 341), it may be added that the later numbers, treating of the Chlorozoosporeæ and the Schizophyceæ, fully justify this opinion, and Dr. Hauck must be congratulated on the successful completion of what has undoubtedly been an arduous undertaking.

In turning over the pages of the work, one cannot but be struck by the variety of views which, in spite of the closest examination by competent observers with the aid of the best microscopes, still prevail among algologists as to the systematic position of certain algæ.

Not to multiply instances, it will be sufficient to mention the genera Porphyra and Bangia. By Dr. Berthold and Dr. Hauck they are classed with the Florideæ; while Dr. Agardh and M. Rosanoff place them among the Ulvaceæ. As to Goniotrichum, which Dr. Agardh relegates to the Ulvaceæ and Dr. Berthold includes in the Bangiaceæ, Dr. Hauck, in despair of discovering its affinities, places it at the end of the description of species, as of still doubtful position.

Although it may be doubted whether all Dr. Hauck's identifications of British Algæ will be admitted by our botanists, yet the work cannot fail to prove extremely useful in this country, and is, in fact, much needed.

Mr. Traill's work, entitled "A Monograph of the Algæ of the Firth of Forth," consists of an alphabetical list of the marine Algæ of this locality, with their habitats, time of appearance and of fruiting, and the names of the host-plants on which grow such species as are epiphitic. Each copy of the work is intended to be illustrated with some half-dozen herbarium specimens of the rarer Algæ. Those in the copy before the writer are in excellent condition, and are interesting from their rarity.

That Mr. Traill is a most patient and painstaking observer goes without saying. An analysis of the list will show how many species he has collected and observed, which are new, not only to the Firth of Forth, but to the British marine flora. He has watched the growth and development of these plants from their first appearance until their maturity. Among them will be found several Algæ which, though frequent in the south, have not previously been seen so far north; and he has also met with some arctic and northern species which are not only new to the British marine flora, but are not described in Dr. Hauck's work.

Among these northern species may be mentioned *Phlœospora tortilis*, which has a range in this country, so far as is known at present, from the Firth of Forth to Bamborough. While this plant is so abundant in the Baltic as to cause much inconvenience to fishermen by getting entangled in their nets, its existence is not recorded on the German shore of the North Sea. *Urospora penicilliformis*, one of the Algæ found by Dr. Kjellman on the coast of Spitzbergen, is another of Mr. Traill's "finds."

It will be observed that he mentions having obtained the cystocarps of *Rhodymenia palmata*. If he has really met with the true crystocarps of this plant he is fortunate, since Dr. Agardh, Dr. Harvey, Dr. Hauck, and other botanists have hitherto searched for them in vain. Harvey has shown ("Phyc. Brit.," Pl. 217) that bodies outwardly resembling cystocarps are common enough; probably these are what Mr. Traill has found. They are not, however, true cystocarps.

The establishment of the Biological Station at Granton, near Edinburgh, will certainly give a fresh impetus to the study of marine botany in that locality; and there is no doubt that Mr. Traill's work will be found extremely serviceable to local collectors of Algæ.

The *Proceedings* of the Berwickshire Naturalist Club for 1884 contain notes by Mr. Edward Batters on seventeen species of rare and little known Algæ found by him at Berwick-upon-Tweed. A short and clear description is given of each species, and the rarer kinds are illustrated by lithographic plates.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Ocular After-Images and Lightning

IT will no doubt be of interest to many of your readers to know that the curious optical phenomenon observed by Prof. C. A. Young, when working with a large Holtz machine, and referred to in Mr. Newall's letter (NATURE, vol. xxxii. p. 77), may be produced with very small apparatus.

I have in my possession one of the small Voss machines with 10-inch plates which are now so common. Upon the stand of this instrument I placed two ordinary Leyden jars, about 5½ inches high, in such a position that their tinfoil-covered bottoms touched the brass sockets in which rest the fixed condensers of the machine, while the rods connected with their inner coatings were in contact with the sliding electrodes; with this arrangement sparks of great brilliancy from 1½ to 2 inches in length could easily be produced at the rate of about six per minute. A copy of NATURE was set up against a dark background 4 feet distant from the machine, and at every discharge the paper appeared to be illuminated by two, or sometimes three, distinct flashes of decreasing brightness, which succeeded one another with great rapidity. Each flash was sufficiently powerful to enable the pictures on the cover to be clearly seen. By throwing the light upon a quickly rotating disk of zinc with a strip of white paper pasted across it, I convinced myself that the phenomenon was a subjective one: the successive images of the white strip always occurred in exactly the same position.

I think these experiments go far towards explaining a matter which must have occurred as a difficulty to many besides myself. Why is it that the illumination produced by a brilliant flash of lightning invariably appears to be of a quivering or intermittent character? We know that the actual duration of a single discharge is sensibly infinitesimal, and both reasoning and laboratory experiments would lead us to believe that a rapid series of discharges between two insulated bodies must at all events be of infrequent occurrence, and due to exceptional circumstances. Yet the quiver of the lightning-flash is proverbial. It would be interesting to ascertain by means of a revolving disk with a single white band across it, whether this is not in most cases a purely subjective phenomenon, due to a succession of after-images. SHELFORD BIDWELL

Wandsworth, June 1

Iridescent Crystals of Potassium Chlorate

WITH regard to the above crystals, described by Prof. Stokes in NATURE (April 16, p. 565), I should like to suggest, with some diffidence, that the colours may be due, not to a continuous hemitropic crystal-film, but to a series of fine tubular cavities ranged parallel to each other between the two main portions of the crystal, such as not unfrequently occur on a large scale in Iceland spar, and appear to be due to bad fitting (so to speak) of hemitrope-films on the rest of the crystal (see Groth's "Physikalische Krystallographie," p. 441).

The surfaces of these prismatic cavities, which may be of almost wave-length fineness, would form a series of furrows from which light would be reflected under the same conditions as from grooved surfaces like those of mother-of-pearl; and, according to the usual laws of interference, we should expect such phenomena to occur as are described by Prof. Stokes: *e.g.*, non-polarisation of the light, predominance of rays of a particular refrangibility in the reflected beam, and total disappearance of this beam at two azimuths differing by 180°, when the length-dimension of the tubes lies parallel to the plane of incidence.

I may mention that plates of opal—at any rate those portions which give a uniform colour—afford spectra extremely similar in character to those of the iridescent crystals: definite bright bands in the reflected light, and dark complementary bands in the transmitted light, changing their position in the spectrum with change of incidence. Now the iridescence of opal is pretty well known to be due to the reflection of light from the surfaces of rows of filaments imbedded in the mass (see Sir David Brewster's paper in *Brit. Ass. Reports*, 1844, part 2, p. 9).

The above hypothesis would also account for Prof. Stokes's observation that the iridescent crystals were best formed when the solution was gently stirred; the molecules then, like a harassed army, being too much disturbed to "fall in" as they should do.

I cannot say that I have yet succeeded in actually bringing out such rows of tubes under the microscope. It is easy to see with a $\frac{1}{4}$-inch power, when the illuminating beam is properly adjusted, a sort of wavy structure at the twin-film (like that seen in opal under the same conditions); but I have not yet made out such definite rows of cavities as would seem to be required to produce the singularly uniform sheet of colour. They may be beyond the power of a microscope altogether.

Eton College H. G. MADAN

P.S.—Since I wrote the above, Prof. Stokes has very kindly pointed out that opal spectra are fully described by Mr. Crookes in *Proc. Roy. Soc.*, xvii. 448. One opal micro-section which I have gives a spectrum almost exactly like No. 12 in that paper, but the band is slightly less refrangible than the D line at an incidence of 20°.

Pre-Existence and Post-Existence of Thought

To express any views on these subjects one might well have hesitated some years ago, as hereditary transmission, tolerated as a doctrine, chiefly with regard to the breeding of sheep and dogs, was held to be unphilosophical. Darwin has settled the matter in the domain of science, but perhaps without altogether disposing of prejudices. Mr. Galton and myself have long since dealt with less material aspects of heredity.

What I want to bring on the scene of consideration is the common notion of throwing the great-grandsire. Few now are inclined to doubt about this.

Throwing the grandsire in the case of man may be taken to represent a period of a hundred years of transmission until birth for three generations, and consequently such period of the pre-existence of a thought or habit, which is in one's self, and of which there may be an actual register. It is better to select the example of a man, and of a great-grandsire, rather than of a father, because it carries with it a period of remoteness.

Taking then a period of a century for pre-existence in the past, there comes the consideration of vitality of occurrence in the future, as we know of it from the past. Taking a generation for the birth of offspring, and adding to it three generations for a great-grandchild, we have, say, one hundred and fifty years. Adding together the two periods, we obtain an epoch of transmission in pre-existence and of possible existence of two hundred and fifty years.

One such epoch antecedently and another subsequently may be counted in round numbers five hundred years, and we shall see our way to a thousand.

Perhaps after all we know less in detail of the transmission of osseous peculiarities than we assume. There are the means in some cases of examining bony structures of epochs and intervals of 1,000, 2,000, 5,000, 10,000 and more years, and we can trace forms of development. What we further want is the power of witnessing the successive individual variations, which is attended with diversity from other beings, and constitutes identity. Though identity may to some extent repose in the process of a bone, in the way in which a vein or sinew has traversed, we have evidence of this rather collectively in a species or a variety, than in the mode in which it periodically or irregularly influences a series of individuals.

The transmission of physical peculiarities in the soft tissues is equally permanent, and can be better traced in the individual. There are good examples of it in well-known cases of family features, and of racial types.

We are now familiar with cases of the hereditary transmission of mental qualities, as in that of the Bernouilli family, though perhaps one of the most remarkable instances is that of the Ottoman dynasty, members of which for several hundred years have displayed capacity, and yet here we have only the male elements of transmission, as in the marriages there has been a great mixture of races. It may, however, be that the Turk, the so-called Circassian (sometimes a Daghestani), and the Georgian are more nearly allied than we have been disposed to consider.

The problem now before us may be treated, irrespective of what laws there may be of male or female transmission, as in breeding, the qualities of an ancestor on either side and of either sex may be reproduced, and it is this reproduction and transmission of mental qualities which is to be considered. The mental qualities must be distinguished from the osseous structure or the soft tissues in degree. There is a vast difference in extent, and probably in distinction, between the transmission of some feature and that of conscious or unconscious thought or even of a dream.

My own term of "unconscious thought" I prefer to "unconscious cerebration," because the main distinction between conscious and unconscious thought is chiefly, if not wholly, dependent on the quality of consciousness. One reason for retaining it here is with reference to dreams. Whatever may be the operation of recording other thoughts, dreams are certainly preserved during life as effectually as any kind of thought, although no organ of seeing or hearing is concerned.

If it is remarkable that purely physical properties should be preserved in the germ of a minute animal, it is much more so that any process allied to the operations of thought should be preserved—the influence of events, the influence of dreams, used age after age to constitute the mind of this day. It will be perceived that I am speaking very loosely and vaguely, to some extent of set purpose, to bring under consideration a general question of long time in the transmission of a mental process, whether connected with what is called instinct or unconscious thought, and without limiting the discussion more than is necessary with postulates or set definitions.

HYDE CLARKE

32, St. George's Square, S.W., May 23

Long Sight

I WAS at school at Rossall, between Fleetwood and Blackpool, on the coast of Lancashire. One day, being on the sea-wall with Arthur A. Dawson, an Irish boy, we could see the Isle of Man as if it were ten miles away, and then to the south of the Calf of Man we could distinctly see on the horizon the summits of two mountains, which we pronounced must be in Ireland. Four years later I was staying at Blackpool with my mother, when we distinctly saw the same blue mountains just appearing above the sea. Being in the Isle of Man later on, I was at Port Erie, to the west of Castletown, and saw the same summits, and was told they were the mountains of Mourne. From there the mountains stood well out of the water, though we could not see the rest of the coast. The Mourne Mountains are 2798 feet high. They are 125 miles from Blackpool.

A. SHAW PAGE

Selsby Vicarage, Gloucestershire, May 28

Museums

THE interest which the readers of NATURE in this country and in America take in the promotion of museums has induced so many of them to inquire of me for a paper recently noticed by yourself that, to spare their time and my own, I shall be glad if you will enable me to refer inquirers to your advertising columns.

THE AUTHOR OF "MUSEUMS OF NATURAL HISTORY"

A NEW EXAMPLE OF THE USE OF THE INFINITE AND IMAGINARY IN THE SERVICE OF THE FINITE AND REAL

GEOMETERS are wont to speak (it seems to me) somewhat laxly of "the line at infinity" as if there were only one such line in a plane; in a certain but not in the most obvious sense this is true—viz. there is but one right line of which all the points are at an infinite distance from all lines external to them in the finite region of the plane, and except these points there are none others having this property; but in the sense that there is but one line infinitely distant from all points external to it in the finite region, the statement is obviously erroneous, for it need only to be mentioned to be at once perceived to be true by any tyro in geometry that all rays passing through either of the two "circular points at infinity" (Cayley's absolute) are infinitely distant from any external point in the finite region; these two imaginary points may indeed without any reference to the circle be *defined* as the points which radiate out in all directions rays infinitely distant from the finite region; the "absolute" being, so to say, the common depository, *i.e.* the crossing points of all infinitely distant rays as the "line at infinity" is the locus of all infinitely distant points. Similarly in space: there is not one infinitely distant plane, "the plane at infinity," but an infinitely infinite number of such planes—viz. any plane touching "the circle at infinity" (an imaginary circle in the plane at infinity) will at once be recognised to be infinitely distant from any external point in the finite region, or, as we may say more briefly and picturesquely, infinitely distant from the finite region itself. It will give greater vivacity to this conception to imagine an axis through which pass planes in all directions, and to travel in idea this axis round "the circle at infinity" keeping it always tangential thereto; the complex or corolla of planes, so to say, thus formed (infinitely infinite in number) contains only planes of infinite distance from the finite region; and "the plane at infinity" is but one of them—viz. the one which passes through all the axes named, just as the line at infinity in a plane is the line which passes through both the centres of infinite distance. The infinitely infinite series of infinitely distant planes is of course the correlative of the infinitely infinite series of infinitely distant points whose locus is the so-called "plane at infinity."

The above statements have only to be made, to be accepted by the geometer, although I do not remember seeing them* anywhere explicitly given; but what I want to show is that, although supersensuous abstractions, so far from being barren they are capable of immediate application to the world of reality, and afford an instantaneous answer to a very simple practical question which has only just lately been mooted. The question is this: Suppose $abcd$ to be a given pyramid, and that perpendiculars are drawn from its four vertices, say A, B, C, D, to a variable plane, then it is easy to show that a certain homogeneous quadratic function of A, B, C, D depending on the form of the pyramid or relative lengths of its edges must be constant, and the question arises, What is this constant quadratic function, this quadric in A, B, C, D, expressed in terms of the edges of the pyramid exclusively?† Just so if we take a triangle, abc, in a plane there will be a constant quadratic homogeneous function of the distances of its three vertices from a variable line; and it is well known in this case that if A, B, C are the distances the constant quadratic function in question will be—

$$(ab)^2(A-C)(B-C)+(bc)^2(B-A)(C-A)+(ca)^2(C-B)(AB).$$

But if we had not known this fact it could have been found as follows:—Calling the above function F, when A, B, C all or two of them become infinite the relation between the ratios of $A:B:C$ will be such as would arise from making $F=0$; on no other supposition will this be the case.

Now, if we use trilinear co-ordinates with abc as the triangle of reference, and take as the co-ordinates of any variable point P, the areas aPb, bPc, cPa instead of the simple distances of P from ab, bc, ca, then every body knows that the line at infinity has for its equation—

$$(1)\quad x+y+z=0,$$

and will easily see that the circle circumscribing abc has for its equation—

$$(2)\quad (ab)^2xy+(bc)^2(yz)+(ca)^2xz=0.$$

Moreover, when such co-ordinates are employed the distances of any line $Ax+By+Cz=0$ (3) from the three vertices are A, B, C each multiplied by the *same* known quantity.

If then A, B, C become infinite this line must pass through one of the intersections of the line at infinity with the circle, or, in other words, the equations (1), (3), (2) must be capable of being satisfied simultaneously, and accordingly by a well-known algebraical law it follows that the determinant to (2) *bordered* by the coefficients of (1) and (3) must vanish. Consequently this determinant so bordered will represent the sought-for form F, *i.e.* the constant quadratic function will be represented by—

$$\begin{matrix} \bullet & A & B & C & \bullet \\ A & \bullet & (ab)^2 & (ac)^2 & 1 \\ B & (ba)^2 & \bullet & (bc)^2 & 1 \\ C & (ca^2) & (cb)^2 & \bullet & 1 \\ \bullet & 1 & 1 & 1 & \end{matrix}$$

On calculating this determinant it will be found to be the function of $A-B$, $B-C$, $C-A$ above given, except that each term is multiplied by the constant factor -2, which may of course be dispensed with.

Now let us apply similar or analogous considerations to the determination of the constant quadratic function of

* The statement concerning the circular point-pair at infinity being centres of pencils of infinitely distant rays I have since met with somewhere in Dr. Salmon's Conics, but stated in quite a casual manner. It may not be unworthy of notice that just as the distance between any two points in a ray passing through either point of the *absolute* in a plane vanishes, so similarly vanishes the area of any triangle drawn in any plane touching "the imaginary circle at infinity" in space.

† If l, m, n, p are the distances of the vertices from the opposite faces, and x, y, z, t from the variable plane, it is well known that

$$\Sigma\left(\frac{x^2}{l^2}-2\,\frac{yz}{mn}\cos m,n\right)$$

is constant, in fact is unity.

$A, B, C, D,$ the four distances on a variable plane from the fixed points a, b, c, d. I must promise that using quadriplanar co-ordinates x, y, z, t analogous to those employed just now for the plane—viz. such as will cause

$$x + y + z + t = 0 \quad (1)$$

to become the equation to "the plane at infinity," the sphere circumscribing the fundamental pyramid $a\,b\,c\,a$ takes the analogous form to that given for the circle from which indeed it may be deduced with a stroke of the pen —viz. the equation to this sphere will be—

$$(a\,b)^2xy + (a\,c)^2xz + (a\,d)^2xt + (b\,c)^2yz + (b\,d)^2yt + (c\,d)^2zt = 0 \quad (2).$$

Moreover the distances of a plane whose equation is—

$$Ax + By + Cz + Dt = 0 \quad (3)$$

from the vertices of the pyramid will be A, B, C, D each multiplied by the same known quantity.

The intersection of the plane at infinity with any sphere, and consequently with the circumscribing sphere named, is "the circle at infinity;" hence if F is the constant function required we may find it as the function of $A, B, C, D,$ which becomes zero when the plane (3) is tangential to the intersection of the plane (1) with the sphere (2), or, which is the same thing, when the intersection of the planes (1) and (3) is tangential to the sphere (2), and this function is well known to algebraists to be the determinant formed by bordering the determinant to (2) with the coefficients of (1) and (3), *i.e.* we may take as the constant function F the determinant following:—

$$\begin{array}{cccccc} \bullet & A & B & C & D & \bullet \\ A & \bullet & (a\,b)^2 & (a\,c)^2 & (a\,d)^2 & 1 \\ B & (b\,a)^2 & \bullet & (b\,c)^2 & (b\,d)^2 & 1 \\ C & (c\,a)^2 & (c\,b)^2 & \bullet & (c\,d)^2 & 1 \\ D & (d\,a)^2 & (d\,b)^2 & (d\,c)^2 & & 1 \\ \bullet & 1 & 1 & 1 & 1 & \bullet \end{array}$$

of which the developed value is easily found to be—

$$-\Sigma(a\,b)^4(C-D)^2 + 2\Sigma(a\,b)^2(a\,c)^2(B-D)(C-D) + 2\Sigma(a\,b)^2(c\,d)^2\left\{\begin{matrix}(A-C)(B-D)\\+(A-D)(B-C)\end{matrix}\right\}$$

This value of the constant function in its expanded form I some time ago found by a different method, and sent in the shape of a question to the *Educational Times*.* In a brief correspondence which ensued with Prof. Cayley, he wrote to me giving the equivalent determinant form which he arrived at by a totally different order of conceptions and in a very beautiful manner, as follows. We may regard the differences between A, B, C, D as equal to the differences between the distances of a, b, c, d from a fifth point, e, at an infinite distance, and may call $a\,e,\ b\,e,\ c\,e,\ d\,e$ equal to $A + K,\ B + K,\ C + K,\ D + K$ respectively, where K is infinite. Hence by his own well-known theorem regarding mutual distances of five points we shall have—

$$\left|\begin{array}{cccccc} \bullet & (a\,b)^2 & (a\,c)^2 & (a\,d)^2 & (A+K)^2 & 1 \\ (b\,a)^2 & \bullet & (b\,c)^2 & (b\,d)^2 & (B+K)^2 & 1 \\ (c\,a)^2 & (c\,b)^2 & \bullet & (c\,d)^2 & (C+K)^2 & 1 \\ (d\,a)^2 & (d\,b)^2 & (d\,c)^2 & \bullet & (D+K)^2 & 1 \\ (A+K)^2 & (B+K)^2 & (C+K)^2 & (D+K)^2 & \bullet & 1 \\ 1 & 1 & 1 & 1 & 1 & \bullet \end{array}\right| = 0$$

And by the ordinary well-known rules in determinants for combining lines with lines and columns with columns it may easily be shown that the above determinant is of the form $4F_1K^2 + GK + H$, where F_1 represents—

$$\begin{array}{cccccc} -\frac{1}{2} & A & B & C & D & \bullet \\ A & \bullet & (a\,b)^2 & (a\,c)^2 & (a\,d)^2 & 1 \\ B & (b\,a)^2 & \bullet & (b\,c)^2 & (b\,d)^2 & 1 \\ C & (c\,a)^2 & (c\,b)^2 & \bullet & (c\,d)^2 & 1 \\ D & (d\,a)^2 & (d\,b)^2 & (d\,c)^2 & \bullet & 1 \\ \bullet & 1 & 1 & 1 & 1 & \bullet \end{array}$$

Consequently $F_1 = 0$. This equation gives not only the form of the constant function but the value of the constant (F_1, when the element $-\frac{1}{2}$ is suppressed, being identical with my F).

On removing the line and column of capital letters the above determinant equated to zero expresses the condition of the points a, b, c, d lying in a plane—as proved by Cayley in days long past (and still ordinarily so proved) by a very artful manner of multiplying a determinant into a numerical multiple of itself; but this result follows as an instantaneous consequence of the reflexion that if a, b, c, d did not lie in a plane the above equation would mean that the circumscribing sphere was *touched* by the plane at infinity, whereas we know that this plane never touches but has the faculty of always cutting *every* sphere in a constant circle of imaginary points. Hence the existence of this equation implies the coplanarity of the four points $a, b, c, d,$ and the converse proposition may be shown by simple algebraical reasoning to follow from this.*

Postscript.—I have been led by what precedes to a rather interesting observation in universal geometry.

Suppose we form a determinant with the squared distances of one group of n points from another equinumerous group any or all of which may be coincident with those of the former one: and to each line and at the foot of each column of this determinant affix a unit; a determinant so formed we may agree to call the bordered determinant of either group in regard to the other. Thus *ex. gr.*

$$\begin{array}{cccc} a\,\alpha^2 & a\,\beta^2 & a\,\gamma^2 & 1 \\ b\,\alpha^2 & b\,\beta^2 & b\,\gamma^2 & 1 \\ c\,\alpha^2 & c\,\beta^2 & c\,\gamma^2 & 1 \\ 1 & 1 & 1 & \end{array}$$

is the bordered determinant of a, b, c in regard to $\alpha, \beta\,\gamma$. When the two groups are one group repeated we may call this determinant the bordered *self*-determinant of the groups.

My theorem is that the bordered determinant of two equi-numerous groups in respect to one another is a mean proportional to the bordered self-determinant of one of the groups, and that of the projection upon its *niveau* of the other group. [The *niveau* to a group of points means the homaloid (Clifford's flat) of the lowest number of dimensions which contains the group.]

We may regard a group of n points as the vertices of a figure whose squared content we know by Cayley's theorem above referred to is a sub-multiple of the bordered self-determinant of the group; it is in fact that quantity divided by $(-)^{n+1}2^n(1 \cdot 2 \cdot 3 \ldots n)^2$, so that we may vary the statement of the theorem and say that the product of the contents of the figures denoted by two equi-numerous groups into the cosine of the inclination of their *niveaus* is a known numerical sub-multiple of the bordered determinant of one group in respect to the other. Thus, keeping at first within the limits of conceivable space, we see

* If the differences between A, B, C, D be regarded as the minor determinants of the bilinear matrix $\begin{matrix}A & B & C & D\\ 1 & 1 & 1 & 1\end{matrix}$ any practised algebraist would at once recognise that my form becomes expressible as a determinant of the 6th order, and I think I could hardly have failed eventually to have made this observation, the more especially as I was aware of the connection of the subject with that of the section of any sphere with the plane at infinity—but as a matter of fact Cayley anticipated me, and was the first to actually write down the function under the form of a determinant.

In each method the concept of infinity appears, but in mine that of the imaginary as well; and although more far-fetched than the other, the latter possesses the advantage of yielding the result as the transcript of a mere mental process without involving the necessity for the performance of any work whatever of algebraical reduction.

* The equation in the text extended to the points $A, B, \ldots L, X$ assumes new importance and rises to philosophic interest when regarded as the *intrinsic equation to the niveau* of $A, B, \ldots L$, in which the co-ordinates of the variable point X in the niveau are the squares of $AX, BX, \ldots LX$; it is of course an equation of the second degree in these co-ordinates. The distances of either of two points from the other are the same in quantity but differ in sign. Hence the *square* of either is the natural measure of the interval *between* the two points.

that the cosine of the angle between abc, abd, the faces of a tetrahedron, will be the determinant—

$$\begin{array}{cccc} \bullet & ab^2 & ad^2 & 1 \\ ab^2 & \bullet & bd^2 & 1 \\ ca^2 & cb^2 & cd^2 & 1 \\ 1 & 1 & 1 & \end{array}$$

divided by sixteen times the product of the faces abc, abd.

Or, again, if ab, cd be any two non-intersecting edges of the tetrahedron, $\pm 2ab \, . \, cd \cos (ab, cd)$ ought to be equal to—

$$\left| \begin{array}{ccc} ac^2 & ad^2 & 1 \\ bc^2 & bd^2 & 1 \\ 1 & 1 & \bullet \end{array} \right|$$

and as a matter of fact the cosine between (ab, cd) is equal to $\dfrac{ad^2 + bc^2 - ac^2 - bd^2}{2ab}$.*

Again, if abc, def are any two triangles in space of 5, 4, or 3 dimensions the product of their areas into the cosine of their inclination will be a numerical multiple of the bordered determinant of the group abc in regard to def, and if they lie in the same plane their product itself will be that numerical multiple.

Similarly for two groups of four points lying in one space (as *ex gr.* that in which *we live, move, and have our being* †) the product of their bordered self-determinants will be equal to the bordered determinant of either group in respect of the other, because their *niveaus* coincide, and if we take two groups of five points each in ordinary space it again follows from the theorem that the bordered determinant between them must vanish, a statement which when the two groups coincide reverts to Cayley's condition concerning the mutual squared distances of five points in ordinary space.

Finally, there can be little doubt, I think, of the truth of the following theorem dealing with determinants (but unbordered) ‡ of which the general theorem we have been considering which deals with bordered determinants must needs be a corollary.

By $P : Q$ where P, Q are two groups of n points each, let us understand the determinant formed by taking the cosines of the angles which the n^2 lines connecting P and Q subtend at a point O equidistant, in space of the necessary number of dimensions, from each of the $2n$ given points, and let P', Q' mean the groups P and Q augmented by the addition of O to each of them, the theorem is that—

$$\cos (P', Q') = \frac{P : Q}{\sqrt{(P : P)(Q : Q)}}. \S$$

Thus for the case of n equal to 2 if O is the centre of the sphere passing through a, b, c, d, we ought to find the cosine of the angle between the arcs ab, cd equal to

$$\left| \begin{array}{cc} \cos ac & \cos cd \\ \cos bc & \cos bd \end{array} \right|$$

divided by a square root of

$$\left| \begin{array}{cc} \cos aa & \cos ab \\ \cos ba & \cos bb \end{array} \right|$$

into a square root of

$$\left| \begin{array}{cc} \cos cc & \cos cd \\ \cos dc & \cos dd \end{array} \right|$$

i.e. equal to

$$\pm \frac{\cos ac \, . \, \cos bd - \cos ad \cos bc}{\sin ab \, . \, \sin cd}$$

as is the case.

There ought also to exist analogous theorems applicable to non-equi-numerous point groups depending in some way upon the minors of a corresponding rectangular matrix.*

J. J. SYLVESTER

New College, Oxford, April 1885

* Obviously therefore we can express the squared shortest distance between two non-intersecting edges of a tetrahedron as a rational function of the squares of all six. The formula in the text is well known and easily proved for the case of $abcd$ being in a plane, which is enough to show that it must be true universally, for if we make BCD rotate about BC, the projection of C upon BD does not move, and consequently AC into the cosine of AC, BD is invariable.

† It would perhaps be more correct to say "*which has its being in us.*"

‡ From which it follows that every algebraical theorem regarding square matrices expressed in the umbral notation is immediately convertible into a proposition in universal geometry; the umbræ cease to be mere abstractions, and acquire a *local habitation and a name* as points in extension.

§ $\sqrt{P : P}$ is in fact the factorial of n divided by the nth power of the distance of O from each point in P into the content of (what I call) the *plasm* (of order n) denoted by P.

A *plasm* of the order 1, 2, 3 means a rectilinear segment, a triangle, a tetrahedron—whence it is easy to deduce and define in exact terms the meaning of a plasm of any order as a figure bounded by plasms of the order next below its own. The squared content of a triangle is equal to the sum of the 3 squared contents of its projections on mutually perpendicular planes in ordinary space: but also to the sum of the 6 squared contents of its projections on 6 such planes in extension of 4 dimensions and so on—and in general the square of the content of a *plasm* denoted by n points is similarly resoluble into a sum of $\dfrac{n(n-1)\ldots(n-i+1)}{1 \, . \, 2 \ldots i}$, such squares in extension of $(n+i-1)$ dimensions; as these squared contents are all expressible immediately by Cayley's theorem in terms of squared distances, the above statement gives rise to a far from self-evident theorem in determinants. What I have here termed *plasms* might with more exactitude be termed *protoplasms*, as being the elements into which all other figures are capable of being resolved.

* It may be objected that the theorems of the text applied in their full generality beyond the limits of empirical space cease to affirm a relation between two different things and therefore lose their efficacy as such and become mere *definitions* of the meaning of the inclination of two figures in supersensible space. To meet this objection it is sufficient to give a general method for determining algebraically the projection of a point in space of n dimensions on the niveau of ν points where ν is any number not greater than n; this it is easy to see may be effected as follows:—

(α) I observe that the niveau of any μ given points in a space of n dimensions may be expressed in Cartesian co-ordinates by means of equating to zero each of $n - \mu + 1$ independent minors of a rectangular matrix containing $n + 1$ columns and $\mu + 1$ lines, the formation of which is too obvious to need stating in detail.

(β) In order to project orthogonally a point whose n co-ordinates in a space of n dimensions are $x', y', \ldots z'$ upon a niveau (of the $(n-1)$th order) passing through n given points defined by the equation $Ax + By + \ldots Cz + L = 0$, we have only to write $x - x' : y - y' : \ldots : z - z' :: A : B : \ldots : C$, and combining the $(n-1)$ equations contained in this proportion with the given equation, the resulting values of $x, y, \ldots z$ determine the projection of the given point on the given niveau.

If now ν points are given in a space of n dimensions and the projection is required of a given point upon their niveau we may proceed as follows:—

(1) Find the $n - \nu + 1$ equations which define the niveau.

(2) On each of the niveaus of the $(n-1)$th order which correspond thereto respectively find the orthogonal projections of the given point.

(3) Through these $n - \nu + 1$ projections of the given points and the given point itself draw a niveau which will be defined by $(n+1) - (n - \nu + 2)$, *i.e.* $\nu - 1$ equations.

Finally, combining these with the $n - \nu + 1$ original equations we have n equations in all, and these will serve to determine the n co-ordinates of the projection required.

This method is not always the most compendious, but is always sufficient, and enables us to attach a definite meaning to the inclination of two spaces of any the same order to one another: thus *ex. gr.*, the content of the projection of $abcd$ on $efgh$ divided by the content of $abcd$ itself is the cosine of the inclination of the niveaus $abcd$, $efgh$, and the projections of the several points a, b, c, d on $efgh$ (say a', b', c', d') being found by the preceding method, the content of the tetrahedron $a'b'c'd'$ (and therefore the inclination of the two niveaus) is a known quantity.

GRESHAM COLLEGE

THE question of what is to be done with one of the greatest of existing London abuses, Gresham College, has again come up in connection with a letter from a "Londoner" in the *Times*. The *Times*, in a somewhat incomplete leader, animadverts strongly on the abuse, and urges its prompt remedying. Surely when the fact that London has no university in the true sense is attracting so much attention and the movement to supply the want is so powerful, it is absurd to allow the funds to be worse than wasted which represent the wreck of those which were originally intended for the maintenance of a real institution of this class. There were once 20,000 students at Gresham College, and when London does have a university, as it must have some time, even Gresham College will be without *raison d'être*.

"Topographically," the *Times* says, "the lecture-rooms are off the track of students. None of the apparatus of systematic instruction, in the way of examinations, accompanies the courses. Provision does not exist, or, at any rate is not employed, for the contact of the mind of the learner with the mind of the teacher. The lecturer ascends to his chair, recites or reads his stipulated discourse, and disappears with the mechanical routine of an automaton. The professorial staff, it might have been added, has as little internal unity as relationship to its classes. It is a concourse of atoms with no affinity except equality of stipends. To call the foundation a college is to use a manifest misnomer. It is as much a college as one at Oxford or Cambridge would be with the undergraduates and fellows suppressed, and the Master, Dean, Bursar, and Butler left to perpetuate the tradition. The Corporation of the City and the Mercers' Company are Sir Thomas Gresham's trustees, and derive very substantial advantages from his bounty.

"The inutility of the Gresham Lectures was recognised in the days of Dr. Johnson. Johnson lamented as bitterly as our correspondent that the able professors of Gresham College, which was 'intended as a place of instruction for London, contrived to have no scholars.' His explanation was that the professors lectured gratis, and grew indolent from the absence of pecuniary incentives to intellectual exertion. 'We would all,' he exclaimed with conviction, 'be idle if we could.' Permission to charge sixpence a pupil for each lecture would, in his opinion, have infused vitality into the institution; every professor would forthwith have grown 'emulous to have many scholars.' There could be no harm in administering his specific now. The good of a condition such as Gresham College has been reduced to is that any experiments may be tried upon it without excessive risk. But the failure of the foundation arises from deeper sources than those to which Johnson attributed it. Several of the present lecturers are notoriously of a temper and standing not to need a money bribe to urge them to do their duty. The Dean who is the Divinity Professor delights in occasions for ecclesiastical exegesis. He would rejoice to find a way of gathering five hundred receptive hearers to listen to the theological expositions he throws away on a meagre fraction of the number. Another Dean was Senior Wrangler, and is abundantly competent for the geometrical themes he has to discuss. The subject of civil law is committed to a most capable jurist. The Professor of Music is able elsewhere without any endowment to attract to his classes a large paying audience. The blame, as our correspondent concedes, does not lie with the lecturers, who only slumber in concert with their classes and their patrons. It must be imputed to the gross contempt which has been shown for all the conditions of educational success. Their founder intended his seven professors to be professors in a College which he did not survive to create. He died at the age of sixty, still immersed in public affairs, and before attaining the leisure for carrying out his idea of an 'epitome of a University in London.' Accidents for which it would be useless to condemn his trustees would have prevented them, had they otherwise been well disposed, from accomplishing his ambitious programme. His estate, so far as it was appropriated to the purpose, proved insufficient for the complete endowment of a College and its staff. A collection of lectures was left as it were in the air. For a time they appeared to have procured favour in spite of their disadvantages. In the nature of things they could not keep it permanently. They were without soil to take root and sprout in. The error of all concerned has been that the want was not supplied by incorporating either them in something else or something else in them. Last century was a period of educational, though not of intellectual, stagnation. Gresham College only languished in company with many other Colleges better furnished with the gifts of fortune. The present age has witnessed a revival of zeal for instruction by methods in which the Gresham foundation might have been turned to the greatest service, and has been turned to none. While London, and, most of all, the City, was careless of learning, it was no reproach to the managers of Sir Thomas Gresham's bounty that they converted it to no account. The absurdity is that for years the town, from its centre to its outskirts, has been crying out for educational appliances, and that Gresham College is suffered to remain as futile and superfluous as ever. Half-a-dozen institutions have been erected in or by the City to effect the objects for which Sir Thomas designed his foundation. For any one of them it would have been the most admirable nucleus; it would have afforded a starting point, and have bestowed the dignity of old descent. Thus it would have gained at last the reason for existence it has been craving in vain for a couple of centuries.

"Tastes of benefactors in distant ages do not always agree with the popular inclinations of the present. Reluctance on the part of trustees to deviate from the will of the men they represent is to be excused, though it cannot always be allowed to block the road to reform. When, however, a founder has let posterity into his confidence, and the application of his gifts clearly conflicts with his own views, it argues strange perversity or default of mental elasticity not to perceive where genuine respect for his wishes should lead. Without a framework in which they could be set and mutually co-ordinated, the Gresham Lectures cannot possibly do what the founder desired them to do. The public spirit of the City would not refuse to take up and finish the work which Gresham sketched out if it could be secure that his original instalment of beneficence was no longer wasted as now. Already it has been endeavouring to fill up the gap by its own exclusive exertions. The City of London College, the courses of the University Extension Society, lectures at the London Institution, the Technical College, Middle Class Schools, and not a few institutions besides, are spontaneous efforts of the past dozen years to work out the original idea of Sir Thomas Gresham. The proper City of London College is Gresham College. Around it as the centre all the other educational instruments of the City ought naturally to group themselves. Not the most punctilious conservatism could reprobate the Corporation and the Mercers' Company if they would use the authority they possess, and seek fresh authority, to aid in the promotion of that general result. Gresham College, as it is, has been for centuries, and is doomed to be, a burlesque of collegiate life. Its lectures must be equally dead whether delivered in a dead or a living tongue. Its choice is between becoming something more or something less than it is now. If it cannot develop, it had better cease to be."

ELECTRICITY AT THE INVENTIONS EXHIBITION

THE International Inventions Exhibition is intended to illustrate the progress of invention during the period that has elapsed since the last Great International Exhibition in this country in the year 1862. Accordingly we find under Group XIII. electricity ranged under twelve classes, entitled respectively, generators, conductors, testing and measuring apparatus, telegraphic and telephonic apparatus, electric lighting apparatus, electro-metallurgy and electro-chemistry, distribution and utilisation of power, electric signalling, lightning-conductors, electro medical apparatus, electrolytic methods for extracting and purifying metals, electrothermic apparatus. Under such a classification there is no doubt that the Exhibition might have been made thoroughly representative of the wonderful progress that has taken place in this branch of science, both in its theory and practice, during the last twenty-three years. The reason that it is not so is twofold: electricity has had of late years many exhibitions dedicated to itself—those of Paris, Vienna, and Sydenham; and it was quite impossible in such an exhibition as the Inventions, where so much has had to be compressed into so little space, to indicate the progress of invention in each class of each group. If, however, electricity is not represented in this way, it is in another way, and that is through the medium of one of its special applications—that of the electric light. Electricity thus forms the light and life of the whole Exhibition after sunset, and in this connection we would view it on the present occasion.

Those who visited the Health Exhibition last year will not notice any great change in the internal illumination beyond the more extensive use of the electric light and its greater steadiness, but will observe that an alteration has been made in the garden lighting, to a description of which we propose to confine this article. In place of the numerous attendants who, a little before darkness set in, were to be seen last year lighting one by one the little oil lamps which, in their coloured glasses, were scattered all over the trees and lawns, an observer discovers at half-past eight or a little later a gradual diminution in the darkness of the evening, and the eye becomes gradually sensible to the fact that the architectural features of the buildings are becoming clearly defined, and by degrees are actually illuminating surrounding objects, whilst at the same time the lawns and shrubberies, the parterres and trees, and even the ponds of water and waterfalls assist in the general illumination with light of every shade and colour. Where before all was darkness, there is a scene of bewildering enchantment: fountains play and throw up into the air, now high, now low, solid sheets of illumined water and spray of mingled water, dust, and light, at one moment of golden hue, at another of the loveliest magenta; while when the silver light of the electric arc alone illuminates the fountains, broken by some magic power below into waterdrops, all the prismatic colours of the rainbow are observable, and, revelling in the beauty, one wonders how it is all brought about.

In what is known as the tower, Sir Francis Bolton has before him a plan of the gardens with switches on it, enabling him to turn the lights on or off, or to increase or diminish their intensity at his will. One of the switches controls the effects in the upper garden, another those in the lower garden, a third commands the statue of the late Prince Consort, a fourth and fifth the illumination of the east and west quadrants and east and west arcades respectively, whilst a sixth controls the external lighting of the conservatory. Four switches on the lower portion of the switch board enable the operator to raise or lower the intensity of the light; the first altering it from $\frac{1}{4}$ to $\frac{3}{8}$, the second from $\frac{3}{8}$ to $\frac{1}{2}$, the third from $\frac{1}{2}$ to $\frac{3}{4}$, and the fourth from $\frac{3}{4}$ to full power.

One of the most interesting features of the illumination, and that which perhaps causes the most wonder and bewilderment, is the play of the fountains. Below the island in the fountain is a water-tight chamber, about 5 feet in height and 20 feet square, into which one obtains access by first descending a ladder from the diving apparatus-house into a low arched passage, from which one ascends into the chamber. The roof of this is covered with water-pipes which convey the water from the main in all directions, the supply being regulated by screw valves; the five large jets are fitted with plug valves and levers, by the manipulation of which the dancing motion and breaking up into water-drops of the columns of water are effected. The average quantity of water expended per hour during a fountain display is 70,000 gallons. Under the five large water jets are five skylights, fitted with thick glass, below each of which is placed a wooden box, containing a powerful arc-light with the carbons set horizontally. Over the top of the lantern is a holophote, such as is used in lighthouses, by means of which the rays of light are concentrated, and projected upwards into and with the column of water, whilst their colours are varied by drawing sheets of stained glass across the lantern. The water is supplied at a pressure of about 70lb. to the square inch, which is sufficient to carry it up to a height of 120 feet.

On one of the walls of the chamber is a board, on which are signalled the instructions from the tower, which are read off by an assistant to the staff. In this manner the various effects which more or less puzzle the spectators are telegraphed from the tower above, and carried out in the concealed chamber below.

The following are the number and distribution of the lamps, all of which are made by the Edison-Swan United Company, most of them being of 5 and 10-candle power, whilst a few of 20-candle power are used on the band stands and verandah of the conservatory:—

	Lamps
Conservatory	1418
E. and W. Quadrants	1584
E. and W. Arcades	1832
Upper Gardens	1550
Lower Gardens	2300
Albert Statue	336
Total	9020

There are fourteen miles of main and branch wires, nine miles of twin wire, and two miles of small connecting wire. On the buildings and on straight lines on the grass specially constructed wooden lamp-holders are used, in other places ordinary spring-holders. The current is generated by three Siemens B 13 self-regulating dynamos, each weighing about 11 tons, and each capable of maintaining 2000 (20-candle) lights at 300 revolutions per minute; the current of each being 500 amperes at an electromotive force of 250 volts, the weight of the armature being 3 tons. The dimensions of the machines are as below:—

	ft.	in.
Height including bed-plate	8	9
Length over all	8	0
Width	4	8
Diameter of armature	2	5
Length of armature	3	2

The four series coils, which are coupled in parallel, are wound with copper-wire 4-10ths of an inch in diameter, and the shunt coils, which are coupled in series, with wire of No. 9 standard gauge; the armature being wound with flat strips instead of wire. Each of the dynamos is coupled to a Goodfellow and Matthew's triplex compound engine of 200-h.p. indicated, two of the machines being easily capable of maintaining all the lights. The main current from the dynamos is led to a switch-board, in connection with which is an electro-dynamometer so arranged that there shall be no break of continuity. In each branch circuit is a fork working in the core of a solenoid, the prongs of the fork dipping into a pair of mercury contact cups. The solenoids are connected by wires with Sir Francis Bolton's room, and by their use he can raise or lower the fork out of or into the contact cups and thus turn the lights off or on as required. The return circuits enter into a single conductor, which is arranged with four sets of mercury cups and solenoids in series; around each set is a bye-pass containing a resistance of determined magnitude, so as to vary the brilliancy of the lamps as desired.

The works for the electric illumination of the gardens and fountains have been carried out by Messrs. Siemens Brothers, to the designs of Sir Francis Bolton. Considering that the instructions for the preparation of the machinery for illuminating the gardens were only given in February last, the result obtained at the Inventions Exhibition is evidence that electric lighting has now advanced to such a stage that orders may be given for very large installations and executed in a perfect manner in a very short space of time.

VESUVIUS

SINCE writing on May 3 Vesuvius has continued to pour forth a continuous stream of lava. From the lowering of the general level of lava in the main chimney no reflection could be seen at its mouth, as is usually the case. This state of things continued till the 6th, when the vapour could only escape in intermittent puff in consequence of the accumulation of *débris* from the crumbling edges of the inner crater edge. As these puffs escaped, they resembled balls of dark grey smoke, from which fell a shower of fine ash, the result of the grinding up of the fine materials that had fallen in as above described, and partially blocked the upper outlet. The crater plain was scattered over with ash and rounded fragments of lava from which that had been ground off. Soon after a faint glimmer was visible, which gradually increased each night until it came to a stationary point, since which little change has taken place. The lava still continues to flow with more or less regularity, but from the small quantity it only gutters and collects on the slope of the great cone. The whole series of events since May 2 is identical with what occurred under similar circumstances in December, 1881, and January, 1882, which I have already described in these pages. The whole sequence of phenomena are easily explicable on the most simple mechanical principles, and do not require that *vulcanological magic* which, even at the present time, is too often employed in describing volcanoes or earthquakes.

I may mention that the above estimate might seem too low as the surface of the streams moved quicker (about 1 m. in 17 seconds), but the lava was particularly viscuous on this occasion, and towards the edges it could not have progressed more than the above distance in two or three minutes. A similar retardation no doubt occurred wherever in contact with its channel, so that I think the estimate of 1 m. per minute is a very fair one. If we allow an average outflow of 5000 cm. during the last twenty-two days (*i.e.* from May 2 to 24), which I am sure many would think under-rated, we have the prodigious output of 110,000 cm.; the product of what would usually be called a very small eruption. But the flow has not stopped, and shows no indication of so doing.

This large amount of material, added to the surface of the great cone, is already making a difference in its outline, and should the outflow continue for nearly three years, as occurred after the December, 1881, outburst, the Vesuvian cone will have another gigantic hump of lava to spoil the graceful curves of its back.

Either as the result of bad writing or of printer's errors some obvious mistakes have crept into my last communication. For "*unattached* pyroxene crystals" read *unattacked*. For "*salbam*" read *salband*. Read for "about one metre per *second*," about one metre per *minute*.

Naples, May 24 H. J. JOHNSTON-LAVIS

THE RUAHINE RANGE, NEW ZEALAND

IN the summer of 1843, Mr. Colenso being at Hawke's Bay, first saw the Ruahine Range, looking sublimely grand under its crest of virgin snow. Hearing at this time of natives living secluded in the interior, in the country lying between this range and the famed central volcanic district, Tongariro, he determined to visit them, and he has lately published a most graphic and interesting account of several visits to and over the range, which were accomplished between the years 1845 and 1847. This narrative is, as would be expected from a botanist like the author, largely interspersed with valuable notes on the flora, and there are also some on the fauna of that region. It is also somewhat interspersed with quotations, for the most part appropriate ones, from the author's favourite poets. It is not necessary that we should make any comments on the fact that this little memoir does not appear in the *Transactions* of the New Zealand Institute, already so full of various important contributions to our knowledge of New Zealand forms from Mr. Colenso's pen, for the publishing Board of that Institute, having declined to publish more than an abstract of it, the memoir was, by request, returned to the Hawke's Bay Philosophical Institute, before which Society it had originally been read, and it has been by them laid before the scientific world with additional and copious notes. The first attempt to cross the range was made under great difficulties in February, 1844: the weather was bad, heavy rain flooded the rivers and mountain streams, and the guide had forgotten the route. Despite all disadvantages, many a rare and several new plants were found. On a Saturday night, after a slender supper amid the deepening gloom of the beech forest, we read: "Here, pendent from some of the trees, hung a most lovely species of Loranthus (*Loranthus flavidus*), while on many other trees that fine species *L. tetrapetalus* formed dense bushes, bearing crimson flowers in profusion, so that in some of the more open spots among the closely-growing trees the whole forest wore a reddish glare." At the very spot where they halted, a fine bushy composite shrub with hydrangea-like leaves was gathered, which has been since named by Sir J. Hooker, *Olearia Colensoi*. Fatigued with the day's work the party slept till 10 o'clock on the Sunday, and then awoke to find themselves completely invaded by a large "blue-bottle fly," which, it appears, inhabited the beech-wood in countless numbers, and was most teasing and audacious: their blankets and woollen clothing had been attacked, and were literally filled with the fly eggs, and the hair of the natives' heads had also similarly suffered. These blue-bottles spoiled the Sabbath day's rest; they had never before been met with by Mr. Colenso. We wonder if the species has been recognised by Baron Osten Sacken, who has recently been engaged in describing New Zealand Diptera. After two days' more fatigue, the party were obliged to descend without crossing the summit, being nearly starved into the bargain. But amid all these troubles, Colenso writes that he at least had some joys, certainly, under the circumstances, unknown to the natives, in that he discovered, on the return, several fine new plants (*Alsophila Colensoi*), several new species of Coprosma, some of which grew so compactly together that in some places it was impossible to get through them, and so they had to walk *upon* them. Here, but only in one spot, that beautiful fern, *Hypolepis millefolium*, was found. Many beautiful and new forms of Veronica, as *V. buxifolia*, *V. nivalis*, and *V. tetragona*, this last species in its barren state resembling much the branch of a Podocarpus. Here we venture to interpose a wish that Mr. Colenso would write an essay on the mimetic resemblances of the species of the genus. But this was not all: a little further up there were found "splendid Celmisias and Ranunculuses in countless numbers, intermixed with elegant Wahlenbergias and beautiful Ourisias, Euphraisias, Gentians, Dracophyllums, Astelias, and Calthas, and many others. Here were plants reminding one of those of our native land, with rare and little known novelties." After the first burst of surprise, the great difficulty of carrying off these prizes presented itself: no collecting materials were at hand. There was no time to lose. "First I pulled off my coat, and made a bag of that; then, driven by necessity, I added thereto my shirt, and, by tying the neck, got an excellent bag. Lastly the crown of my hat held a few. Fortunately the day turned out a fine one, and on returning to the camp the night was spent placing them among spare clothing, bedding, and books." Of this "find" drawings of nearly fifty were published by Sir W. J. Hooker, or Sir J. Hooker, in the "Flora Novæ Zelandiæ" or the "Icones Plantarum." The graphic account of that terrible plant, *Aciphylla Colensoi*, we must content ourselves by thus referring to; it is too long to quote, and too good to condense.

Two solitary tufts of two Alpine plants were also detected on this occasion. One, *Helichrysum Colensoi*, the edelweiss of New Zealand, was found on the edge of the top of a mountain composed entirely of dry shingle of various sizes, from big lumps to dust. The other, *Geum parviflorum*, grew near the former, but, unlike it, has been found on the South Island. This first attempt to cross the range failed, though its summit was reached; but a second attempt, made in February, 1847, was successful. A short sojourn was made at Matuku, the principal of the Patea villages; the route thereto was the long round-about by Taupo. From Matuku, on March 25, the ascent of the Ruahine was made, and the Mission Station at Waitanga was reached on March 3, after many hardships and difficulties. The narrative abounds in numerous records of great interest. The following is an account of one of the largest, we suspect, of flower visitors, honey-seekers, and one unknown to Darwin or Hermann Müller:—

"Close to the village, and even within its fence, were several very large Kewhai trees (*Edwardsia grandiflora*); these were covered with their golden flowers, and mostly without leaves. The sun was shining brightly, and the parrots (*Nestor meridionalis*) flocked screaming from the forests around to the Edwardsia blooms; it was a strange sight to see them, how deftly they managed to go out to the end of a long lithe branch (preferring to walk parrot fashion), and there, swinging back downwards, lick out the honey with their big tongues, without injuring the young fruit . . . For, seeing but very few petals falling (and those only vexillæ), I sent some of the boys to climb the trees and bring me several marked flowering branches, which had been visited by the parrots. I found that all of the fully expanded flowers had had the upper part of their calyces torn open, and the uppermost petal (vexillum) torn out; this the parrots had done to get at the honey. As the flowers are produced in large thick bunches, some are necessarily twisted or turned upside down; still it was always that peculiar petal and that part of the calyx (though often in such cases undermost) which had been torn away. Through this no injury was done to the young fruit inclosed, which would in all probability have been the case if any of the other petals had been bitten off. It cannot be said that it is owing to the vexillum being the largest petal (as it is in many papilionaceous flowers) that it is thus laid hold of and torn away by the parrot, such not being the case in this genus: for the long fruit runs down through the two carinated lowermost petals, that are often quite two inches long, and is further protected by the two side ones (alæ), which four, from their being closely imbricated together, form a much larger and firmer hold for the bird's beak.

"Further, as these parrots are large birds with huge bills, and as the flowers are always produced on the tips of the small branches, which bend and play about under the weight of their bodies, one cannot but suppose that it is no easy matter for the birds to get a bite at them at all, so as to make the proper openings whereby to insert their thick tongues and lick out the sweet contents without injuring the young immature fruits, especially when we further consider that the common practice of this parrot is to take up in its claws whatever it wishes to discuss. Of all the flowers I examined, only the upper part of the calyx and corolla had been torn, and on none was the young fruit wanting, nor did I notice any bunches which had had their flowers wholly torn off. What with the glistening snow, the sun shining, and the golden blossoms of those trees, the numerous parrots diligently and fearlessly at work so close to the village, yet often screaming, it was altogether a peculiar and interesting sight."

What delightful corners for the botanist are to be met with in this range the next paragraph will show. Many of the species are of the greatest interest—quite Alpine gems; and some few of them, or of closely-allied species, grow freely with us. We would be prepared to welcome them all.

"In the open ground, on two or three mound-like hills of peaty-looking soil, and near each other, on the west side, grew that remarkably fine Ranunculus, *R. insignis*. On my discovering it I was astonished at its size—its largest golden flowers being nearly 2 inches in diameter, its flowering stems 3 to 4 feet high, and some of its round crenated leaves measuring 8 to 9 inches across! Both Sir Joseph Hooker and his father were equally surprised and delighted, and as it was (then) by far the largest species known, Sir Joseph Hooker gave it that appropriate specific name—*insignis*. I only found it in that locality, but it was in great plenty; its principal neighbour was the notorious Tamarea plant (*Aciphylla Colensoi*), already fully noticed; and those splendid compositaceous plants *Celmisia spectabilis* and *C. incana*, which generally grew close together, forming large, dark-green, shining patches, and bearing a profusion of fine white flowers—a striking contrast to their leaves. At first sight I saw that this new Ranunculus was closely allied to *R. pinguis*, of Lord Auckland's group and Campbell's Island—then lately described in the "Flora Antarctica," of which work I had received an early part just before I left the station. Other plants of those far-off Antarctic islets were also found here, on the summits—notably *Oreobolis pumilio*, growing in dense tufts in exposed places; while the peculiar straggling *Cyathodes empetrifolia*, and the pretty little flowering-plants *Euphrasia antarctica* and *Myosotis antarctica* flourished in half-sheltered hollows with *Plantago Brownii* and the grass *Catabrosa antarctica*. With these last also grew, very closely intermixed (much as we have seen the daisies and buttercups among low turfy grasses in our English meadows), the curious plant *Drapetes dieffenbachii*; the little elegant *Ourisia cæspitosa*, abounding in flowers; a very small and new species of Plantago (*P. uniflora*); and a similar-sized botanical novelty, *Astelia linearis*, a tiny plant bearing a large orange-coloured fruit; a little Caltha (*C. Novæ Zealandiæ*), having pale, star-like flowers; two graceful Gentians (*G. montana* and *G. pleurogynoides*), and a very small, shrubby, prostrate Coprosma (*C. pumila*), together with several elegant, shrubby little Veronicæ. Two orchideous plants, *Pterostylis foliata* and *Caladenia bifolia* (of which I wished for better specimens), I also detected growing sparingly, and with them a couple of Carices, *C. acicularis* and *C. inversa*, and also two species of Uncinia, *U. divaricata* and *U. filiformis*; and with them several interesting Hepaticæ and Mosses. Only in one or two spots, in shady, sheltered places near the top, and just within the forest, did I meet with that pretty little plant, *Ourisia Colensoi*, but in those spots there were plenty of them, and always beautifully in flower; the plants of this species grew apart, as if they liked room—in this respect differing altogether from the other species of this genus I have seen."

The lover of flowers can easily judge from these extracts how interesting to them would be this memoir of the now venerable explorer; there is much more of the like nature throughout its pages, and we trust the Hawke's Bay Philosophical Institute will send some copies of this "In Memoriam" narrative to this country, on sale for their benefit.

NOTES

THERE will be a *conversazione* at the Royal Society on Wednesday next, June 10.

THE *conversazione* of Sir F. Bramwell, the President of the Institution of Civil Engineers, will be held in the International

Exhibition Buildings, South Kensington, to-morrow evening, from nine to twelve. The Society of Arts *conversazione* will be held in the same place on July 3 next.

A PUBLIC meeting has been held in Birmingham to make preliminary arrangements for the reception of the British Association for the Advancement of Science on its visit to Birmingham in 1886. The mayor, Mr. Alderman Martineau, presided, and there was a large attendance. After referring to the four previous visits of the Association to Birmingham, the last of which was in 1865, the mayor stated that the forthcoming visit would involve a large amount of preliminary work, for which arrangements had to be made by the appointment of local committees. The meeting would probably be under the presidency of Principal Dawson, of Montreal. A large local committee was appointed, together with honorary officers, and the meeting terminated with a vote of thanks to the mayor.

THE statue to Linnæus which was recently unveiled with so much ceremony in Stockholm, stands in the well-known park Humlegården. It represents the "flower-king"—as he is called in Sweden—at the age of sixty in a meditating attitude, holding the "Systema Naturæ" and a bunch of flowers in his left hand. It is surrounded by allegorical female figures representing botany, zoology, medicine, and mineralogy, and is executed by Prof. Kjelberg, the work having occupied five years.

A ZOOLOGICAL garden is being formed in Stockholm, at the well-known pleasure resort of Djurgården, which will be the first of its kind in Scandinavia. Most of the animals are being purchased in Germany.

THE Rede Lecture was delivered on Tuesday in the Senate House at Cambridge by Mr. G. J. Romanes, F.R.S., the subject being "Mind and Motion."

THE *Central News* has received a telegram from Bombay announcing that a fearful earthquake has devastated a portion of Cashmere. The first shocks were experienced on Sunday, and created intense consternation. The oscillation was repeated at intervals of about ten minutes, and the shocks still continued up to the time the despatch was sent off. A wild panic is stated to have seized upon the people, who ran to the rivers and lakes, and sought to escape by embarking upon floating craft of any description. The town of Srinagar seems to have suffered severely. A great portion of the city is stated to have been demolished by the most severe shocks. Later accounts state that although some severe shocks have occurred in Cashmere, the loss has been trifling.

A SMART shock of earthquake was felt in Cape Town and the surrounding districts shortly before midnight on May 10, but no damage was reported.

THE results of a series of observations carried out by the Hydrographical Bureau at Washington, in order to determine the length, depth, and duration of ocean waves, have been published. The largest wave observed is said to have had a length of half a mile, and to have spent itself in 23 seconds. During storms in the North Atlantic waves sometimes extend to a length of 500 and 600 feet, and last from 10 to 11 seconds. The most careful measurements of the heights of waves give from 44 to 48 feet as an extreme limit; the average height of great waves is about 30 feet. These measurements refer to ordinary marine action, and do not relate to earthquake action or other exceptional agencies.

A CORRESPONDENT to *Ausland* makes a communication regarding the present condition of the artesian wells in Sahara. It is well known that such wells have been in operation there from a very remote period, and in the Algerian Sahara additiona wells have been opened with considerable success by the French. Between Biskra and Tuggurt the 434 old wells yielded in 1879 64,000 litres of water per minute, the 68 French ones 113,000 litres. The number of palms had increased from 359,000 to 517,000, that of other fruit-trees from 40,000 to 90,000, the population from 6672 to 12,827. In December, 1881, the yield of water from the wells had risen to 209,000 litres per minute. But this success is confined to a narrow zone within which water can be reached within a depth of 100 metres, and even here the borings that have been made since 1881 indicate a diminution in the yield of water, making it appear as if the limit of production of the underground reservoirs had almost been reached. Many of the French borings, too, are getting stopped up by sand, and are of too small calibre to be cleaned out and restored ike the wider Arabic ones. It is believed that it will be absoutely necessary to set about the sinking of new wells with a wider bore.

DR. ANDRÉE, of Leipzig, discussed before a recent meeting of the Anthropological Society of Vienna the question whether iron was known in America in pre-Columbian times. Meteoric iron was certainly in use amongst certain Indian tribes and the Esquimaux, but Dr. Andrée thinks that they were wholly unacquainted with the art of forging iron. This conclusion is based on the fact, among others, that while there is ample proof that the Indians knew how to obtain and employ gold, silver, tin, copper, quicksilver, &c., we hear nothing of iron mines in the history of the civilisation of ancient America. The language itself proves this, for there is no expression for *iron*. Some writers, it is true, speak of the word *panilgue* as that for iron, but it really means metal in general. Moreover, in pre-historic, or rather pre-Columbian, graves, especially in the rainless regions of Peru and Northern Chili, ornaments of all kinds, weapons and implements are found, but no objects in iron have been discovered, although the Indians placed their most valued articles in their tombs. There is no reason, he thinks, to believe that the tools employed in the great masonry works of Peru, such as that at Tiahuanaco, were other than those in use in the rest of Peru, which were of *champi*, a species of bronze. The chisels found in Peruvian graves soon become blunted when used on the hard strut; but it is suggested that there was some method of sharpening them easily. Indians certainly have worked a hard stone like nephrite without iron; and there is no improbability, says the writer, in the theory that these chisels were employed, when we recollect the patient temperament of the Indians, who for generations were accustomed to the repetition of the same work, to indolently pursuing an uniform task, and also that *gutta cavat lapidem.*

BEFORE the last meeting of the Asiatic Society of Japan (reported in the *Japan Weekly Mail*) Mr. H. Pryer read a paper entitled "Notes on the *Mustela itatsi* and on the *Corvus japonensis*, Bonaparte." The paper was largely a criticism of views advanced by Dr. Brauns regarding the generic affinities of these animals, and published in the Society's *Transactions*. A series of comparative measurements of the beak, metatarsus and wing of the *Corvus corax* and *Corvus japonensis* were given, with comparisons of the tail, eggs, and larynx, which proved that they were not identical. It was suggested that Dr. Brauns' specimen of the *Corvus japonensis* was really a specimen of the *Corvus corone.*

THE *Johns Hopkins University Circular* for May contains the abstract of a paper by Mr. Donaldson, entitled "Observations on Temperature-Sense." Blix, of Upsala, and Eulenberg, of Berlin, have observed that there are definite points on the skin at which sensations of cold only are aroused; others, distinct from the first and equally definite, for the sensation of heat, while between these two sets of spots sensations of pressure only are aroused. These reactions were obtained by electrical and thermal stimulation of the skin. Mr. Donaldson, whose attention had previously been attracted to the subject, endeavoured to make accurate maps of these cold and hot spots. It was found that their distribution on corresponding parts differed in different individuals, that the distribution on symmetrical parts of the body was different, that the number of cold spots was greater than the number of hot spots, that the relative abundance of the two kinds varied in different parts of the skin, and that, roughly speaking, there are two grades of spots, viz. those which react almost always and those which react only half the time and with a comparatively faint sensation. The spots, as a rule, are less than a millimetre in diameter, and they are easily exhausted. The sensation roused by a single stimulus often lasts, however, for some minutes after the removal of the stimulus. As the thermally sensitive spots move about as the skin moves, it is clear that they are in the skin and not below. On being cut from the skin and examined, the spots showed no structures with which the sensations could be associated. The spots were found quite as sensitive on scars as on the sound skin. Using the radiant-heat method described by Pollitzer, the hot spots were found to respond from eight to forty times more quickly to a given stimulus than the not-hot ones. The explanation of any sensation of heat on the not-hot spots appears to be that there is conducting heat through the skin, so that the stimulus finally reaches a hot spot.

THE death is announced of Mr. Alexander Croall, Curator of the Smith Institute, Stirling, and a botanist of some reputation.

WE have just received Band v. of the *Verhandlungen des Vereins für naturwissenchaftliche Unterhaltung zu Hamburg*, 1878–1882; the title-page bears the date 1883; it appears to have been published in monthly numbers. Was Band v. actually published until 1885? There is no internal evidence against its appearance in 1883, but we fail to find any reference to certain papers in it in the published records for that year. This ambiguity as to date is awkward. The contents are varied and valuable, and embrace natural history in its broadest sense, as will be seen from the titles of some of the papers, such as "Die Umgestaltung unserer Gegend durch Wasser und Wind und die Abnahme des Wassers in unserem Gebiete;" "Die Variabilität der Schmetterlinge in ihren verschiedenen Entwickelungs-Stadien, und der biologische Werth von Form, Farbe, und Zeichnung;" "Die Entwickelung unserer Kenntnisse der Länder im Süden von Amerika;" "Hammer und Messer in der Sprachgeschichte;" "Haben auch in Deutschland gleichzeitig mit dem Mammuth Menschen gelebt?" "Die Insel Rotumah und ihre Bewohner;" "Mittheilungen über einen Taifun bei Jokohama und Jeddo," &c. Of the papers enumerated that on typhoons seems especially interesting on account of the analyses given of the reports of various ship-captains. There are several zoological and botanical papers, in addition to the one already quoted.

THE new annual report of the Canadian Minister of Agriculture to the Governor-General contains, for the first time, the report of the Dominion entomologist, Mr. James Fletcher. The Minister explains that as an acquaintance with the results of entomological science is a matter of necessity to every tiller of the soil, he took the step of appointing an official entomologist in order that the attention of those whose interests are materially affected might be called to the subject. As Mr. Fletcher was only appointed in June last year, his report is necessarily a preliminary one. He has succeeded in establishing a system of correspondence all over the Dominion, and from extracts of letters which are published in his report it is clear that he has ample work before him. In parts of Nova Scotia, for example, the cultivation of wheat has had to be abandoned, on account of the wheat-midge, or *Diplosis tritici*. In other places, clover, peas, roots, fruit and forest trees have suffered heavily by the ravages of various insects. The position of entomologists, therefore, is one with large possibilities of material benefit to the Dominion and its inhabitants.

A SERIES of photographs of lightning flashes were lately obtained at Berlin by Dr. Kayser, and are the subject of a paper to the Academy there (*Wied. Ann.*, No. 5). The lightning is shown (as previously) to have gone very often from one point to several, the aspect in the photograph being like that of a river with numerous tributaries (only the fluid takes the opposite direction). The weaker flashes did not so branch out. In one remarkable effect the stem consists not of one bright line only, but of four parallel throughout, the second being rather a band, and stratified transversely. The explanation Dr. Kayser offers is, that in this case there was an oscillating discharge. The first spark, in passing from cloud to earth, would leave a channel of heated air, which would be used by the next spark from earth to cloud, only it was meanwhile a little displaced by the wind; and so with the others. Such oscillatory discharges may sometimes be observed with the eye in violent thunderstorms if the oscillation be pretty slow. Dr. Kayser reckons the whole phenomenon in the present case to have occurred in less than half a second. The stratified appearance of the band he is unable to account for.

THE eels of the ponds in the woods of Vincennes leave them every spring in large numbers, making their way to the Seine or the Marne, several kilometres distant. They take advantage of rainy weather, when the herbage is wet, and their instinct guides them directly to their destination. New species have repeatedly been introduced into the lakes, but in vain; all seem to have this disposition to leave. Some have thought that the water of these ponds, having been brought by hydraulic engines, has undergone some change which drives the eels away. But the phenomenon of such migrations by eels and some other fishes is not uncommon. Thus in the marshes of Picardy eels are often found on the grass, going from one pond to another.

THE reports of the Aëronautical Society of Great Britain for the years 1883 and 1884 have just been issued together in a small volume. It is mainly occupied by papers read before the Society. Amongst these is one on the mechanics of flight and their application to flying machines, by Mr. H. Middleton; artificial flight attainable by Mr. Hollands; the possibility of man-flight, by Mr. Barry; on the methods of soaring birds, and the bearing of the facts connected with them, by Mr. J. Lancaster, of Chicago. Amongst the shorter papers are: a visit to the Aëronautical Exhibition at Paris, by Mr. Frost; a memoir of Mr. John Stringfellow, by Mr. Brearey; a light and economical motor for propulsion in air, by Capt. Griffiths; and conjoint gas and mechanical action as applied to flight, by Mr. Brearey.

AN aëronautical exhibition under the patronage of the Aëronautical Society of Great Britain is to be opened during the present month in connection with the International Exhibition at the Alexandra Palace. The objects for exhibition will be models of designs for the accomplishment of aërial navigation by mechanical means only, or partly by buoyancy and partly by mechanical means; objects which are capable of flight and carrying their own motive power; machines constructed upon a scale calculated to carry a weight equal to that of a man upon the principles advocated by the inventors; light motors; balloons, navigable or otherwise; balloon material; kites, or similar aërial appliances, for saving life at sea, or for traction; and other objects of interest connected with aëronautics. The large outdoor space will be made available for various competitions, such as the nearest approach to a given locality. The disputed question of aërial locomotion by the aid of buoyancy will also be conclusively tested.

THE scientific society, Isis, of Dresden, having recently attained the fiftieth year of its existence, has issued a special jubilee or festival number of its *Proceedings*. It was founded in 1834, at the end of which year it had 27 members, and in 1835 it was reorganised and called Isis. During the first thirty years of its existence the Society was fortunate in having in keeping a single president, Dr. Reichenbach, whose lectures were mainly instrumental in the formation of the Society. In 1860 the twenty-fifth anniversary of the founding was celebrated with much ceremony, and as the occasion was also Reichenbach's jubilee, the double event was commemorated by the establishment of a memorial fund which bore his name, and the income from which was to be devoted to the support of a Saxon student travelling for zoological investigation. A record was then issued of the work of the Society so far; the number before us carries on the story for another twenty-five years, thus completing the history of the half century. The 27 members of 1835 have swollen to about 465 in 1885, and progress in other directions has been in proportion. In addition to the secretary's record of the advances of the last quarter of a century, the *Festschrift* contains a paper by Prof. Stelzner on the development of the methods of petrographic investigation during the last fifty years, and one by Herr Töpler on the history of discoveries in electromagnetism and inductional electricity. Most of the remaining papers deal with local science, such traces of animals in the coal formations of Zwickau, and several others on subjects connected chiefly with Dresden and its neighbourhood. The Society starts on the second half of the first century of its existence with ample vigour and promise of an unlimited lease of existence and activity.

ON May 22, at about 6.30 p.m., a mirage was seen from Visby, on the island of Gothland, in the Baltic. It appeared out at sea, on the western horizon, and represented a town on both sides, surrounded by high forest-clad mountains, which seemed to be within a distance of only a few miles. A large vessel with three masts lay in front of the town. The mirage lasted a couple of minutes, when it suddenly disappeared.

ONE hundred thousand shad have been reared in the United States during the last year, to say nothing of other species of fish, the exact number of which it is impossible to compute. It will be remembered that the shad was once exceedingly prolific in the Thames, but owing to the impure state of the river their numerical proportions have decreased to a very large extent. The Fish Commissioners of America have acted wisely in acclimatising the shad to their own waters, it being a valuable fish and easy of cultivation.

A SHORT time since we commented upon the enormous quantities of rats which infested the Health Exhibition, but which entirely disappeared shortly after it closed. Soon after the present Inventions Exhibition opened, these pests commenced to reappear, and their numbers are daily increasing. The authorities would do well to check their movements before they assume gigantic proportions.

ALTHOUGH the Professorship of Anatomy and Histology at the University of Lund has been twice officially announced vacant no applicant has come forward. It will now have to remain unoccupied till 1886.

THE Mexican Government has at length determined to undertake a geological survey of the whole country, as far as practicable. 10,000 dollars have been assigned for preliminary expenses.

WE have received from Messrs. Theiler and Sons specimens of their Universal Pocket Microscope and their Demonstration Microscope. The former magnifies 50 diameters, while the latter, intended for "schools and the drawing-room," has three powers—30, 100, and 150 diameters. They are both very admirable contrivances, and should be in the hands of all young people. The definition and achromatism of the Demonstration Microscope are perfect.

THE additions to the Zoological Society's Gardens during the past week include two Javan Cats (*Felis javanensis*), a Marbled Cat (*Felis marmorata*) from Malacca, presented by Mr. Frank Swettenham; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Dr. L. Morgan; a Slender-billed Cockatoo (*Cacatua tenuirostris*) from Australia, presented by Mrs. E. H. Watson; two Tuatera Lizards (*Sphenodon punctata*) from New Zealand, presented by Prof. T. J. Parker; a Smooth Snake (*Coronella lævis*), a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Slender-billed Cockatoo (*Cacatua tenuirostris*) from Australia, thirteen Tuatera Lizards (*Sphenodon punctata*) from New Zealand, deposited; an Osprey (*Pandion haliaetus*), caught in the North Sea, purchased; a Darwin's Rhea (*Rhea darwini*) from Patagonia, received in exchange; a Hog Deer (*Cervus porcinus* ♂), two Four-horned Antelopes (*Tetraceros quadricornis*), two Prairie Marmots (*Arctomys ludovicianus*), two Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE OBSERVATORY OF PARIS.—Rear-Admiral Mouchez has issued his report on the work of this establishment during the year 1884. The completion of the re-observation of Lalande's stars has led to a new disposition of the meridian-instruments, one of which, on the proposal of M. Lœwy, is now occupied with the determination of a number of circumpolar stars on his new method; the great meridian-circle and the circle of Gambey are still employed for observations of the minor planets, and of comparison-stars for planets, comets, and nebulæ observed with the equatorials. The great telescope of 0·74 m. is still unmounted, no suitable position being available in the present state of the grounds of the Observatory. M. Mouchez mentions having received communications from the authorities in Algeria, referring to the possibility of obtaining from the local budget the greater part of the sum that would be required to mount the instrument at the Observatory of Algiers on the summit of the Boudjaréah—an exceptionally favourable situation, which might be visited by the astronomers of the Paris Observatory for special observations, but the Council of the latter institution have not availed themselves of the proposition, in the hope that the equatorial may yet be erected at Paris. Amongst the observations made with the instruments in the west tower and the Henry equatorial, are many of the satellites of Uranus and Neptune, the companion of Sirius, the belts of Uranus, nebulæ, and double-stars. MM. Henry have been occupied with astronomical photography during the year, and, as is well known, with great success; various clusters of stars have been photographed, and M. Mouchez appends to his report a reproduction by heliogravure of a plate of the great clusters in Perseus. A trace of the motion of the minor planet Pallas was shown after an exposure of thirty-five minutes. The important results obtained by MM. Henry in photographing very small stars in those crowded parts of the heavens where the Galaxy crosses the ecliptic have been already referred to in this column. Steady progress has been made both with the calculations and printing of the Paris Catalogue of Stars, and it is expected that the first volume of both series (star-positions as observed, and catalogue) will be completed by the end of the year. Vol. xviii. of the *Mémoires* is finished. The Report further details the personal work of the members of the Observatory staff. Amongst the additions to the Museum is a portrait of Pons, presented by M. Tempel.

The Report for the year 1884 is preceded by one which enters specially into the present condition of a scheme for removing the principal instruments in the Observatory to a site where not only greater steadiness can be secured in their mounting but where the objections of being surrounded by a great city will not exist. It appears that the Academy of Sciences have not, so far, favoured this scheme. M. Mouchez states very clearly his view of the question.

THE COMET TEMPEL-SWIFT (1869–80).—M. Bossert, of Paris, is engaged upon the determination of the orbit of this comet, which may be expected to reach perihelion again about May, 1886, the period of revolution being rather less than 5½ years. Since the last perihelion passage on November 8, 1880, the perturbations are not likely to have been material, and should the comet arrive at its least distance from the sun early in May the chances of reobservation will be very small indeed, the longitude of perihelion being in 43°, and the inclination of the orbit to the ecliptic less than 5½°.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, JUNE 7–13

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 7

Sun rises, 3h. 47m.; souths, 11h. 58m. 35·5s.; sets, 20h. 10m.; decl. on meridian, 22° 48′ N.: Sidereal Time at Sunset, 13h. 15m.

Moon (New on June 12, 23h.) rises, 0h. 56m.; souths, 7h. 3m.; sets, 13h. 22m.; decl. on meridian, 0° 41′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	2 59	10 34	18 9	17 10 N.
Venus	4 17	12 38	20 59	23 57 N.
Mars	2 34	10 14	17 54	17 58 N.
Jupiter	9 51	17 1	0 11*	12 52 N.
Saturn	4 31	12 40	20 49	22 26 N.

* Indicates that the setting is that of the following day.

Phenomena of Jupiter's Satellites

June	h. m.		June	h. m.	
7	20 42	I. ecl. reap.	11	20 36	II. occ. disap.
8	0 2	IV. tr. ing.	13	22 0	I. tr. ing.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

June	h.	
11	1	Mars in conjunction with and 3° 51′ north of the Moon.
11	16	Mercury in conjunction with and 2° 47′ north of the Moon.
13	6	Saturn in conjunction with and 4° 3′ north of the Moon.
13	17	Venus in conjunction with and 5° 48′ north of the Moon.

GEOGRAPHICAL NOTES

The Pamir is the subject of another contribution, by M. Ivanoff, to the last issue of the *Izvestia* of the Russian Geographical Society. Several objections having been made to his views on the Pamir, already mentioned in Nature, and especially to his tendency of limiting the name of Pamir to the eastern part of the great Central Asian mountain mass. M. Ivanoff answers by a paper accompanied by a map of the Pamir, on which the whole of the region is represented; the chains of mountains being drawn, however, merely schematically, which circumstance is a great obstacle to catching on the map their real characters. He insists on the fact that the denominations "Great" and "Little Pamir," introduced by Messrs. Gordon and Trotter, are not known to those natives who are best acquainted with the region, and they lay altogether too much stress upon the names in use among Kirghizes. He thus limits the discussion as to what must be considered as the Pamir, which discussion had been so very well put by his former orographical papers on its proper ground—that of physical geography—where it obviously must remain. We notice in the same issue a paper by M. Wolter on the Prussian Lithuanians; and a preliminary report, by M. Sorokin, on his journey in Russian Tian-Shan.

The new and promising route to Central Asia from the Mortvyi Kultuk Gulf of the Caspian viâ the Ust-Urt to Kungrad is the subject of an interesting paper read by M. Belavskiy before the Russian Geographical Society, and analysed in the last issue of the *Izvestia* (xxi. 2). Until lately the Mortvyi Kultuk was considered too shallow for navigation, east winds being said to reduce its depth to 3·5 feet. Recent soundings proved, however, that, the usual depth being about 9 feet, no winds reduce it more than to 4½ feet; in fact, flat steamers freely navigate the gulf. Those which do not take more than 4½ feet of water approach the shores for 60 to 230 yards at Ayrakly. From that port, which has sweet-water wells, the route goes on to the Ust-Urt plateau. The Ust-Urt was formerly considered as quite dry, and as having a very severe climate. But this belief was exaggerated. Water is found at each 10 to 13 miles; there are also pasture-grounds, and neither the cold in winter nor the heat in summer is excessive. This last is moderated by winds. The *saksaoul*, brushes, and the excrement of camels give the necessary fuel. On the whole stretch, 270 miles long, from the Mortvyi Kultuk to Kungrad, there is no difficulty in crossing the Ust-Urt in carriages, and want of water is felt only near Kungrad. From this town steamers may ply on the Amu-daria; a steamer has already gone up the river to Khodja-Sala. Moreover, a route, available for carriages, runs along the left bank of the river. On the whole this new route has already proved to be more advantageous for the transport of merchandise from Bokhara to Russia than he old one viâ Orenburg.

From a communication to the Russian Geographical Society, made by Dr. Dybovskiy, it appears that the Commodore Islands—Behring, Copper, and two smaller ones—situated 300 miles east of Kamschatka, ought to be regarded in a better light than they have been hitherto. Behring Island is covered with excellent prairies, and Dr. Dybovskiy is sure that agriculture could be carried on it. The southern part of this island is hilly, and reminds one of the alpine regions of Kamstchatka. No forests, but only shrubs of the *Rhododendron Sorbus*, and so on, grow on the islands; but the explorer's experiments of planting forest-trees proved quite successful. The higher tracts offering excellent grazing grounds for reindeer, a number of these last were imported in 1882, and the experiment of acclimatising them on the island proved also quite successful. The narrow valleys of Copper Island are also considered quite suitable for agriculture. The islands are formed of crystalline rocks covered with Tertiary deposits; they contain copper ore and brown coal, of course unworked. Fuel is brought from Kamtschatka. The climate is far milder than on the peninsula, and while in May snow a yard thick lay at Petropavlovsk, vegetables are freely grown on the islands. Snow is altogether so scanty that horses brought on to Behring Island were feeding throughout the winter on the prairies. The fauna of the islands has been well explored by M. Dybovskiy. The flora is much like that of the alpine regions of Kamtschatka. The inhabitants, all Aleutes, 514 in number, live in wooden houses. They are all Christians, and can read.

The attention of geographers and men of science ought to be called to several numbers of the *Archiv für die naturwissenschaftliche Landesdurchforschung von Böhmen*, which have recently been issued (Prague: Franz Rzuonatz). The numbers of most interest to geographers pure and simple are those forming the first division of the third volume, and containing a list of the heights in Bohemia trigonometrically determined by the Imperial Institute of Military Geography in the years 1877–79. Numbers 2 to 6 of the fourth volume deal with the geology and botany of Bohemia, and numbers 1 to 3 of the fifth volume are also devoted to geology. The monographs composing this work are said to constitute a real treasury of information concerning the physical conditions and natural resources of the Austrian Crownland of which it treats.

At the last meeting of the Paris Geographical Society a communication was read from Capt. Sorensen respecting his visit last year to Spitzbergen. It contained numerous observations on climatology and the configuration of the coasts (especially in correction of the English charts). His remarks with regard to the state of the ice during the spring are of special interest. He found the ice around Spitzbergen very different from what he had observed in previous years. Usually the western side is accessible at the commencement of the season, viz., May and June. *Drifts* are to be met with, but they disappear about the middle of June, or, at the latest, in the beginning of July. Last year, on the other hand, the west coast was blocked by ice the whole summer through. No captain can recollect having ever encountered such a mass of ice on this coast. The Norwegians have observed that for three years past the melting of the ice has grown later year by year. On the east coast the sea is generally full of icebergs, but it was wholly free from them last year. Off Barentz Island also the sea was free from ice, and one of the captains who penetrated farther to the east discovered two islands. Capt. Sorensen suggests, therefore, that Spitzbergen and Franz-Josef Land form parts of a vast archipelago, and not two wholly distinct territories, as has hitherto been believed. He promises during coming years to continue his meteorological observations in his annual visits to these regions.

THE last number of the Royal Geographical Society of Antwerp (tome ix. 5e fascicule) contains a paper by M. van den Gheyn on the European origin of the Aryas, a discussion of recent researches on this subject, especially of the works of Schrader, Penka, von Löher, Roth, Geiger, and Ujfalvy. The author, while regarding the subject as open to discussion, thinks that the probabilities are in favour of an Asiatic origin. Dr. Haine writes on the manners of the Californian Indians, amongst whom he passed some time about 1850. M. August Thys contributes a brief account of an early Flemish navigator, Dietrich Paesschen, who made several voyages to the Levant about 1511; and M. Baguet describes Steinen's late journey on the Xingu. An instalment of the report of the commission to study the Scheldt concludes the number.

THE expedition which the Norwegian Government dispatches this summer to the coast of Finmarken, to which we have previously referred, has for its chief object to ascertain whether there are banks or fishing grounds far from the coast, a circumstance which has never been ascertained, but which would be of great value if proved. Hitherto all fishing has been confined to the shore, but, judging from what is the case further south in Norway, such a discovery is very likely.

ON May 27 the Arctic steamer *Alert* sailed from Halifax with a scientific expedition for Hudson's Bay, to examine its harbours and the facilities that exist for a trade route from the Western Territory to Europe.

ARTIFICIAL EARTHQUAKES

QUITE recently we noticed a paper by Prof. Milne, of Japan, which contained exhaustive records of nearly 250 earthquakes that occurred in that country in two years, and which was an earthquake history of Northern Japan during that period. We have now before us another paper from the same indefatigable investigator, also on earthquakes, but on a totally different branch, viz. seismic experiments—in other words, on artificial earthquakes. These experiments are so original in their inception, and in some respects so unexpected in their results, that they are worth describing at some length. The paper, which was read before two successive meetings of the Seismological Society of Japan towards the close of last year, covers over eighty octavo pages, and contains several illustrations; but it will be possible to extract its principal results in a comparatively short space. There were in all ten series of experiments, carried on over three years. The object was to study phenomena connected with earth-vibrations produced either by some explosive like dynamite, or by allowing a heavy weight to fall from a height. Each set of experiments involved several weeks' preparation; amongst the chief difficulties to be overcome were the procuring, transporting, and storing dynamite, putting the observing-stations in telegraphic connection, arranging the firing apparatus, making electric fuses, and the like, and doing all this in the midst of a populous city. These initial difficulties could never have been overcome but for the assistance of various departments of the Japanese administration, and it is pleasing to notice the help which Japanese officials freely render Prof. Milne in his interesting and important work in the field of seismic science. Nevertheless, he warns his readers at the outset that his experiments were such that it is hardly just to expect them to be carried out satisfactorily by a private individual; the trouble, expense, danger, and magnitude of the arrangements which they involve make them fitter undertakings for an army corps.

The only guiding data which he had when he commenced were the results obtained by the late Mr. Robert Mallet and by Gen. Abbot. These referred only to the velocity with which earth-vibrations were propagated, and in taking diagrams of earth-motion he was therefore entering upon new ground, and therefore continually encountered new results. Sometimes it was found that the instruments employed required modification before satisfactory records could be obtained; at other times the records which were obtained gave indications of new lines of investigation, to pursue which new apparatus would be needed, and so on. Hence many of his results, he observes, can only be regarded as provisional; for example, those which relate to the velocities of normal and transverse vibrations. The experiments were carried out, as far as circumstances would permit, in different soils, the chief agents employed being heavy weights of 1700 lbs. and upwards dropped from heights up to 40 feet, and different quantities of dynamite exploded in cavities of varying depths. The effects of these were observed with different seismographs. The observations thus made in the ten series of experiments are described with the utmost detail, illustrated by numerous plans and tables, under their appropriate heads. Prof. Milne sums up his results under a succession of heads, and the most important of them are given below. He observes, however, that in reading these conclusions it must be remembered that they only refer to experiments performed in certain kinds of ground.

Effect of Ground on Vibration.—Hills have but little effect in stopping vibrations, but excavations exert considerable influence on them. In soft, damp ground it is easy to produce vibrations of large amplitude and considerable duration; in loose, dry ground an explosion of dynamite yields a disturbance of large amplitude but of short duration, while in soft rock it is difficult to produce a disturbance the amplitude of which is sufficiently great to be recorded on an ordinary seismograph.

General Character of the Motion.—The pointer of a seismograph with a single index first moves in a normal direction, after which it is suddenly deflected, and the resulting diagram yields a figure partially dependent on the relative phases of the normal and transverse motion, which phases are in turn dependent upon the distance of the seismograph from the origin of the disturbance. A bracket seismograph indicating normal motion at a given station commences its indications before a similar seismograph arranged to write transverse motion. If the diagrams yielded by two such seismographs be compounded, they yield figures containing loops and other irregularities not unlike the figures yielded by the seismograph with the single index. Near to an origin the first movement will be in a straight line outwards from the origin; subsequently the motion may be elliptical, like the figure 8, and irregular. The general direction of the motion is, however, normal. Two points of ground only a few feet apart may not synchronise in their motions, and earthquake motion is probably not a simple harmonic one.

Normal Motion.—Near to an origin the first motion is outwards; at a distance from the origin the first motion may be inwards, the nature of the movement being dependent probably on the intensity of the initial disturbance and on the distance of the observing station from the origin. At a station near the origin the second or third wave is usually the largest, after which the motion dies down very rapidly in its amplitude, the motion inwards decreasing more rapidly than the motion outwards. Roughly speaking, the amplitude of normal motion is inversely as the distance from the origin. As a disturbance radiates, the period of oscillation increases, until finally it becomes equal to the period of the transverse motion. It may thus be inferred that the greater the initial disturbance the greater the frequency of the waves. A wave which appeared single at one observing station had split up into two by the time it reached the second. At stations near the origin the motion inwards is greater than the motion outwards; but at a distance the two motions are practically equal. At a station near the origin the period of the waves is at first short, but it becomes longer as the disturbance dies out. The semi-oscillations inwards are described more rapidly than those outwards.

Transverse Motion.—The laws governing the transverse motion are practically identical with those which govern the normal motion, the only difference being that in the case of normal motion they are more clearly pronounced. Near to an origin the transverse motion commences definitely but irregularly; the first two or three movements are decided, and their amplitude slightly exceeds that of those which follow, but it decreases as the disturbance radiates at a slower rate than that of the normal motion. The period increases as the disturbance radiates, and decreases as the latter begins to die out.

Relation of Normal to Transverse Motion.—Near to an origin the amplitude of normal is much greater than that of transverse motion, and as a disturbance radiates the amplitude of the latter decreases at a slower rate than that of the former, so that at a certain distance they may be equal.

Maximum Velocity and Intensity of Movements.—An earth-particle usually reaches its maximum velocity during the first inward movement, but a high velocity is sometimes attained in the first outward semi-oscillation. The value

$$V^2 = \tfrac{1}{2} g \sqrt{a^2 + b^2} \times \left(\frac{1 - \cos\theta}{\cos^2\theta}\right)$$

used by Mallet and other seismologists to express the velocity of shock, as determined from the dimensions of a body which it has overturned, is a quantity not obtainable from an earthquake diagram. It represents the effect of a sudden impulse. In an earthquake a body is overturned or shattered by an acceleration, f, which is calculable for a body of definite dimensions. As obtained from an earthquake diagram f lies between $\frac{V}{t}$ and $\frac{V^2}{a}$, where V is the maximum velocity, t is the quarter period, and a is the amplitude. The initial velocity given in the formula $V^2 = \frac{2a^2}{b}$ for horizontal projection used by Mallet as identical with V^2 in the first formula, are not identical quantities. The velocity calculated from the range of projection, when projection occurs, is identical with the maximum velocity as measured directly or calculated from a diagram. The values $\frac{V^2}{a}$ are those used by Prof. Milne in discussing the intensity of movement. The intensity of an earthquake at first decreases rapidly as the disturbance radiates, subsequently it decreases more slowly. A curve of intensities deduced from observations at a sufficient number of stations would furnish the means of approximately calculating an absolute value for the intensity of an earthquake.

Vertical Motion.—In soft ground vertical motion appears to be a free surface-wave which advances more rapidly than the horizontal component of motion. It commences with small, rapid vibrations, and ends with vibrations which are long and slow. High velocities of transit may be obtained by the observation of this component of motion, and this is possibly an explanation of the preliminary tremors of an earthquake and the sound phenomenon.

Velocity.—The velocity of transit decreases as a disturbance radiates; near to an origin it varies with the intensity of the initial disturbance. In different kinds of ground, with different intensities of initial disturbance, and with different systems of observation, velocities lying between 630 feet and 200 feet per second were determined. Mr. Mallet determined a velocity in sand of 824 feet, and in granite of 1664 feet per second. Gen. Abbot observed velocities of 8800 feet. These various determinations may all be strictly correct, the great difference between them being due partly to the nature of the rock, the intensity of the initial disturbance, and the kind of wave which was observed. In Prof. Milne's experiments the vertical free surface wave had the quickest rate of transit, the normal being next, and the transverse motion being the slowest; but the rate at which the normal motion exceeds the transverse is not constant. As the amplitude and period of the normal motion approach in value those of the transverse motion, so do the velocities of transit of these motions approach each other.

In stating the results, of which those given above are the principal, Prof. Milne refers to the particular experiments which support them, thus giving chapter and verse for his conclusions; but he thinks that if the investigations were repeated by himself or by any other investigator, although much of what he has recorded would be substantiated, more accurate results might be obtained by taking advantage of his experience. Finally he gives examples of investigations which have yet to be undertaken, and as these are valuable for others working in the same field, we append them here:—(1) An accurate determination of the rate at which the velocity of transit decreases as a disturbance radiates from its origin; (2) the relation between the velocity of transit and the intensity of the initial disturbance; (3) the determination of the rate at which the intensity of a disturbance decreases as measured at different distances from the origin. This might perhaps lead to the construction of a curve of intensities from which the absolute intensity of the initial disturbance could be learnt; (4) a more complete investigation of the vertical motion and of free surface waves; (5) an investigation of the inward motion of shocks. In Prof. Milne's experiments the movement of the ground from its neutral position *in* towards the origin of the disturbance has been performed so rapidly that he has been unable with the instruments at his disposal to measure its velocity accurately. As this is probably the most destructive element of motion, he regards its investigation as exceedingly important; (6) further investigations on the relationship between earthquake diagrams, and the overturning and projecting of various bodies; (7) a repetition of these and of all other experiments, on different kinds of ground.

THE INFLUENCE OF FORESTS ON CLIMATE

THE third number of *Petermann's Mittheilungen* for this year contains an article by Herr A. Woeikof on the influence of forests on climate. The commencement of a scientific investigation of this subject was made when the Bavarian forest meteorological stations were established, and when Prussia, Alsace-Lorraine, France, Switzerland, and Italy followed the example. As a general rule it may be laid down that in the warm seasons, as between forests and places close at hand which are treeless (1) the temperatures of the earth and air are lower in the former, (2) their variations are less, (3) the relative humidity is greater. After examining observations as to evaporations, Herr Woeikof states that the influence of forests in diminishing evaporation from water and the soil is so great that it cannot be accounted for alone by the lower temperature of the hot months, the greater humidity, or even by the shade. An important influence, which has hitherto been but little appreciated, is the protection from the wind afforded by the trees, and this the writer regards as more important than all the others together in reducing the degree of evaporation. With regard to the influence of forests on rain and snowfall, there is as yet only a single series of observations supplying comparative statistics, and extending over a sufficiently long period. These were taken in the neighbourhood of Nancy, and they show an important influence of forests in increasing the rainfall. It might appear that the effect of forests on rain in the climate of Central Europe in winter would be small, for the difference between the temperature and humidity of the forest and the open is very little, and the quantity of moisture in the atmosphere is small. But the observations show that it is at this time of the year that forests get much more rain. This the writer attributes to the clouds being lower, the resistance which the forest offers to the movement of the air, and to the moist west wind. Forests retain rain by the undergrowths of grass, moss, &c., much better than open ground, and let water off superficially only after a heavy rainfall; the remainder filters upwards slowly, and much of it is used for the evaporation of the trees. Although forests, especially thick, luxuriant forests, cannot exist without certain supplies of moisture, yet it is the same to them when the supplies come, for they retain what they get and use it over a long period. One example of this is the Lenkoran forest on the west coast of the Caspian, where the vegetation is more luxuriant than in any other part of Europe, yet very little rain falls in summer, but the rainfall in autumn and winter is great. The water is stored up by the forest, and is used in evaporation during the heat of summer. Humidity of the atmosphere, however, is not inconsistent with a high temperature, as the Red Sea shows; but in forests the humidity is due to the evaporation of the leaves—in other words, to a process by which heat is converted into work, and hence the coolness. Herr Woeikof then endeavours to ascertain the influence of forests on the climatic conditions of their neighbourhoods in the western parts of the Old World, between the 38th and 52nd degrees N. latitude, the places selected being in all cases in the open. Thus for the 52nd degree eight stations are taken between Valentia in Ireland on the west and the Kirghiz steppes on the east; for the 50th, Guernsey on the west, Semipalatinsk on the east, and thirteen stations, and so on for each two degrees of latitude to 38°. The general result of the observations in fifty-stations in six different degrees of latitude is that in Western Europe and Asia large forests have a great influence on the temperature of places near them, and that by their influence the normal increase of temperature as we travel eastward from the Atlantic Ocean to the interior of the continent is not merely interrupted, but they give places far removed from the coast a cooler summer than those actually on the sea. A striking example of this is Bosnia. An examination of the statistics shows (1) that in Bosnia the summer is 2°·5 to 4°·5 cooler than in Herzegovina; (2) even on the island of Lissa, in the full influence of the Adriatic Sea, the summer temperature is more than a degree higher than that of Bosnia, which is separated by lofty mountain ranges from the sea. Bosnia owes this comparatively cool summer to its great forests, while Herzegovina is almost disafforested. To sum up: forests exercise an influence on climate which does not cease on their borders, but extends over a larger or smaller adjacent region according to the size, kind, and position of forest. Hence man by afforestation and disafforestation can modify the climate around him; but it is an extreme position to hold that by afforestation the waste places of the earth can be made fertile. There are places incapable of being afforested, which would not give the necessary nourishment to trees.

ORIGIN OF THE CEREALS

RECENT numbers of *Naturen* contain interesting papers, by Prof. Schübeler, on the original habitat of some of the cereals, and the subsequent cultivation in the Scandinavian lands and Iceland of barley and rye more especially. It would appear that barley was cultivated before other cereals in Scandinavia, and that the generic term "corn" was applied among Northmen to this grain only from the oldest times, and that in the Norwegian laws of the seventeenth and eighteenth centuries wherever reference was made to the "*Kornskat*"—or standard by which land in the Northern lands was, and still is, rated in accordance with the corn it is capable of yielding—the term was understood to apply to barley. Proof of the high latitude to which the cultivation was carried in early ages is afforded by the Egil's Saga, where mention is made of a barn in Helgeland (65° N. lat.) used for the storing of corn, and which was so large that tables could be spread within it for the entertainment of 800 guests. In Iceland barley was cultivated from the time of its colonisation, in 870, till the middle of the fourteenth century, or, according to Jón Storrason, as lately as 1400. From that period down to our own times barley has not been grown in Iceland with any systematic attention, the islanders being dependent on the home country for their supplies of corn. In the last century, however, various attempts were made both by the Danish Government and private individuals to obtain home-grown corn in Iceland, and the success with which these endeavours were attended gives additional importance to the systematic undertaking, which has been set on foot by Dr. Schübeler and others, within the last three years, for the introduction into the island of the hardier cereals, vegetables, and fruits. As many as 382 samples of seeds of ornamental and useful plants, most of which were collected from the neighbourhood of Christiania, are now being cultivated at Reykjavik under the special direction of the local government doctor, Herr Schierbeck, who succeeded in 1883 in cutting barley ninety-eight days after the sowing of the seed, which had come from Alten (70° N. lat.). And here it may be observed that this seems the polar limit in Norway for anything like good barley crops. The seed is generally sown at the end of May, and in favourable seasons it may be cut at the end of August; the growth of the stalk being often 2½ inches in twenty-four hours. North of 60° or 61° barley cannot be successfully grown in Norway at more than from 1800 to 2000 feet above the sea-level. In Sweden the polar limit is about 68° or 66°, but even there, as in Finland, night-frosts prove very destructive to the young barley. In some of the fjeld valleys of Norway, on the other hand, barley may in favourable seasons be cut eight or nine weeks after its sowing, and thus two crops may be reaped in one summer. According even to a tradition current in Thelemarken, a farm there owes its name *Triset* to the *three* crops reaped in the land in one year! Rye early came into use as a bread-stuff in Scandinavia, and in 1490 the Norwegian Council of State issued an ordinance making it obligatory on every peasant to lay down a certain proportion of his land in rye. In Norway the polar limit of summer rye is about 69°, and that of winter rye about 61°; but in Sweden it has been carried along the coast as far north as 65°. The summer rye crops are generally sown and fit for cutting about the same time as barley, although occasionally in Southern Norway less than ninety days are required for their full maturity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Gilchrist Trustees have instituted a Scholarship of the annual value of 50*l.*, for three years, tenable at either Girton or Newnham College, Cambridge, to be awarded in connection with the Cambridge Higher Local Examination. The first award will be made on the results of the examination to be held in June. Further information may be obtained from the secretaries of the two colleges.

AT a recent meeting of the Senate of the Royal University of Ireland, two Fellows in the Department of Natural Science were elected. The successful competitors were the Rev. Marshal L. Klein, of the Catholic University College, and Mr. Marcus M. Hartog, Professor of Natural History, Queen's College, Cork. The salary attached to each of the Fellowships is 400*l.* a year.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science, April, contains:—On the urinary organs of the Amphipoda, by W. B. Spencer, B.A. (plate 13).—The skin and nervous system of Priapulus and Halicryptus, by R. Scharff, Ph.D. (plate 14).—The eye and optic tract of insects, by S. J. Hickson, B.A. (plates 15–17).—A peculiar sense organ in *Scutigera coleoptrata*, one of the Myriopoda, by F. G. Heathcote, B.A. (plate 18).—The structure and development of Loxosoma, by S. F. Harmer, B.Sc. (plates 19–21).—A new hypothesis as to the relationship of the lung-book of Scorpio to the gill-book of Limulus, by E. R. Lankester, M.A.—A supplement number is announced to be published during May.

The Journal of the Royal Microscopical Society for April contains:—The Rev. W. H. Dallinger's address as President (plates 4–6).—The Lantern Microscope, by L. Wright.—On some unusual forms of lactic ferment; *Bacterium lactis*, by R. L. Maddox, M.D.—On a cata-dioptric immersion illuminator, by J. W. Stephenson.—With the usual summary of current researches in zoology and botany.

American Journal of Science, May.—Experiments undertaken to determine the modulus of elasticity of ice and the velocity of sound in ice, by John Trowbridge and Austin L. McRae. The average of all the observations was found to be 72×10^9 as compared with Bevan's absolute modulus 54×10^9. The velocity was determined at 2900 m. per second, or about nine times the velocity of sound in air.—Contributions from the Agricultural Experiment Station of the University of Wisconsin: digestion experiments, by H. P. Armsby. These experiments, made on sheep fed with hay, clover, malt-sprouts, and cotton seed-meal, yielded so many uncertain results that no satisfactory averages could be determined. Such averages may be made the basis of the calculation of rations in practice; but neither they nor the single results upon any given fodder can properly enter into any scientific calculation of the nutritive effect of a ration.—Chemical analysis of massive safflorite, by Le Roy W. McCay.—Application of photography to the study of electrical measurements (two illustrations), by John Trowbridge and Hammond Vinton Hayes.—On the production of alternating currents by means of a direct-current dynamo-electric machine, by John Trowbridge and Hammond Vinton Hayes.—Chemical analysis of a variety of topaz discovered in 1882 by Mr. N. H. Perry in the Stoneham district, State of Maine (two illustrations), by F. W. Clarke and J. S. Diller.—A notice of the relation observed by Dr. Weber between the residual elasticity and the chemical constitution of glass, by O. T. Sherman.—On the meridional deflection of ice-streams, as shown in the *moraines* of the extinct glaciers in the Mono Lake Valley, Eastern California (two illustrations), by W. J. McGee.—The pre-Glacial channel of Eagle River, Keweenaw Point, Lake Superior (one illustration), by Charles Whittlesey.—Note on the age of the slaty and arenaceous rocks in the vicinity of Schenectady, Schenectady County, New York, by S. W. Ford. These formations, usually referred to the epoch of the Lorraine shales, are regarded by the author as belonging to the Utica age. From them were obtained various fossils, including a species of Lingula which he considers to be the Utica species, *L. curta*.

The American Naturalist, March, contains:—Indian corn and the Indians, by E. L. Sturtevant.—The evolution of the Vertebrata, progressive and retrogressive, by E. D. Cope.—On the larval forms of *Spirorbis borealis*, by J. W. Fewkes.—Pennsylvania, before and after the elevation of the Appalachian Mountains; a study in dynamical geology, by E. W. Claypole.—Life and nature in Southern Labrador, by A. S. Packard.

April.—Why certain kinds of timber prevail in certain localities, by J. T. Campbell.—The evolution of the Vertebrata, by E. D. Cope.—Progress of North American Invertebrate palæontology for 1884, by J. B. Marcou.—The clam-worm, by S. Lockwood.—Life and nature in Southern Labrador, by A. S. Packard.

May.—Some new Infusoria (with illustrations), by A. C. Stokes.—Kitchen-garden esculents of American origin (I.), by E. L. Sturtevant.—The Lemuroidea and the Insectivora of the

Eocene period of North America (illustrated), by E. D. Cope. —On the Labrador Eskimo and their former range southward, by A. S. Packard.

Rendiconti del Reale Istituto Lombardo, April 23.—Some formulas for the calculation of the momenta of inertia in plain polygons, by Prof. G. Bardelli.—Some remarks on the functions which satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Note on the morphological distinction between the various homologous and analogous organs of the different orders in the animal kingdom, by E. L. Maggi.—On a generalisation of the involute properties of complete squares and quadrilateral figures, by Gino Loria.—On a method of plain representation for the descriptive geometry of ordinary space, by Prof. F. Aschieri.—On the discontinuities in the secondary derived forms of the potential functions of a surface, by Dr. Paolo Paci.—Meteorological observations made in the Royal Brera Observatory, Milan, during the month of April.

Rivista Scientifico-Industriale, April 15-30.—Remarks on the velocity of the wind in connection with Prof. Archibald's experiments with Biram's anemometers, by the Editor.—Variations in the electric resistance of solid and pure metallic wires, according to the temperature (continued), by Prof. Angelo Emo.—Description of a new steam generator based on the principle of vortex circulation, by Prof. Annibale Riccò.—Note on the *Emberiza intermedia* discovered by Dr. Michaellis in Dalmatia is it a distinct species in this family of birds? by Dante Roster.

SOCIETIES AND ACADEMIES

London

Royal Society, May 7.—"Contributions to the Chemistry of Chlorophyll. Part I.," by Edward Schunck, F.R.S.

The paper treats of the products formed by the action of acids on chlorophyll. All who have worked with chlorophyll are familiar with the peculiar effects produced in solutions of chlorophyll by the action of acids. The colour is changed, and an absorption spectrum makes its appearance, which differs from that of chlorophyll. According to some, these changes are due to a simple modification of the chlorophyll, others consider they are caused by the formation of products of decomposition. The latter view seems the more probable.

On passing a current of hydrochloric acid gas into an alcoholic solution of chlorophyll, a dark green, almost black, precipitate is formed at once. The greenish-yellow liquid contains substances extracted along with chlorophyll by the alcohol, and not connected with the latter. The precipitate consists essentially of two colouring matters, phyllocyanin and phylloxanthin, bodies that had been previously observed and so named by Fremy, who, however, did not obtain them in a state of purity. They are best separated by Fremy's method, which consists in dissolving the mixture in ether, and then adding concentrated hydrochloric acid, when the liquid separates into two layers, a lower blue one containing phyllocyanin and an upper yellowish-green one containing phylloxanthin. It is immaterial what kind of leaves are taken for extraction, the products are always the same.

The paper deals only with the properties of phyllocyanin, which are very peculiar. After being purified in the manner described, it is obtained as a dark blue mass resembling indigo, and consisting of microscopic crystals which are generally opaque, but sometimes when very thin are translucent, and then appear olive-coloured. It stands heating to 160° without decomposition, but between that temperature and 180° it is decomposed without previously fusing, leaving a charred mass which, on further heating, burns away without residue. It contains nitrogen, but is free from sulphur.

Phyllocyanin is insoluble in water, petroleum ether, and ligroin, but dissolves in alcohol, ether, chloroform, glacial acetic acid, benzol, aniline, and carbon disulphide. The best solvent is chloroform. A minute quantity of the substance imparts an intense colour to any one of these solvents. It is only on diluting largely that the solutions lose their opacity. They then appear of a dull green or olive colour, and show the well-known and often described spectrum of so-called "acid chlorophyll," consisting of five bands, three of which are very dark, one of moderate intensity, and the fifth very faint.

By oxidising agents, such as nitric or chromic acid, phyllocyanin is easily decomposed, yielding yellow amorphous products, the solutions of which show no absorption bands. It shows a remarkable degree of permanence as compared with chlorophyll, when exposed to the combined action of air and light. A chloroformic solution contained in a loosely-stoppered bottle may be exposed for weeks, or even months, to alternate sunlight and diffused daylight before its peculiar colour and all trace of absorption bands have disappeared. When the process is complete a yellow liquid results, which contains several products, all of them amorphous, one being easily soluble in water, and exceedingly bitter to the taste. The decoloration of a chlorophyll solution under the same circumstances would take place in a day or two.

Phyllocyanin dissolves easily in concentrated sulphuric, hydrochloric, and hydrobromic acids, yielding dark blue solutions, which show spectra differing from that of phyllocyanin, and no doubt contain compounds of the latter with acids. These compounds, however, are unstable; for, on the addition of water to the solutions, phyllocyanin is precipitated unchanged. Phyllocyanin shows no tendency to combine with weaker acids, such as phosphoric, oxalic, tartaric, or citric acid.

Phyllocyanin dissolves easily in dilute caustic potash or soda lye. The solution gives precipitates of various shades of green with earthy and metallic salts, such as barium chloride, calcium chloride, lead acetate, and cupric acetate, and these might be called phyllocyanates. It seems, however, that by mere solution in alkali, phyllocyanin undergoes some change, for if acetic acid in excess be added to the solution, and it be then shaken up with ether, the precipitate dissolves in the ether, giving a solution which shows the bands of phyllocyanin; but if the whole be left to stand some time, the colour of the ethereal solution changes from green to brown, and it now shows a distinct and peculiar spectrum, characterised by two bands in the red and two fine but well-marked bands in the green, the third and fourth bands of phyllocyanin having disappeared, while the fifth still remains. The body yielding this spectrum has been prepared and found to yield microscopic crystals like phyllocyanin. A different product is formed when hot alkaline lye, or, what is better, boiling alcoholic potash or soda, is employed. It crystallises in small rosettes, which are green by transmitted, of a fine purple by reflected, light. Its solutions have a dull purple colour, and exhibit a distinct spectrum characterised by a broad, very dark band in the green. It may be identical with one of the products obtained by Hoppe-Seyler from his chlorophyllan with alkalis.

The concluding part of the paper treats of what may be called double compounds of phyllocyanin, into which metals and acids, especially organic acids, enter as constituents. Phyllocyanin seems to act the part of a weak base, uniting with strong acids and forming unstable compounds. In acetic acid it merely dissolves without yielding any compound. In like manner, when freshly precipitated cupric oxide or zinc oxide is added to a solution of phyllocyanin in boiling alcohol no combination takes place. A very different effect is observed when either of the two oxides is employed along with acetic acid. When cupric oxide is added to a solution of phyllocyanin in boiling acetic acid the solution acquires at once a deep greenish blue colour, and it no longer contains uncombined phyllocyanin, for its spectrum is different, and, on standing, it deposits lustrous crystals, which doubtless consist of a compound containing phyllocyanin, acetic acid, and copper. If zinc oxide be employed, a similar effect is observed: the liquid acquires an intense green colour like that of a chlorophyll solution, and now contains the corresponding acetate of phyllocyanin and zinc. The same phenomenon is seen when ferrous oxide, manganese oxide, or silver oxide is taken, liquids of various shades of green being obtained which contain phyllocyanin compounds; but no similar compounds are formed when potassium, sodium, barium, calcium, magnesium, or lead acetate is employed. Acetic acid is, however, not the only acid which yields the reaction. If palmitic, stearic, oleic, tartaric, citric, malic, or phosphoric acid be employed, it takes place just as with acetic acid, but in some cases time is required for its completion. Oxalic acid, however, seems to be without effect, and tartaric acid fails in some cases.

The behaviour of phyllocyanin towards zinc oxide in the presence of acids may serve to explain a peculiar phenomenon first observed by Prof. Church, and subsequently described by Tschirch. The former took chlorophyll that had become brown on standing, and, acting on it with zinc powder, obtained a body yielding green solutions, which he took to be regenerated chlorophyll. Tschirch acted on Hoppe-Seyler's chlorophyllan with zinc powder and observed the same phenomena, the conclusion at which he arrived being the same, viz. that chlorophyll is reproduced from chlorophyllan by reduction. It is probable, however, that what they obtained was in reality a zinc compound of phyllocyanin, and would have been formed just as well by using zinc oxide. Chlorophyllan is probably an impure substance containing some fatty acid along with phyllocyanin, so that by the action of zinc oxide it may yield a compound similar to those above mentioned. The experiment was tried with the crude product obtained by passing hydrochloric acid gas into a solution of chlorophyll. Some of this was dissolved in alcohol, and the solution was boiled with zinc oxide, when it gradually became of a bright green like a solution of chlorophyll, but its spectrum differed, being identical with that of the zinc compounds obtained directly from phyllocyanin.

May 21.—"Contributions to the History of the Pleiocene and Pleistocene Deer. Part I. *Cervus verticornis*, *Cervus savini*." By W. Boyd Dawkins, M.A., F.R.S., F.G.S., Professor of Geology and Palæontology in the Victoria University.

The numerous cervine remains which occur in the various collections in Britain and on the Continent have been studied by the author for the last twenty-five years, and in this communication two species, the one hitherto ill-defined, and the other new to science, have been described.

The first, or *Cervus verticornis*, Dawkins, remarkable for the singular forward and downward curvature of the first tine, is represented by a large series of skulls and antlers, which enable the author to define the changes in antler-form from youth to old age, as well as to relegate it to the division of deer with palmated antlers, and to establish its geological age to be Pleiocene and early Pleistocene in Norfolk and Suffolk.

The second, or *Cervus savini*, is represented by several skulls and many antlers, which present considerable modifications in form at varying ages. It also belongs to the section of deer with palmated antlers, and is probably the ancestral form of the extinct (*Cervus browni*, Dawkins) and living (*C. dama*) types of fallow deer. It has hitherto only been met with in the early Pleistocene forest-bed series of Norfolk and Suffolk.

Mathematical Society, May 14.—J. W. L. Glaisher, F.R.S., President, in the chair.—B. Hanumanta Rau, Madras, was elected a member.—Papers were read by Rev. T. C. Simmons, on an application of determinants to the solution of certain types of simultaneous equations; and by H. M. Jeffery, F.R.S., on binodal quartics, on the latter of which the President, S. Roberts, F.R.S., and the author made further remarks.—Mr. Tucker read part of a paper by Prof. J. Larmon on the flow of electricity in a system of linear conductors.

Zoological Society, May 19.—F. Du Cane Godman, F.R.S., in the chair.—A letter was read from the Rev. G. H. R. Fisk, C.M.Z.S., respecting the capture of a Sea-snake among the rocks at the entrance to Table Bay, which he believed to be referable to *Pelamis bicolor*.—A letter was read from Mr. B. Crowther, stating that he was about to send the Society a pair of Duckbills (*Ornithorhynchus paradoxus*), and giving some instructions as to the treatment of these animals in captivity.—Mr. F. Day exhibited and made remarks on a curious specimen illustrative of an extensive injury to the intestines of a Trout and its subsequent recovery therefrom. Mr. Day also exhibited a piece of the sifting-apparatus of the Basking-Shark, together with specimens of the food upon which it lives; and an example of the Vendace taken in Derwentwater Lake.—Mr. Osbert H. Howarth exhibited a specimen of coral of the genus *Dendrophyllia* attached to a brown stoneware bottle, which had been dredged up in the Atlantic, off Madeira, at a depth of about fifteen fathoms.—A communication was read from Prof. J. von Haast, C.M.Z.S., on *Dinornis oweni*, in which the author gave a detailed description of the bones of this recently-discovered new species of the extinct wingless birds of New Zealand, which was remarkable for its small size.—A communication was read from Dr. St. George Mivart, F.R.S., containing notes on the genetic affinities of the group of Pinnipeds.—Dr. F. H. H. Guillemard read the third part of his report on the collection of birds formed during the voyage of the yacht *Marchesa*. The paper dealt with the birds obtained on the island of Sumbawa, a locality hitherto almost unknown to ornithologists. During the *Marchesa's* short visit examples of thirty-nine species were collected. Of these, two (*Turnix powelli* and *Zosterops sumbavensis*) were new to science. The remaining species had been previously recorded from islands to the eastward or westward in the same group.—A communication was read from Dr. Hubrecht, C.M.Z.S., containing a description of a Pennatulid obtained by Capt. St. John in the Japanese Sea at a depth of seventy-one fathoms. A careful examination of the specimen in question induced the author to assign it to a new genus and species, which he proposed to name *Echinoptilum mackintoshii*.—Mr. Herbert Druce, F.Z.S., read a paper on some new species of Lepidoptera-Heterocera, founded on specimens obtained by the late Mr. C. Buckley in Ecuador, to which were added descriptions of some recent acquisitions of the same group from various other localities.—Mr. F. D. Godman, F.R.S., read descriptions of the Lepidoptera collected by Mr. H. H. Johnstone on Kilimanjaro. The collection contained examples of twenty-one species of the Rhopalocera and six of Heterocera. Of the Rhopalocera the author described three species as new.

Geological Society, May 13.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the chair.—William Horton Ellis and Prof. J. Hoyes Panton, M.A., were elected Fellows; and Prof. J. Gosselet, of Lille, a Foregn Member of the Society.—The following communications were read:—On the Ostracoda of the Purbeck formation, with notes on the Wealden species, by Prof. T. Rupert Jones, F.R.S., F.G.S.—Evidence of the action of land-ice at Great Crosby, Lancashire, by T. Mellard Reade, F.R.S.—The North Wales and Shrewsbury coal-fields, by D. C. Davies, F.G.S. After discussing the origin of coal-beds, and the causes of their variation in structure and quality, the author proceeded to describe the North Wales and Shrewsbury coal-field, which consists of three parts: (1) The Shrewsbury field south of the Severn, exclusively composed of Upper Coal-measures; (2) the tracts north of the Severn, extending from near Oswestry to north of Wrexham; and (3) the Flintshire coal-field. The first and second are separated from each other by the alluvial plain of the Severn and Vyrmoy, and the second and third by the Great Bala and Yule faults. Some remarks on the scenery of the Welsh border-land followed, and then a general section of the Carboniferous system, as developed in the country described, was given, the Permian beds being included, as the author considered them the upper portion of one great division of Palæozoic time. The section was as follows, with the maximum thickness of each subdivision:—

	Thickness in yards	
1. Dark red Sandstone	210	Permian, 590 yards.
2. Ifton or St. Martin's Coal-measures	75	
3. Red marls with calcareous matter ..	180	
4. Green rocks and Conglomerates ...	125	
5. Upper Coal-measures	80	Coal-measures, 665 yards.
6. Cefn rock to Cefn coal	100	
7. Cefn coal to Lower yard-coal... ...	270	
8. Lower yard-coal to Chwarcle coal...	80	
9. Chwarcle coal to Millstone Grit ...	135	
	1255 yards	

A detailed description of the strata was next given, beginning with the lowest, together with details of each coal-seam as worked in various parts of the field. After describing the beds from the Millstone Grit to the Cefn rock in the North Wales coal-field, the author proceeded to notice the Upper Coal-measures and Permian strata in the Shrewsbury area, and showed that no break exists between the two, the former passing gradually into the latter. He then discussed the probability of Lower Coal-measures existing beneath the upper beds near Shrewsbury, and showed from sections that the existence of the lower measures might be anticipated. A similar inquiry as to the presence of the Coal-measures beneath the New Red Sandstone of the Vale of Clwyd should also, in the author's opinion, be answered in the affirmative. The organic remains found in the different beds were briefly noticed, and then the faults of the district were discussed at some length. The principal faults run north and south, with an upthrow to the east, but are crossed by lines of fracture running east and west. In conclusion, the correlation of the strata in the North Wales and Shrewsbury coal-fields, and especially of the coal-seams, with the beds found in other parts of Great Britain, was discussed, and a section was given to show the representation of the different measures in various coal-basins. The author was disposed to adopt four subdivisions rather than three only, as usually accepted, and pointed out some of the characteristics of each subdivision.

Royal Meteorological Society, May 20.—Mr. R. H. Scott, F.R.S., President, in the chair.—Dr. H. Dobell and Mr. J. N. Longden were elected Fellows of the Society.—The following papers were read:—The temperature zones of the earth considered in relation to the duration of the hot, temperate, and cold period, and to the effect of temperature upon the organic world, by Dr. W. Koppen, Hon. Mem. R. Met. Soc.—Velocities of winds and their measurement, by Lieut.-Col. H. S. Knight, F. R. Met. Soc. The author, after describing the various ways of ascertaining the direction and velocity of the wind, makes several suggestions for the improvement of Robinson's anemometer.—On the equivalent of Beaufort's scale in absolute velocity of wind, by Dr. W. Koppen, Hon. Mem. R. Met. Soc. The author refers to Mr. C. Harding's paper read before the Society in December last on the anomalies in the various wind velocities given by different authors as equivalents for the numbers in Beaufort's scale, and, as illustrating the point, calls special attention to the want of agreement between the velocities obtained by Mr. Scott and those subsequently obtained by Dr. Sprung, and confirmed by himself.—Note on a peculiar form of auroral cloud seen in Northamptonshire, March 1, 1885, by the Rev. James Davis.

EDINBURGH

Royal Physical Society, May 20.—Prof. Duns, D.D., F.R.S.E., President, in the chair.—The following communications were read, viz. :—On new Selachian remains from the Calciferous Sandstone series, by Ramsay H. Traquair, M.D., F.R.S., L. and E.—Observations on living Cephalopoda, and note on *Loligo forbesii* (Steenstrup), by W. E. Hoyle, M.A., F.R.S.E.—Note on ulceration of the skin of a fish, by G. Sims Woodhead, M.D., F.R.C.P.E.—Note on the presence of a double dorsal vessel in certain earthworms, by Frank E. Beddard, M.A., F.R.S.E., F.Z.S.—The north-west coasts of Sutherland and their bird-life, by John A. Harvie-Brown, F.Z.S., F.R.S.E.—Note on the contents of two bits of clay from the elephant bed at Kilmaurs in 1817, by James Bennie, H.M. Geological Survey. The Secretary (Mr. Robert Gray, V.P.R.S.E.) drew attention to several interesting birds that had been taken during the present month on the Island of May by Mr. Agnew, light-house-keeper, and forwarded to Mr. J. A. Harvie Brown, in whose collection they had since been placed. These were two specimens of the Ortolan bunting (*Embariza hortulana*) and others of the pied flycatcher (*Muscicapa atricapilla*), red-backed shrike (*Lanius collurio*). The Secretary remarked that these birds had occurred during their spring migration, and that in the case of the Ortolan bunting the captures proved that any Scottish specimens of the bird that had been recorded could not be said to be escaped birds, seeing that they had been in company with well-known migratory species, and were in all likelihood on their way to Scandinavia, where they were known to breed.

SYDNEY

Linnean Society of New South Wales, March 25.—Prof. W. J. Stephens, M.A., F.G.S., President, in the chair.—The following papers were read :—On a Devonian fossil, allied to *Worthenia* (de Koninck), from New South Wales, by F. Ratte.—On the Phoriaspongiæ (Marshall), by Dr. R. von Lendenfeld. Both species described by Marshall have been found by the author, who considers them, together with some new species discovered by himself, to be Ceraospongiæ, with flesh-spicules, and not, as Marshall had supposed, Desmacidanidæ, or Cianidæ, living in sand. There exist many sponges on the Australian shores with a skeleton consisting of arenaceous fibres, which form an irregular network, thus connecting the Phoriaspongiæ with the ordinary horny sponges. Eleven species of horny sponges, with fleshspicules, have been found in Australian waters. Their spicules are described and their relative position to other sponges discussed. The author upholds his previously published views on the relationship between Ceraospongia and Monactinellidæ, and discusses the hypothesis recently put forward by Vosmaer.—Synonymy of, and remarks upon, four species of shells, originally described by Dr. J. E. Gray, by John Brazier, C.M.Z.S., &c.—Notes on the Australian Amphipoda, by William A. Haswell, M.A., B.Sc., &c.—On the Toxoglossate Mollusca of New Zealand, by Capt. F. W. Hutton, F.G.S.—Notes descriptive of some rare Port Jackson fishes, by J. Douglas Ogilby, Assistant in Zoology, Australian Museum, Sydney.

PARIS

Academy of Sciences, May 25.—M. Bouley, President, in the chair.—After the formal proceedings, the President referred in the following terms to the late Victor Hugo :—"France is to-day widowed of one of her great writers, a man by whose works of genius the glory of our land has been spread furthest and widest during the present century. Victor Hugo is about to descend into the grave, but by the greatness of his writings he is himself saved from death. Years may henceforth roll on until they are reckoned by hundreds and thousands ; but in the series of future ages there never will be a time when André Chénier's lines on Homer will not also be applicable to our great poet :—

> " Trois mille ans ont passé sur la cendre d'Homère,
> Et depuis trois mille ans Homère respecté
> Est jeune encor de gloire et d'immortalité."

For the work of Victor Hugo belongs to that class which defies years and for everlasting ages secures the youth of glory and immortality to those by whom it has been accomplished. And now the five Academies of the French Institute must consider it a sacred duty to render like homage to this great memory. Our Bureau has the honour of asking you, in sign of mourning, to suspend your proceedings for to-day." The proposal having received general assent, the public meeting of the Academy was adjourned.—Account of an elliptical halo of unusual brilliancy, and evidently connected with the halo of 22° so frequently noticed for some weeks past, observed during the afternoon of Tuesday, May 19, by M. A. Cornu.—A contribution to the history of sulphur and quicksilver, by M. Berthelot.—Note on the algebraic integers of linear equations, by M. E. Goursat.—Demonstration of a particular property of geometrical curves of double curvature, by M. V. Jamet.—On the verification of the laws of vibration of circular plaques, second note, by M. E. Mercadier.—Remarks on the peculiar properties of the electric current generated by the rheostatic machine, by M. Gaston Planté.—On a method of determining and recording the charge of electric accumulators, by MM. A. Crova and P. Garbe. The authors claim to have discovered a means of determining and automatically recording the exact amount of energy stored in accumulators, and so regulating the discharge as to be able to ascertain the quantity still held in reserve at any given moment. The machines used in their experiments were of the Planté type modified by Faure.—Note on the phenomenon of crystalline superfusion of sulphur, and on the velocity of transformation from prismatic to octahedric sulphur, by M. D. Gernez.—Remarks on the composition of the persulphuret of hydrogen, and on the nacreous variety of sulphur, by M. P. Sabatier.—Note on the product of addition $PhFl^3Br^2$ obtained by the action of bromine on the trifluoride of phosphorus, by M. H. Moissan.—A synthesis of some specimens of anorthite recently obtained from the gas-works of Vaugirard, by M. Stanislaus Meunier.—Note on the microscopic anatomy of *Dentalium entale* from the Roscoff coast, by M. H. Fol.—On the Penian formations (red sandstones associated with clay-stone and felspar grit) prevalent in the secondary ranges of the Vosges Mountains, by M. Ch. Vélain.—The election of M. Laguerre as member of the section for geometry in the place of the late M. Serret was confirmed by the President of the Republic.

BERLIN

Physiological Society, May 1.—Dr. Raudnitz had subjected to examination, by new experiments, a statement advanced by Profs. Eulenberg and Landois, and which was controverted by several investigators, namely, that there was a vasomotor centre having its seat in the cortex of the cerebrum. For the measurement of the peripherical temperature he made use of mercurial thermometers, which he fastened into the paw of the animal. It was found, by preliminary experiments, that subcutaneously inserted thermometers, on stimulation of the nerves or of the central organs, yielded variations of temperature essentially different from, often opposite to, those fixed into the paw—a circumstance referable, no doubt, to the influence of the contraction of the muscles. Thermo-electric piles, again, were not suitable for application, for the reason that it was not possible to find for the second contact a medium that remained constant as far as 0°·04 C. Dr. Raudnitz had investigated a large number of conditions influencing the temperature of the skin, such as motion, the muscular rhythm, paralytic poisons, the situation of the paralysed animal, &c. Of the phenomena observed in the course of such investigation, the fact was specially striking that the difference in the situation of the investigated extremity was able to give rise to differences of temperature as great as 13° C. The results of the whole investigation went to show that it was not possible to demonstrate with certainty the existence of a vaso-motor centre in the cortex of the cerebrum. In the case of each epileptic attack resulting from stimulation of the membrane the change of temperature in the skin was induced in large part by the muscular movement, and in part also otherwise. Whether, however, the influence of the stimulation of the brain on the vaso-motor system was direct or indirect was a question not to be determined either by experiments of stimulation or by extirpation of the part of the cerebral cortex concerned. — Dr. Leo communicated his experiments on the formation of fat and conveyance of fat in the case of phosphorus-poisoning. Seeing that some physiologists ranged themselves on the side of the view that fat, and especially in fatty liver after phosphorus-poisoning, was formed in the body through decomposition of albumen, but others, on the contrary, held that the fat of the internal organs was derived from the alimentary fat, either directly conveyed to these organs, or transported from the skin, where it had been deposited, the speaker instituted the following experiments: two young guinea-pigs of the same litter, of very similar constitution, and of almost the same dry weight, were kept in a state of hunger for a considerable time; then one was poisoned with phosphorus, and after three days both were killed. On determining the fatty contents of each of the animals, it was found that the poisoned animal showed a very considerably larger percentage of fat than the other. It had now to be ascertained what amount of fat an animal experimented on had before, and what amount it had after the phosphorus-poisoning. For this purpose two rats were employed, living under precisely the same conditions. One of them, accordingly, was killed on the same day on which the poisoning of the second begun. After three days the latter was likewise killed, and an essentially smaller quantity of fat was found in the poisoned animal than in the former. Finally, experiments were made with eighteen frogs, of which six were killed before the poisoning, six after the poisoning, and at the same time with these, six control frogs were killed. The result was that the six poisoned frogs contained a larger per cent. of fat than the six killed before the poisoning, and than the six unpoisoned and in other respects similar frogs. In all experiments the fatty contents of the liver after the phosphorus-poisoning were considerably greater than in the case of the unpoisoned animals. The increase per cent. of the liver fat, in comparison with the dry substance, tended to show with great probability that fat was not only formed anew, but was conveyed to the liver from other quarters. According to present views fat was formed in the body of the animal only by decomposition of the albumen, and it was conjectured that the lecithin was an intermediate product of this transformation. The quantitative determination of the lecithin in the animals poisoned with phosphorus, and in the control animals yielded, however in both, like percentages, so that this conjecture was not confirmed by the experiment.

Rome

Reale Accademia dei Lincei, March 15.—The unthinkable; a logico-psychological note by Signor Bonatelli. In this note the author proposed to show that what is called the impossibility of thinking a thing is not really an impossibility on the part of the thinking subject to form any given thought, but rather either the absolute impossibility of imagining or the impossibility of the existence of the object. And in this fact there is found a confirmation of that philosophical doctrine which maintains the existence of the ideal. That which is absolutely unthinkable is out of all relation to our thought, and we can say nothing about it.—Concerning a vase found at Metapontum with a Greek alphabet of the Achæan colonies of South Italy. Signor Barnabei exhibited a vase found in a burying-place during the excavations now being carried on at Metapontum, and which may be considered one of the most important discoveries that have been made in recent times. The vase is in perfect preservation and shows by its form that it belongs to about 300 B.C. In the annular space surrounding the raised rim the letters of the entire alphabet are inscribed. Signor Barnabei, after citing the opinions of various authors on the origin of writing, showed that it could not be attributed to the Phœnicians, but that the art of writing was actually introduced into Italy by the Greeks.—On the distribution in latitude of the solar maculæ, faculæ, protuberances, and eruptions observed in 1884 in the Royal Observatory of the College of Rome. In this note Signor Tacchini explained at length the methods by which his observations on the solar maculæ, faculæ, and protuberances were made, and the tables relating to them drawn up, as well as the means taken to insure the accuracy of both. He defended, against the criticisms of Prof. Respighi, the conclusions which he had laid before the last meeting of the Academy on the strength of his own observations and those of other astronomers.—Resumption of the observations of red glows. Prof. Riccò communicated the conclusion of his previous note, in which he gave an account of all the observations made by him on red glows from December, 1883, to April, 1884. As some features of the phenomenon would induce us to admit the presence of an extremely fine dust at a great height in the atmosphere, Prof. Riccò wished to ascertain the fact as to whether fresh dust had fallen during and after the glows. But the examination of the dust collected at those times in rain-water or water long exposed to the air, showed no traces of fresh dust in the atmospheric deposits, and, in particular, no recognisable traces of volcanic dust.—Other communications:—Prof. Millosevich communicated the observations made by him on a new planetoid between Mars and Jupiter (245), discovered by Signor Borelly.—Drs. Ciamician and Silber explained the reactions by means of which they had succeeded in obtaining acetyl-pyrrol in a state of perfect purity without any trace of pyrrol-methyl-ketone. They also stated the result of their experiments with a view to obtain a sulphur acid from pyrrol-methyl-ketone: experiments which show clearly the analogy between pyrrol, pyrridin, and benzol.—Prof. Besso communicated a note by himself on trinomial equations, and in particular on those of the seventh degree.—Dr. Bianchi communicated a note by himself on the triple orthogonal systems of Weingarten.

Christiania

Society of Science, May 4.—The President, Prof. Guldberg, in giving an account of the working of the Society last year, stated that there had been eighteen meetings, and that fifty-two articles and papers had been presented by members.—The number of members is at present 112.—Prof. Lochman gave a lecture on biology in relation to life.

CONTENTS

THURSDAY, JUNE 11, 1885

THE DARWIN MEMORIAL

IT is not often that the unveiling of a statue is attended with an interest at all comparable with that which characterised this ceremony as performed last Tuesday in the Great Hall of the Natural History Museum. If the greatness of a man is to be estimated by the measure in which he has influenced the thoughts of men it is scarcely open to question that the greatest man of our century is Charles Darwin. As Prof. Huxley remarked in the course of his singularly judicious and well-balanced address, Mr. Darwin's work has not only reconstructed the science of biology, but has spread with an organising influence through almost every department of philosophical thought. Yet it was not merely the greatness of the naturalist which invested the proceedings in the Natural History Museum with an interest so unique. It was known to the whole assembly that the man whom they delighted to honour was one whose moral nature had been cast in the same lines of simple grandeur as those which belonged to his intellectual nature. It therefore only needed a passing allusion from Prof. Huxley to enable the whole assembly to reflect that it was due as much to massiveness of character as to massiveness of work that within three years of his death Mr. Darwin's name should constitute a new centre of gravity in every system of thought. And it was this reflection which gave to the ceremony so unusual a measure of interest. Around the statue were congregated the most representative men of every branch of culture, from the Prince of Wales and the Archbishop of Canterbury, to the opposite extremes of Radicalism and freethought. Indeed, it is not too much to say that there can scarcely ever have been an occasion on which so many illustrious men of opposite ways of thinking have met to express a common agreement upon a man to whom they have felt that honour is due. The international memorial could not in any nation have found a more worthy site than the one in which it has been placed; but if anything could have added to the "solemn gladness" with which the personal friends of Mr. Darwin witnessed the presentation of this memorial, it must have been the evidence which the assembly yielded that among the innumerable differences of opinion which it represented, his memory must henceforth be always and universally regarded as a changeless monument of all that is greatest in human nature, as well as of all that is greatest in human achievement.

Concerning the statue itself, we have only to speak in terms of almost unqualified praise. It is, in the truest sense of the phrase, a noble work of art. The attitude is not only easy and dignified, but also natural and characteristic; the modelling of the head and face is unexceptionable; and the portrait is admirable. The only criticism we have to advance has reference to the hands, which not only do not bear the smallest resemblance to those of Mr. Darwin, but are of a kind which, had they been possessed by him, would have rendered impossible the accomplishment of much of his work. Although this misrepresentation is a matter to be deplored, it is not one for which the artist can be justly held responsible. Never having had the advantage of seeing Mr. Darwin, Mr. Boehm has only to be congratulated upon the wonderful success which has attended his portraiture of the face and figure; the hands were no doubt supplied by guess-work, and therefore we have only to regret that the guess did not happen to have been more fortunate.

The following is the address made by Prof. Huxley, in the name of the Darwin Memorial Committee, on handing over the statue to H.R.H. the Prince of Wales, as representative of the Trustees of the British Museum:—

YOUR ROYAL HIGHNESS,—It is now three years since the announcement of the death of our famous countryman, Charles Darwin, gave rise to a manifestation of public feeling, not only in these realms, but throughout the civilised world, which, if I mistake not, is without precedent in the modest annals of scientific biography.

The causes of this deep and wide outburst of emotion are not far to seek. We had lost one of those rare ministers and interpreters of Nature whose names mark epochs in the advance of natural knowledge. For, whatever be the ultimate verdict of posterity upon this or that opinion which Mr. Darwin has propounded; whatever adumbrations or anticipations of his doctrines may be found in the writings of his predecessors; the broad fact remains that since the publication, and by reason of the publication, of the "Origin of Species" the fundamental conceptions and the aims of the students of living Nature have been completely changed. From that work has sprung a great renewal, a true "instauratio magna" of the zoological and botanical sciences.

But the impulse thus given to scientific thought rapidly spread beyond the ordinarily recognised limits of biology. Psychology, Ethics, Cosmology were stirred to their foundations, and the "Origin of Species" proved itself to be the fixed point which the general doctrine of evolution needed in order to move the world. "Darwinism," in one form or another, sometimes strangely distorted and mutilated, became an everyday topic of men's speech, the object of an abundance both of vituperation and of praise, more often than of serious study.

It is curious now to remember how largely, at first, the objectors predominated; but, considering the usual fate of new views, it is still more curious to consider for how short a time the phase of vehement opposition lasted. Before twenty years had passed, not only had the importance of Mr. Darwin's work been fully recognised, but the world had discerned the simple, earnest, generous character of the man that shone through every page of his writings.

I imagine that reflections such as these swept through the minds alike of loving friends and of honourable antagonists when Mr. Darwin died; and that they were at one in the desire to honour the memory of the man who, without fear and without reproach, had successfully fought the hardest intellectual battle of these days.

It was in satisfaction of these just and generous impulses that our great naturalist's remains were deposited in Westminster Abbey; and that, immediately afterwards, a public meeting, presided over by my lamented predecessor Mr. Spottiswoode, was held in the rooms of the

Royal Society, for the purpose of considering what further steps should be taken towards the same end.

It was resolved to invite subscriptions, with the view of erecting a statue of Mr. Darwin in some suitable locality; and to devote any surplus to the advancement of the biological sciences.

Contributions at once flowed in from Austria, Belgium, Brazil, Denmark, France, Germany, Holland, Italy, Norway, Portugal, Russia, Spain, Sweden, Switzerland, the United States, and the British Colonies, no less than from all parts of the three kingdoms; and they came from all classes of the community. To mention one interesting case, Sweden sent in 2296 subscriptions "from all sorts of people," as the distinguished man of science who transmitted them wrote, "from the bishop to the seamstress, and in sums from five pounds to two pence."

The Executive Committee has thus been enabled to carry out the objects proposed. A "Darwin Fund" has been created, which is to be held in trust by the Royal Society, and is to be employed in the promotion of biological research.

The execution of the statue was entrusted to Mr. Boehm; and I think that those who had the good fortune to know Mr. Darwin personally will admire the power of artistic divination which has enabled the sculptor to place before us so very characteristic a likeness of one whom he had not seen.

It appeared to the Committee that, whether they regarded Mr. Darwin's career or the requirements of a work of art, no site could be so appropriate as this great hall, and they applied to the Trustees of the British Museum for permission to erect it in its present position.

That permission was most cordially granted, and I am desired to tender the best thanks of the Committee to the Trustees for their willingness to accede to our wishes.

I also beg leave to offer the expression of our gratitude to your Royal Highness for kindly consenting to represent the Trustees to-day.

It only remains for me, your Royal Highness, my Lords and Gentlemen, Trustees of the British Museum, in the name of the Darwin Memorial Committee, to request you to accept this statue of Charles Darwin.

We do not make this request for the mere sake of perpetuating a memory; for so long as men occupy themselves with the pursuit of truth, the name of Darwin runs no more risk of oblivion than does that of Copernicus or that of Harvey.

Nor, most assuredly, do we ask you to preserve the statue in its cynosural position in this entrance-hall of our National Museum of Natural History as evidence that Mr. Darwin's views have received your official sanction; for science does not recognise such sanctions, and commits suicide when it adopts a creed.

No; we beg you to cherish this Memorial as a symbol by which, as generation after generation of students of Nature enter yonder door, they shall be reminded of the ideal according to which they must shape their lives, if they would turn to the best account the opportunities offered by the great institution under your charge.

The following reply was made by H.R.H. the Prince of Wales:—

PROF. HUXLEY AND GENTLEMEN,—I consider it to be a high privilege to have been deputed by the unanimous wish of my colleagues, the Trustees of the British Museum, to accept, in their name, the gift which you have offered us on behalf of the Committee of the Darwin Memorial. The Committee and subscribers may rest assured that we have most willingly assigned this honourable place to the statue of the great Englishman who has exerted so vast an influence upon the progress of those branches of natural knowledge the advancement of which is the object of the vast collections gathered here. It has given me much pleasure to learn that the memorial has received so much support in foreign countries that it may be regarded as cosmopolitan rather than as simply national; while the fact that persons of every condition of life have contributed to it affords remarkable evidence of the popular interest in the discussion of scientific problems. A memorial to which all nations and all classes of society have contributed cannot be more fitly lodged than in our Museum, which, though national, is open to all the world, and the resources of which are at the disposal of every student of nature, whatever his condition or his country, who enters our doors.

CLAUS'S "ELEMENTARY TEXT-BOOK OF ZOOLOGY"

Elementary Text-Book of Zoology. Special Part: Mollusca to Man. By Dr. C. Claus. Translated and edited by Adam Sedgwick, M.A., Fellow and Lecturer of Trinity College, Cambridge, with the assistance of F. G. Heathcote, B.A., Trinity College, Cambridge. (London: W. Swan Sonnenschein and Co., 1885.)

THE first 109 pages of this volume are devoted to the Mollusca and Tunicata, and the remarks offered in NATURE (vol. xxxi. p. 191) in criticism upon Vol. I. apply equally well here.

The information imparted is fully up to date, and the Tunicate section may be taken, on the whole, as a type of that well-balanced and succinct writing indispensable in a work of this order.

The unqualified statement on p. 9 that the mollusca are "*bilaterally symmetrical*" is unfortunate, and typical of a general insufficiency and sketchiness, evident throughout the entire work, in the diagnoses given of the great groups. No better instance of this can be quoted than those relating to the birds and mammals, where characters so vitally important as the modes of articulation of the jaw-apparatus upon the skull are omitted, and, although mentioned elsewhere, are inserted without that emphasis demanded of *primâ facie* characters applicable to both the living and extinct forms.

It is disappointing to find the invertebrate digestive-gland still spoken of as a "liver," no mention being made of the researches of Weber, Barfurth, and others, into its structure and functions. It is highly desirable in a book of this kind that any statements made concerning animals, such as are likely to fall into the hands of the average student, should be absolutely reliable. It cannot be said (p. 52) that the shell of Aplysia is "covered by two lobes of the foot," and the beginner would soon find that Limax and Arion are not the only common Gasteropods in which the pedal gland is present, while, from the statements made on p. 27 he would never infer that the common Anodon shell is destitute of teeth. The Argonauta, although somewhat less commonplace than the aforenamed, is to be found in our museums, and no mention is made in this volume of the exceptional characters of its shell—in fact, the beginner would rather infer from the descriptions given that it is a normal Cephalopod shell. Less pardonable are the inadequate remarks devoted to the rest of the Cephalopod group, which are especially unfortunate in their reference to connecting-links with the extinct forms. The anomalous but characteristic Aptychi go without a mention.

Viewed in the light of Prof. Moseley's recent discoveries, the reasons adduced on p. 44 for the absence of the cerebral ganglia in Chiton are of some interest, as a caution against making too sweeping generalisations.

Under the head of Molluscoidea there is a bare mention of the genus Rhabdopleura, and we are at a loss to conceive why the reference to this important form printed in the original index should have been omitted in the translation.

Turning now to that portion of the work which follows, the fact that but 231 pages are devoted to the Vertebrata, exclusive of Tunicates, is sufficient in itself to raise suspicion, especially when we reflect that 115 pages of Vol. I. are given up to Tracheates alone. When Mr. Sedgwick published the first volume of this work it was patent to any one familiar with the original that nothing short of a complete revision of the Vertebrate section could justify that claim set up by him in his translator's preface. Having admitted his willingness to supplement the original where he "thought it necessary"—thereby, we presume, countenancing the weakness of the volume now before us—it is surprising to find how little he has carried that resolve into execution, the more so as he acknowledges the assistance and advice of others, some of whom are authorities. That this defect is not due to any want of intention on the translator's part is clear from insertions such as that on p. 167; but we look in vain for dozens of other similar modifications, connected with matters of infinitely greater importance than that just referred to. Similarly, why should the recent discovery of the meroblastic segmentation of the Monotreme's egg be inserted by the translators and referred to some two or three times when there is no mention whatever of the far more weighty characters of the skull of that group? Even were defects such as the above-named rectified, the book would still remain wholly insufficient and incompetent. The exclusive use of the old classification of birds—the dogmatic statements made concerning many of the most involved fields of Vertebrate morphology; for example, that of the auditory ossicles, where Reichert's views are alone given—the entire omission of any description of such a characteristic structure as the lizard's hind-limb and ankle-joint—the feeble and confused descriptions of the vertebrate skull, obvious throughout the entire work and ushered in on p. 118 by the barbarous "*os linguale*" and "*copulæ*"—the ambiguous statements made on p. 124 concerning the vertebrate diaphragm, which still (p. 250) finds its place among the respiratory organs of birds, are, to say nothing of other similar defects, sufficient in themselves to stamp the vertebrate portion of the Text-book as little short of a failure. That that section of the work falls short of the needs of the English-speaking student is certain, especially as it is so far behind other manuals current in the tongue. Errors, the bare enumeration of which would be superfluous, are predominant on all hands, and the retention of the "Cetacea Carnivora" and "Cetacea Herbivora or Sirenia" (*sic*) of the ancients, is, leaving the Hydrosauria with its sub-classes aside, certainly not creditable to any one concerned. We heartily recommend the invertebrate portion of the work to the student. He may find that which follows useful, but he need be no specialist to see that it is insufficient on all points, and absolutely inaccurate and misleading on many of vital importance. It but remains to enumerate certain of the more conspicuous defects, respecting which at least, should a second edition of the work be demanded, it is to be hoped that the translators will see fit to effect an alteration.

The cumbrous and fanciful method of accounting (p. 113) for the characters of the thoracic region of the vertebrate body is to be regretted, leading the beginner, as it does to suppose this to be the most modified region of the trunk—a conception the precise reverse of that which the properly-trained student will soon form for himself. The exclusion of the teeth from the list (p. 119) of dermal derivatives and the complete confusion between scutes and scales evident throughout, are but slight faults compared with such as we have already enumerated. On p. 127 we are introduced to a thorough mixing up of the urinary receptacle of fishes with the allantoic bladder of Amniotes—a serious error, and one which the translator ought to have been expected to rectify.

The above remarks apply more especially to the general part of the vertebrate section of the work; but, on passing to that treating of the special groups, we find a general feebleness nowhere more evident than in that portion devoted to fishes. The diagnoses of that group are meagre in the extreme, and descriptions of even their tails such as are given on p. 164 are wanting in accuracy. No wonder, then, that the "jugular" pelvic fin should be once more to the front, that there is a disregard of characters so important as are those of the maxillary apparatus of Teleostei, and that such genera as Albula, Cheirocentrus, Megalops, &c., go unnoticed. The treatment of the Sauropsida is no less unfortunate than the above. Reference has already been made to some of the more conspicuous defects of this section, barely less pardonable than which are the bad descriptions of the bird's manus (p. 237) and the bare mention of the structure of the avian lung.

We are told on p. 243 that birds possess a rudimentary "corpus callosum," no mention being made of that tract which may probably answer to it in Amphibia. The treatment of the Sauropsidian pelvis and of the bird's shoulder-girdle are miserably poor, and the student is informed on p. 196 that Crocodiles possess an "*abdominal* sternum," which is "composed of a number of ventral ribs (without dorsal part)"; he will learn a valuable lesson who—Prof. Claus's manual in hand—discovers for himself that the ventral sternal ribs and these abdominal splints coexist in Hatteria, skeletons of which are now to be found in our museums. Considering the above facts, it is not surprising that nearly all reference to important matters of affinity between living birds and reptiles should be overlooked. The characters of the mesotarsal joint and of the tarso-metatarsus are imperfectly defined, and those of the pelvis of Apteryx ignored; while among the extinct forms, the Dinosauria—several of whose features we are told on p. 220 "recall mammals, especially the Pachydermata"—the Ornithoscelida, and the Odontornithes, are all dismissed in a few lines. Little would the student, taking his text from this work, dream of the noble array of direct affinities to be found among even living birds and reptiles.

The translators have evidently realised that the statements reproduced on pp. 198 and 215, concerning the lizard's quadrato-jugal arcade are contradictory, and a supplemental paragraph of their own on p. 198 only serves to increase the perplexity. Chapter IX. is devoted to the Mammalia, but 69 pages of it starting with the assertion (p. 282) that the Monotremes' hemispheres are "still smooth," is poor fare. The cutting down of every group of mammals to a minimum would be in a sense pardonable, if only concise diagnoses were given such as should cover the broad lines of modification; but when, bearing in mind certain of the more glaring defects of this chapter referred to at the outset, we read (p. 306) that the Whales approach the Ungulates "through the Sirenia," and that the "Sirenia are intermediate, so far as their form is concerned, between the whales and seals" (p. 309), our faith is shaken in that which remains. There is the usual confusion concerning the position and movements of the hind-limbs of the Pinnipedia, the condition of the parts in the eared seals being entirely overlooked. In diagnosing a group of animals for purposes such as are here required, where the living and the extinct are both under consideration, it is but fair to assume that special attention should be paid to the hard parts, the teeth not excepted; but we look in vain for statements such as shall embody the extremes of modification of these parts in any one group of living mammals—for example, in dealing with the Rodents the utmost sketchiness prevails, the modifications of even the fibula are not hinted at, and while Hydromys is placed among the mice with grinders $\frac{2}{2}$, Heliophobius is not mentioned. No wonder, then, that Hyœmoschus should go unnoticed, that Hyrax should here be found under the order Proboscidea (with a caution, it is true), and that the Carnivora, Cheiroptera, Lemurs, and Primates should be treated with disrespect. We are told (p. 301) that the epipubes support the marsupial pouch, and there is no reference at all to the most important facts concerning the marsupial dentition. There is something so specifically English about gross vertebrate anatomy that we search in vain for bare mention, not to say recognition, of discoveries bearing upon the above, and many similar matters of first importance.

From what has been said it will be obvious to English students that the vertebrate section of Prof. Claus's manual is weakest where works on the subject already current in our language are strong; and, with all respect to our Continental cousins, we are of opinion that the market is becoming overstocked with translations such as that before us. Their period is past; the English student in earnest must sooner or later fit himself for access to the originals, and the repeated production of English versions serves only to prolong the fatal day. We cannot but regret, though reluctantly, the publication of this work in its present form, the more so as it threatens to encourage the growing tendency to under-estimate the value of gross vertebrate anatomy, a field of labour essentially English, but still the very backbone of zoological science.

Mr. Sedgwick has performed the task of translation with a thoroughness and skill deserving the thanks of his countrymen. Some few passages in the original, at best clumsy, might have been better rendered than they are; and settings such as the "above together," on p. 16, might be advantageously modified. The translators give in Vol. I. a list of English synonyms for the geological terms employed in the original, but these are not always adopted in Vol. II.; thus we find the Jurassic beds referred to again and again as the "Jura," a rendering certainly not that of English geologists. The original illustrations are for the most part excellent, and those which remain are admirably selected. That on p. 284, however, certainly does not illustrate the anatomy of the human ear, and the figures selected from the classic of Johannes Müller, in illustration of the anatomy of the lamprey's skull (p. 154) do scant justice to the work of a great genius, and he a German. G. B. H.

CLIFFORD'S EXACT SCIENCES

The Common Sense of the Exact Sciences. By the late W. K. Clifford. (London: Kegan Paul, Trench, and Co., 1885.)

ONCE more a characteristic record of the work of a most remarkable, but too brief, life lies before us. In rapidity of accurate thinking, even on abstruse matters, Clifford had few equals; in clearness of exposition, on subjects which suited the peculiar bent of his genius and on which he could be persuaded to bestow sufficient attention, still fewer. But the ease with which he mastered the more prominent features of a subject often led him to dispense with important steps which had been taken by some of his less agile concurrents. These steps, however, he was obliged to take when he was engaged in exposition; and he consequently gave them (of course in perfect good faith) without indicating that they were not his own. Thus, especially in matters connected with the development of recent mathematical and kinematical methods, his statements were by no means satisfactory (from the historical point of view) to those who recognised, as their own, some of the best "nuggets" that shine here and there in his pages. His *Kinematic* was, throughout, specially open to this objection:—and it applies, though by no means to the same extent, to the present work. On the other hand, the specially important and distinctive features of this work, viz. the homely, yet apt and often complete, illustrations of matters intrinsically difficult, are entirely due to the Author himself.

The Editor, in his *Preface*, tells us the whole story of the difficulties he had to face in completing the volume for press. All will sympathise with him when they find that he had to furnish one entire chapter, and large portions of two others, in addition to thorough revisal of the whole. For Clifford's style is here entirely *sui generis.* The track to his homely yet hardy expositions often lay in regions where but a single careless step would have led to the Inconsequent or the Ridiculous. And one who tries to imitate him successfully must possess not only his nerve, but also his wonderful agility and resource of every kind. We shall therefore say no more on the subject of the Editor's additions to the volume, than that his daring has met with comparative immunity from the more obvious dangers of his course.

The original title of the work was, we are told, *The First Principles of the Mathematical Sciences Explained to the Non-Mathematical.* There can be no doubt that the new title is much to be preferred. We do *not* believe that the Mathematical Sciences, even in their first principles, can be explained to the Non-Mathematical. Whosoever understands the explanation has, to that extent at least, *become* Mathematical in the very act of understanding. But this observation is made on the assumption that Non-Mathematical means "uninstructed in mathematics." There is another sense which the term may bear:—viz. "incapable of understanding mathematics." Among mankind there are none who more persistently claim the almost exclusive possession of the highest grade of human intelligence than do the (so-called) Metaphysicians. How many of these self-accredited possessors of all but superhuman acuteness have been able to cross the *Pons Asinorum?* How many have been able to understand even the *objects* (not the *processes*) of mathematical investigation? When the answer comes (it probably will not come, as it *can not* come in a favourable form) it will be time to comment on it.

The chief good of this book, and in many respects it is very good, lies in the fact that the versatility of its gifted author has enabled him to present to his readers many trite things, simple as well as complex, from so novel a point of view that they acquire a perfectly fresh and unexpected interest in the eyes of those to whom they had become commonplace. Surely this was an object worthy of attainment! But it is altogether thrown away on the non-mathematical, to whom neither new nor old points of view are accessible.

Considering the circumstances under which the book has been produced, it would be unfair to comment on the smaller errors. But there are a few very awkward statements, and one or two grave errors, which ought not to have escaped correction. We give an example of each class. Thus, p. 16, the following statement is quite unnecessarily puzzling:—

"If we can fill a box with cubes whose height, length, and breadth are all equal to one another, the shape of the box will be itself a cube."

This out-germans German itself in the displacement of the words from their natural position in English; and, at first sight, seems to be nonsense. Read it, however, thus:—

"If we can fill with cubes a box whose height, &c. . . . the shape of the box itself will be a cube,"

and the absurdity, suggested by the collocation, disappears.

Again, p. 66, what are we to make of the following, standing, as it does, without comment or explanation of any kind?—

"The statement that a thing can be moved about without altering its shape may be shown to amount only to this, that two angles which fit in one place will fit also in another, no matter how they have been brought from the one place to the other."

Several most serious qualifications must be imposed upon this statement before it can possibly be accepted as true.

The chapter on *Motion* properly forms a part of this work, so far at least as kinematics is concerned. But it seems to be a mistake to conclude it with a few editorial sentences on the *Laws of Motion.* For here we have a perfectly new subject, and one which would require at least a full chapter to itself. It is probable enough that, at some period of his life, Clifford imagined that it might be possible to get rid of the idea of matter as well as of that of force, and so to reduce Dynamics to mere Kinematics. He never so expressed himself to me. But purely physical subjects were, properly speaking, beyond his sphere; his ideas about them were always more or less vague, because always of a somewhat transitional character, and were much modified at times by the momentary turn of his philosophical speculations. We are told in a foot-note to the first page of the *Preface* that Clifford left his *Kinetic* (a companion volume to his Kinematic) *in a completed state.* Surely, keeping this in view, the introduction of Laws of Motion into the present work was superfluous.

This foot-note unfortunately strikes a jarring chord at the very first opening of the book. We are told that "more serious delay seems likely to attend the publication" of Clifford's *completed* MS.; this is followed by a mysterious species of protest or remonstrance. Clifford could never have written in this vein. He would either have kept silence, or have blurted out the whole truth. Mystery and insinuation were not weapons of his, and should not be employed in connection with his name.[1]

P. G. TAIT

OUR BOOK SHELF

New Commercial Plants and Drugs. No. 8. By Thos. Christy, F.L.S., &c. (London: Christy and Co., 155, Fenchurch Street, 1885.)

THE eighth number of Mr. Thos. Christy's "New Commercial Plants and Drugs" has recently appeared, and the contents are of a similar character to those that have preceded it, the most recently introduced commercial products derived from the vegetable kingdom being enumerated and what has been written about them brought together. The first plant referred to in the book is of course the Kola nut (*Cola acuminata*), as being one of the most important, or at least one that has attracted a very large share of attention during the past year. This article is illustrated by a coloured plate of the fruit and seeds of this species, as well as of the Guttiferous plant known as the Bitter Kola. Besides having the property of cleansing or purifying and thus rendering wholesome stagnant or foul water, it has also been used for clarifying beer and spirits. One of its most remarkable properties is in restoring the senses after partaking to excess of intoxicating drinks. The most recent application of the Kola nut, however, is in the preparation of a paste for mixing with cocoa or chocolate, which it is said to improve "both in strength and flavour to an astonishing degree." It is considerably more nutritious and strengthening; so much so indeed "that a workman can, on a single cup taken at breakfast time, go on with his work through the day without feeling fatigued."

In consequence of this and many other medicinal

[1] In NATURE, vol. xxxii. p. 4, Mr. Tucker intimated that Messrs. Macmillan and Co. would publish the remaining mathematical papers of the late Prof. Clifford.—ED.

virtues the Kola nut is considered to have a great future before it in European commerce, and is consequently strongly recommended to the notice of planters in our colonies for extensive cultivation. With regard to the preservation of the germinating properties of the seeds, Mr. Christy says he has received them in good condition, both in baskets and barrels lined with the leathery leaves of a tree known as the "bal tree." Some received in dry loam arrived as fresh as when they were gathered, and of some that arrived eighteen months since, the bulk is stated to be perfectly fresh and retaining still their beautiful red colour.

From a list of fifteen species of *Myristica*, the fruits or seeds of which are described, the value of the nutmeg genus is shown, especially as oil seeds. Seeds new to commerce are frequently arriving in the Liverpool and London markets, intended for the expression of oil and for the preparation of oil cake. Such seeds are of a very varied character and belong to widely different natural orders, and not long since those of *Myristica surinamensis* came into Liverpool under the name of African nuts. Upon analysis they were found to contain a large quantity of solid oil or fat with an agreeable taste, and but little, if any, odour, and when fairly pure it is said to resemble cocoa butter.

Amongst other important economic plants or drugs mentioned are the Coca (*Erythroxylon coca*), the medical effects of which have attracted so much attention of late; the Jamaica Chewstick (*Gouania domingensis*), which, it is stated, "has recently been introduced into this country by one of our leading London dentists for use in tooth powder and mouth wash," and also in the form of a fluid extract as a gargle for relaxed throat.

Of Papaine, the active principle of the Papaw (*Carica papaya*), some interesting records are given regarding its effects in treatment of diphtheria, croup, indigestion, dyspepsia, &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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Ocular After-Images and Lightning

In reply to Mr. Shelford Bidwell's query whether the quiver of the lightning flash is a purely subjective phenomenon or not, I send the following extract from my note-book, made October, 1873:—"A flash of lightning consists of several separate flashes all occurring within a fraction of a second of each other. There was a very severe thunder storm at night, the thunder almost continuous. Drawing the curtain across the window so as to expose only a narrow slit of skylight, I observed this slit in the looking-glass which I kept moving rapidly backwards and forwards on its axis. Whenever a flash occurred, several images of the slit appeared, showing that there were several successive illuminations of the slit."

This was not the result I had expected, the experiment having been suggested to my mind in consequence of some experiments I had been making on the phenomenon of recurrent vision. The results of these experiments were published in the *Phil. Mag.*, December (supplement), 1872. One object of my experiments was to determine in what way the colour of the recurrent image depends upon the colour of the light producing it. By using a sliding shutter and a small window covered with different coloured glasses, I found that the colour of the recurrent image tends to be of a tint complementary to that of the light causing it, being, however, in all cases bluer than the complementary tint. I add the following extract from my paper:—"A recurrent image of an object may be produced without any apparatus whatever. To do this, place the right hand over the eyes so that the palm of the hand covers the right eye, and the fingers the left eye. If the middle finger be then raised for a moment, so as to admit light for as short a time as possible into the eye, a recurrent image of any light-coloured object held against a dark background may be seen. The effect is much better seen by twilight or gaslight than in full daylight. This method of producing a recurrent image is, however, much inferior to that in which a sliding shutter is used, owing probably to the illumination of the retina not being sufficiently instantaneous.

Cheltenham College, June 6 A. S. Davis

A Quinquefoliate Strawberry

In your issue for April 30 (vol. xxxi. p. 601) is an account of a quinquefoliate strawberry. In the garden of the New York Agricultural Experiment Station at Geneva we have some second year seedling strawberries, some of which are bearing three, four, and five leaflets on the same plant, the leaves all large and perfect. We have other plants in which the two extra leaves are borne half way down the petiole, and which attain fair size, and yet others where these stipulary-like appendages are reduced to hair-like bracts. The variety of strawberry introduced under the name "Mrs. Garfield" frequently has these bract-like appendages. While speaking of the strawberry, I would remark that seedling strawberries very frequently are unifoliate during their early growth, and it appears as if Duchesne's *Fragaria monophylla* may be regarded as an instance of arrested development in one of these one-leaved younglings.

E. Lewis Sturtevant

New York Agricultural Experiment Station, Geneva, N.Y., May 28

OBSERVATIONS OF THE TEMPERATURE OF THE SEA AND AIR, MADE DURING A VOYAGE FROM ENGLAND TO THE RIVER PLATE IN THE S.S. "LEIBNITZ"

Being obliged to proceed to South America at the beginning of this year, I took with me a thermometer and a hydrometer in order, if circumstances were favourable, to provide myself with occupation during the somewhat long and monotonous voyage. Thanks to the kindness and courtesy of Capt. Brown, of the s.s. *Leibnitz*, who took a lively interest, and assisted me greatly in carrying out my observations, the voyage was neither long nor tedious.

The *Leibnitz* sailed from Southampton on January 16, 1885, and made the passage direct, without touching at intermediate ports, to Monte Video, where she arrived on February 8, after a very favourable voyage. The route lay through the most interesting meteorological districts of the Atlantic, and my principal object at starting was to make as many observations of the temperature and the density of the surface-water along the route as possible. With these I combined observations of the temperature of the air, and frequently also of the wet-bulb thermometer. Observations were begun on January 21 in lat. 34° N., and continued up to the morning of arrival in the River Plate.

I have put together the simultaneous observations of the temperature of the air and the water with those of the wet-bulb thermometer, as they possess some interest of their own; the observations of density are kept for a future opportunity, as the reductions in connection with them are not quite finished.

The *thermometer* used for all the observations was divided into simple degrees of the Centigrade scale, and was of the ordinary form of German manufacture, with a paper scale. The degrees were 1·6 mm. apart, so that there was no difficulty in estimating tenths of a degree. Its zero was verified on board by immersing it in pounded ice, and found correct. The ice was well pounded in a clean towel, and a soda-water tumbler filled with it; the thermometer was then thrust into it and allowed to remain till sufficient ice had melted to fill up the interstices, producing a perfect magma of ice and water down to the bottom. The mercury remained constant on the zero line. The temperature of the air was 25° C.[1]

Temperature of the Water.—The water was collected in a small bucket, well clear of the side of the ship, and on the opposite side from that through which the condensing water of the engine is discharged. Its temperature was determined as soon as the sample was brought on board.

As the ship left the Channel in the middle of winter, and proceeded nearly due south, the temperature of the water rose rapidly at first. Observations were begun on January 21, in lat. 34° N., and between this latitude and lat. 10° N. the rate of rise was very steady, averaging 0·36° C. per degree of latitude. From lat. 5° N. to 15° S. the temperature is very uniform and high, averaging 26·86° C. After passing lat. 15° S. the temperature falls, and begins to show greater variations, as the shallow water on the Abrothes Bank is approached. The average temperature of the water over this bank was 25·56° C. After passing Cape Frio, and between the parallels of 25° and 30° of south latitude, the variations of temperature are considerable and often abrupt; the maximum observed in this part was 26°·7 C., and the minimum 24°·3 C. As the higher temperature generally accompanies a greater salinity, it is probable that these variations are due, not to any terrestrial source, such as large rivers, but to an oceanic cause, the less salt and colder water of the deeper ocean strata being thrown up against the coast, and mixing imperfectly with the hot and dense surface-water. In lat 30° S. the influence of the River Plate makes itself distinctly felt by a general rapid fall of temperature. As the ship got into soundings, with the change in colour and other properties of the water, the temperature fell rapidly to between 23° and 24° C., and to 22° C. in six fathoms off Flores Island close to Monte Video. The minimum temperature observed in this part was 20° C. at 2 a.m. between Lobos Island and Maldonado Point.

Excluding the latter part of the voyage between the River Plate and lat. 15° S., where the conditions are a good deal affected by purely local causes, the surface-water shows well-marked diurnal maxima and minima of temperature. From lat. 9° N. to lat. 2° N. the ship passed through the equatorial belt of calms and rains, which separates the regions of the north-east and the south-east trade-winds from each other. It is characterised by a calm sea, a cloudy sky, and heavy rains. Here the temperature was subject to very little diurnal variation (0°·3 C.) On approaching St. Paul's Rocks, a few miles north of the equator, the clouds cleared away completely, and there was a calm sea, a clear sky, and a very powerful sun. The result was a comparatively great rise of temperature in the afternoon; and yet the greatest difference between any neighbouring maximum and minimum in this region was only 1°·1 C.

The maximum temperature of the sea-surface observed during the voyage was 27°·4 C. (81°·3 F.) at 2 p.m. on January 31, in lat. 7° 35′ S., the Brazilian coast being about 100 miles distant. The temperature of the water will be further considered in connection with its density; at present its connection with the temperature of the air will be more particularly considered.

Temperature of the Air.—Along with the temperature of the water, that of the air during daylight was determined. It is probably very rare, in any part of the ocean, to find the mean temperature of the air agreeing accurately with that of the surface water, and in many places the differences are considerable. In order to be able to compare the temperature of the air with that of the water, it is necessary that both should be determined with equal accuracy. The temperature of the water is easily and accurately determined by agitating the thermometer in a bucket of it freshly collected. With the air it is somewhat different. Having only one thermometer with me, I was obliged to use it for all purposes, and I could not hang it up in a thermometer-box, even if I had had one, and had deemed it advisable to do so. On board ship, however, I am convinced that it is quite impossible to fix a thermometer-box in such a position as always to secure such an air-pressure as to justify the assumption that the indications of the thermometer may be taken as the true temperature of the air. Even on shore and under the most advantageous circumstances, the temperature of the thermometer in the atmosphere of the best constructed box is too much dependent on the temperature and capacity for heat of the material of the box for it to be assumed always to be identical with that of the air outside, at the moment of reading. I was obliged, therefore, to adopt the method of whirling the thermometer, at the end of a short string, in the air, in whatever part of the ship happened at the moment to afford the most favourable conditions, and reading it when it had assumed a constant temperature. The temperature of the air is thus determined in mostly the same way as that of the water, namely, by agitating a thermometer in it, and the comparison of the two is therefore likely to lead to trustworthy conclusions.

Temperature of Wet-bulb Thermometer.—The series of observations with this instrument is not so complete as that with the dry thermometer, but they possess some interest. The method of observation was the following:—The temperature of the air having been determined by whirling the thermometer in it, a bucket of sea-water was fetched and its temperature taken; the thermometer was then exposed, with its bulb still wet with sea-water, to the breeze in a proper part of the ship, and its temperature observed when it became constant. The exposure of the instrument requires some care. The bulb must be quite free from grease, which can be readily secured by washing it with soap and water. It is then dipped into the water and allowed to drip for a second. It is then held somewhat inclined to the direction of the wind and to the horizon, and rotated gently on its axis so that the bulb be kept covered with a continuous film of water which is locally thickened by gravity, which tends to form a drop on the lower side of the bulb. The reading of the thermometer is observed while it is being rotated. Had I intended from the beginning to make a series of wet and dry bulb observations, I should probably have used fresh water from the first. I began to expose the thermometer, merely in order to have an indication whether the atmosphere were saturated or not, and I expected, in the damp equatorial regions, to find the atmosphere so heavily saturated as to be incapable of producing any sensible lowering of the thermometer with damped bulb. For this purpose it seemed to be quite sufficient to expose the thermometer wet with sea-water. Having begun with

[1] Having plenty of pounded ice at my disposal, I poured off the water which had formed by melting, and replaced it by sea-water, containing 35·65 grammes salt per kilogramme, and then immersed the thermometer; it fell rapidly below zero, and remained constant at −1°·0. I then strained away the sea water from the ice and replaced it by a mixture of equal volumes sea-water and distilled water: the thermometer fell to −0·45, and remained constant for some time at that temperature. When the ice was mixed with distilled water alone, the thermometer again stood at 0° C. These experiments were made to verify some observations of Pettersson, quoted in his investigations into the nature of ice formed from waters of different degrees of salinity, in connection with the voyage of the *Vega*. He there says, referring to the melting temperature of different kinds of ice, that pure fresh-water ice, when immersed in sea water, melts at a temperature considerably below 0° C. Writing from memory, I think he puts the melting-point at from −1° to −2° C. Having both the ice and the sea-water ready at hand, I repeated this remarkable experiment. The result showed that Pettersson's observation is quite correct, and that the lowering of the melting-point is roughly proportional to the salt held in solution. When equal volumes of the sea-water and distilled water of the same temperature were mixed, there was no change of temperature. I do not remember if Dr. Pettersson furnished an explanation of this remarkable phenomenon, and I am unable to supply one myself, but it must necessarily affect the validity of conclusions as to the composition of sea-water ice drawn from its melting-point. When the *Challenger* was in Antarctic waters I made a number of observations on the melting-point of ice collected from broken pieces of the pack, and found it begin to melt a little below −1° C. I concluded that either it was one solid substance or a mixture of several solids. But if pure ice melts at a different temperature according to the medium in which it is placed, then this reasoning is faulty, for inclosed brine would have much the same effect as inclosed salt or crystalline hydrate.

sea-water the observations were continued with it. A few comparative observations were made in order to determine the effect of replacing the sea-water by fresh water. On February 2, after a shower, the temperature of the air was 25°·0 C. When wet with sea-water the temperature of the thermometer was 23°·5 C., and with rain-water 23°·1 C. Similarly, at noon on the same day, the following temperatures were observed: dry bulb, 26°·1 C.; wet bulb (sea), 24°5 C.; wet bulb (rain), 24°·2 C. The air, at this time, appeared, to the sensation, to be damper than at any other time, and yet, when suitably exposed, there was a difference of nearly 2° C. between the wet and dry thermometers.

There is an advantage in having the bulb of the thermometer wet with a continuous film of water, instead of being surrounded with damp muslin, namely, that it more nearly resembles the surface of the sea, which is exposed to the influence of the atmosphere. Observations with the wet thermometer were not made as regularly as those with the dry instrument, and no observations were made with either of them after dark, owing to the difficulty of securing proper exposure and reading the instrument with a lantern, without heating it.

The temperature of the air and of the water were taken generally every two hours from 6 a.m. to 6 p.m., but the intervals between the observations were not always the same. These observations showed that only on two days, January 31 and February 1, between lat. 6° S. and 12° S., did the mean *day* temperature of the air exceed that of the surface-water. On these days the temperatures were taken every two hours from 6 a.m. to 6 p.m., and the means of the groups of seven observations gave, on January 31: air, 27°·13 C.; sea, 26°·90 C.; difference, 0°·23 C.; and on February 1, air, 27°·26 C.; sea, 26°·96 C.; difference, 0°·30 C. These differences would have been reduced in amount if the observations had been carried on through the night, though, from the very high temperature of the air just before sunrise on February 1 and 2, they would not have been reduced to zero.

In the table (p. 129) all the simultaneous observations of temperature of air and water made during the voyage, except those of the last day, when approaching the mouth of the River Plate, are collected in small tables for each day. The time of day is given in hours, from 0 to 24; the temperatures are in Centigrade degrees; t denotes the temperature of the sea-surface, $t-T$ the difference between that of the temperature of the air, and $T-T$ the difference between the readings of the thermometer in air with its bulb dry and when it is wet with sea-water. At the head of each table is given the meteorological district of the ocean through which the ship was passing, as "north-east trade-winds," "equatorial calms," and the like; also the day of the month (1885) and the latitude and longitude at noon of the day. The means at the foot of each table are simply the arithmetical means of the numbers in each column; and their meaning and value are at once apparent on inspecting the column.

With the two exceptions above-named, the temperature of the sea was always found higher than that of the air, over the day, and only very seldom was it exceeded by that of the air at the hottest time of the day. Had the observations been carried on through the night, the contrast between the two temperatures would have been much greater. On January 31 and February 1 the conditions were somewhat exceptional. On the former of these days the ship passed into the northerly monsoon, which prevails all down the Brazilian coast during the southern summer. Like the similar monsoons in the northern hemisphere, it is caused by the proximity of a large mass of land, which gets intensely heated by the vertical rays of the sun. On January 30 the wind had been light south-easterly; during the night it fell calm, and at sunrise a light easterly wind sprang up, which gradually drew around towards the north and blew all day, with just sufficient force to travel exactly at the same rate as the ship (11½ knots); consequently, during the whole of the day the atmosphere on the deck was motionless, with a very powerful sun beating on it and heating up every thing, so that it was impossible to find any place where the air could be got, coming fresh on board, without having been exposed to the influence of the highly-heated deck and fittings. It is therefore certain that the air-temperatures are somewhat above the water.

It is probable that, when the true temperature of the air can be ascertained, it will be found to be usually below that of the sea-surface. The cause of this is, I think, to be found in the relative dryness of the atmosphere over the ocean. If the observations with the wet-bulb thermometer be considered, it will be seen that the least difference of reading between the dry- and the wet-bulb thermometers was 1°·0 C. on January 28, when the ship was in the middle of the equatorial belt of calms and rains. In this region perfectly saturated air might be expected, and with instruments exposed in the usual form of box I have no doubt that here, and in the very oppressive weather of the northerly monsoon, the two instruments would have given identical readings. The readings of the air-temperature on January 28 were perfectly trustworthy, as the sky was thickly overcast with dense rain-clouds all day; there was thus no risk of overheating; the readings with the wetted bulb were equally satisfactory, so that the results of the observations on that day may be taken to represent fairly the normal state of things in the "Doldrums." The temperature of the sea varied from 26°·3 to 26°·6 C., the mean of five observations during the day being 26°·42 C. The mean temperature of the air during the day was 0°·92 lower than that of the sea, or 25°·5 C., and the temperature of the wet-bulb thermometer 1°·3 lower still, or 24°·2 C. It will be seen that, on the two exceptional days, January 31 and February 1, the difference between the wet- and the dry-bulb thermometer is greater than would be expected from the oppressive damp feeling of the air; it is therefore all the more likely that the dry-bulb readings are too high as indicated above. However, it is important to observe that in all the regions passed through, whether in the westerly winds of the North Atlantic or the equatorial calms, or the monsoon of the South Atlantic, the temperature of the wet-bulb thermometer is always very markedly below that of the dry-bulb thermometer. In fact, such is the mobility of the atmosphere that it rarely has the opportunity of saturating itself; and if the effect which must be produced when this air meets the surface of the water be considered, it will, I think, afford some explanation of why at sea the temperature of the air, even by day alone, is usually markedly below that of the sea-surface.

If we consider the film of water immediately at the surface of the sea, having the atmosphere on the one side of it and the bulk of the water on the other, it is strictly comparable with the film of water surrounding the bulb of the thermometer, when exposed to the atmosphere in the way described above; and the air playing upon it must produce exactly the same effect in the one case as in the other. The evaporation lowers the temperature of the aqueous film, which proceeds to extract heat from the neighbouring bodies—namely, in the one case the air and the bulb of the thermometer and in the other case the air and the layer of water immediately below the surface film. If we imagine for a moment the surface film separated from the bulk of the water below it by a diaphragm impervious to heat, then exposed to the atmosphere so as to suffer evaporation and lowering of temperature, then on the removal of the diaphragm it would immediately sink away from the surface and its place would be taken by warmer, and therefore less dense, water from below. In the case of sea-water this effect would be slightly intensified by the concentration produced by evaporation. But

Table giving the Temperature of the Sea Surface (t), the Difference between it and the Temperature of the Air ($t-T$), and the Difference between the Readings of the Dry Bulb and the Wet Bulb Thermometers in Air ($T-T'$), at Different Hours of the Day

N.W. Winds — Jan. 23, Lat. 26° 24′ N., Long. 21° 21′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	18.9	2.1	
10	19.3	1.1	
12	19.2	0.7	
14	19.3	0.8	
16½	19.7	1.7	
17½	19.6	1.9	
Mean	19.33	1.38	

N.E. Trade Wind — Jan. 24, Lat. 22° 5′ N., Long. 23° 6′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	20.5	1.5	
10½	20.7	1.0	
12	20.9	0.8	
14	21.1	1.1	
16	21.2	1.2	
17½	21.2	1.3	
Mean	20.93	1.15	

N.E. Trade Wind — Jan. 25, Lat. 18° 6′ N., Long. 24° 39′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	22.0	1.4	1.6
10	22.0	0.8	
12	22.2	0.7	
14	22.2	1.0	
16	22.7	1.7	
17¼	22.3	1.2	
Mean	22.23	1.13	

N.E. Trade Wind — Jan. 26, Lat. 13° 46′ N., Long. 26° 6′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8	23.2	1.0	3.0
10	23.8	0.8	—
12	24.0	0.7	1.8
14	24.0	0.9	2.1
16	24.2	1.1	
17¼	24.2	1.0	
Mean	23.90	0.92	

N.E. Trade Wind — Jan. 27, Lat. 9° 25′ N., Long. 27° 21′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	25.4	1.5	
8	25.6	0.9	2.7
10	25.7	0.9	
13	26.0	1.0	3.0
16	26.0	1.0	
17½	26.0	1.0	
Mean	25.79	1.05	

Equatorial Calms — Jan. 28, Lat. 5° 16′ N., Long. 28° 32′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26.4	6.7	1.7
9	26.3	1.0	—
12	26.3	1.1	1.4
15	26.6	1.0	1.1
18	26.5	0.8	1.0
Mean	26.42	0.92	1.30

Equatorial Calms — Jan. 29, Lat. 1° 15′ N., Long. 29° 16′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26.5	0.6	1.4
9	26.7	0.8	—
12	27.0	0.3	1.8
15	27.0	0.0	2.5
18	26.8	0.2	2.3
Mean	26.80	0.38	2.00

S.E. Trade Wind — Jan. 30, Lat. 2° 53′ S., Long. 31° 5′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26.3	0.3	1.6
9	26.4	−0.2	1.9
12	26.8	0.0	2.4
15	27.0	+0.4	2.2
18	26.8	0.7	1.8
Mean	26.67	0.24	1.98

Northerly Monsoon — Jan. 31, Lat. 7° 5′ S., Long. 33° 2′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26.5	0.5	1.7
8	26.5	−0.2	2.3
10	26.8	−0.6	2.6
12	27.1	−0.7	2.8
14	27.4	−0.3	2.6
16	27.1	−0.3	—
18	26.9	0.0	2.3
Mean	26.90	−0.23	2.38

Northerly Monsoon — Feb. 1, Lat. 11° 18′ S., Long. 34° 53′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26.8	0.1	2.4
8	26.9	−0.1	2.2
10	27.0	−0.3	2.7
12	27.0	−0.8	—
14	27.0	−0.7	2.8
16	27.0	−0.3	2.3
18	27.0	0.0	2.0
Mean	26.96	−0.30	2.40

Northerly Monsoon — Feb. 2, Lat. 15° 30′ S., Long. 36° 53′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	26.9	−0.1	2.3
8	26.9	−0.1	2.0
10½	26.7	+1.7	1.5
12	26.9	0.8	1.6
16¼	26.3	0.3	
18	25.5	−0.2	
Mean	26.54	0.40	1.85

Northerly Monsoon — Feb. 3, Lat. 19° 48′ S., Long. 38° 42′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	24.3	0.1	1.8
8	25.7	0.8	2.1
9	25.4	0.6	—
12	25.2	1.2	—
14	25.9	1.3	1.8
16	26.0	0.1	1.6
18	25.9	0.0	—
Mean	25.48	0.60	1.82

S.E. Trade Wind — Feb. 4, Lat. 24° 0′ S., Long. 40° 33′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
5½	25.5	1.5	—
8	26.0	1.1	2.9
10	25.8	0.2	—
12	25.7	0.5	2.9
14	25.8	0.8	2.8
16	26.0	1.0	—
Mean	25.80	0.85	2.87

S.E. Trade Wind — Feb. 5, Lat. 27° 8′ S., Long. 44° 1′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
5½	24.4	0.6	—
8	24.5	0.2	2.8
10	24.5	−0.3	3.7
12	25.2	−0.1	3.3
14	26.4	+1.4	4.7
16¼	26.7	2.0	3.5
18	26.3	2.0	4.3
Mean	25.43	0.97	3.72

S.E. Trade Wind — Feb. 6, Lat. 30° 13′ S., Long. 47° 52′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	24.7	0.6	2.8
8	25.0	0.7	2.7
10	24.8	1.1	2.7
14	25.2	0.9	3.0
16	24.7	0.7	2.9
18	24.8	1.1	3.7
Mean	24.87	0.85	2.97

while the water below supplies some of the heat rendered latent by the evaporation of the water, the air above it supplies its share, and is cooled. In both cases the heat thus lost is made good by the direct radiation from the sun. Through a moderately dry atmosphere the rays pass with comparatively little heating effect, but are largely absorbed on entering the water. Consequently the loss of heat which the water suffers by evaporation at the surface of separation is made good more abundantly than that sustained by the air; and the difference in power of absorption of radiant heat exhibited by these two substances is thus sufficient to keep up a permanent difference of temperature between the water and the air immediately above it.

Starting with air and water at the same temperature, we may imagine the process taking place in three acts. First, the water at the surface evaporates, and the air on the one side, and the water on the other, are cooled; second, in order to make up for the heat thus rendered latent and lost, the sun shines upon both alike, but the water absorbs a larger proportion of the heat of its rays than the air does; and finally, a portion of this excess is then removed from the water by the simple contact of the air at its surface. The nett effect of these causes is to produce a permanent excess of temperature of the surface-water of the sea over that of the air above it, provided that that air is not completely saturated with moisture.

From what I have seen and experienced in the regions visited by the south-west monsoon in the east, I cannot doubt that there are often cases where the most carefully exposed wet- and dry-bulb thermometers would show identical readings, and the atmosphere is completely saturated with vapour of water. Thus it is probable that the temperature of the air would not be inferior to that of the water. Further, when, on the eastern coasts of Asia, the south-west monsoon blows out of the China Sea and penetrates far into the North Pacific, off the coasts of Japan it attains a latitude of naturally lower temperature than that from which it proceeded, so that much of the water with which it was laden, and which is held diffused through it as a mere gas, is condensed and remains suspended in it, producing a visible haze, which obscures the horizon and condenses on all solid objects exposed to it. Here the conditions are reversed, and instead of the air losing heat to evaporate the water, it receives the heat liberated by the condensation of the steam removed from waters of lower latitudes. Such conditions are, however, certainly exceptional, and there can be little doubt that, as a rule, the temperature of the surface-water of the sea is higher than that of the air. The temperature of the air depends on that of the water which tends to warm it and the degree of its own dryness, by virtue of which the water has a tendency to evaporate into it and, by extracting heat from it for this purpose, to cool it.

It is obvious that local circumstances such as currents may produce differences between the temperature of the air and the water, but such cases are not here under consideration. J. Y. BUCHANAN

Mendoza, March 18

THE REV. T. W. WEBB

BY the death of the Rev. Thomas William Webb, M.A., F.R.A.S., English astronomy has lost one of its most assiduous and accomplished votaries. Mr. Webb, who had reached the age of 79 years, passed a long life as the incumbent of two obscure Welsh livings, held by him in succession. At Tretire he may be said to have laid the foundations of those astronomical tastes which took their finished and best-known shape during the later years of his life whilst he was incumbent of Hardwick, in Breconshire. He was a genial and right-thinking parish priest, whose highest aim was the performance of his duty. For the sake of astronomy it was well perhaps that he obtained so little ecclesiastical advancement; for had things been otherwise it is probable that he would never have developed those scientific tastes which have made his name almost a household word. It was my privilege to make his acquaintance upwards of twenty years ago, and I look back with extreme pleasure to the many letters which have passed between us on practical matters connected with observational astronomy and the use of instruments. Whilst Mr. Webb in bygone years used to write a good deal in the current scientific magazines of the day, especially the *Intellectual Observer* and the *Student*, it was by his "Celestial Objects for Common Telescopes" that he became chiefly known in the astronomical world. This work, published in the year 1859, was designed to be a cheap popular abridgment in a modified form of Admiral Smyth's "Celestial Cycle," which had done right good service in providing English amateurs with information as to what to look for and how to find. By 1859 Smyth's work had become both out of print and somewhat out of date, and Mr. Webb's unpretending abridgment filled at once an undoubted void. It is indeed not wholly correct to speak of Webb's "Celestial Objects" as an abridgment of Smyth's older, larger, and more expensive volume. It was this; but it was also a good deal more, for whilst it offered to the possessors of small telescopes convenient lists of objects deserving of their attention, it also supplied an enormous amount of original information connected with the sun, moon, and planets, and the use of telescopes. This information, though no doubt suggested by Admiral Smyth's style, was no mere *rechauffé* of other people's work, but represented the personal experience of an intensely industrious and persevering man working under great difficulties through lack of instrumental means.

I shall never forget the feeling of blank astonishment which crept over my mind one day when (in, I think, the year 1864) Mr. Webb told me that the first edition of his book, and all his magazine articles up to that date describing double stars and clusters, were founded on studies pursued by means of a telescope set up in his garden and not equatorially mounted. This, I well remember, was not said in any spirit of boasting in the garb of mock modesty, but was the casual utterance of a simple truth disclosed without effort or intention. I do not think I ever came in the way of any student of nature of whom it could be so truly said that he was "without guile."

Mr. Webb was every inch a gentleman, and a philosopher in the highest sense of the word. Every line that he wrote contained either the record of some fact noticed by himself, or a sensible deduction from some other facts. When his facts had come to an end his pen ceased to pass over paper, and the result was that no one ever read a sentence written by him without learning something useful, set forth in the fewest possible words, often, indeed, in a form of concentration which erred on the side of inconvenient brevity; but in these days of penny-a-lining (and it may even be admitted that there is even such a thing as science penny-a-lining) Mr. Webb's habitual terseness cannot be described as a vice. His private letters show that, where necessary for the instruction of a young astronomer, he never grudged time and trouble for going into details. The highest praise that can be awarded him is that he not only did many useful things himself, but that he set an example of patient and industrious research which resulted in many young men all over the British Empire seeking to imitate his cheery and sensible style of work and thought.

G. F. CHAMBERS

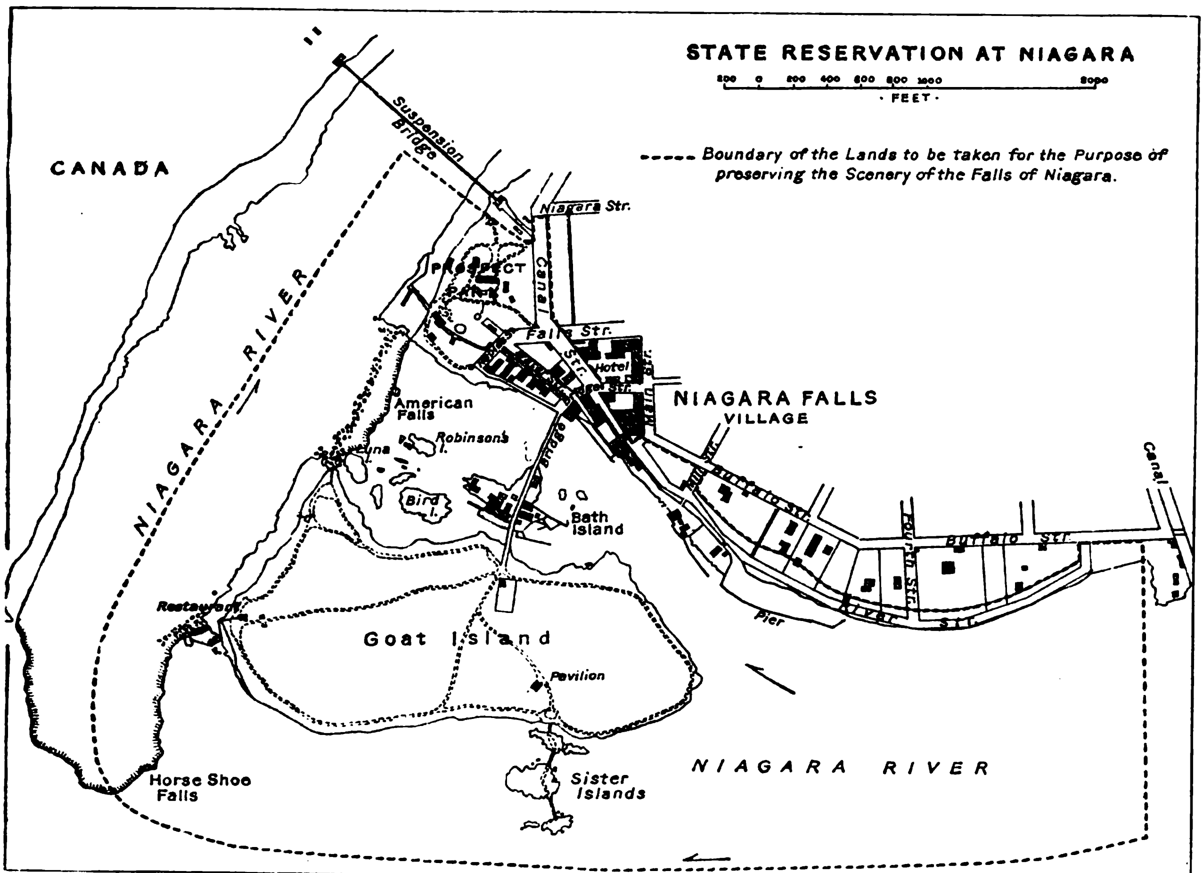
THE PRESERVATION OF NIAGARA[1]

NEARLY seven years ago Lord Dufferin, then governor-general of Canada, suggested to Gov. Robinson of New York that the governments of the province of Ontario and the state of New York should purchase such lands about Niagara Falls as would be required to give free access to the principal points of view, and serve to restore and preserve the natural scenery of the great cataract, beside securing to visitors freedom from those vexatious annoyances which now abound. Subsequently the governor-general called the attention of the government of Ontario to the matter, and recommended co-operation with the state of New York in accomplishing this purpose.

Later, in January, 1879, Gov. Robinson, in his annual message to the legislature of New York, presented this matter, and recommended the appointment of a commission to investigate the question, to confer with the Canadian authorities, to consider what measures were necessary, and to report the results to a succeeding legislature.

By resolution the commissioners of the State Survey were charged with the investigation. This commission included some of the most distinguished men of the state,—Ex-Gov. Horatio Seymour, Vice-President of the United States, W. A. Wheeler, Lieut.-Gov. Dorsheimer, President Barnard of Columbia College, and others.

With breadth of view worthy of such men, they state in their report that, "under this resolution, it became the duty of the commissioners to ascertain how far the private holding of land about Niagara Falls has worked to public



Stanford's Geogr Establ.

disadvantage through defacements of the scenery; to estimate the tendency to greater injury; and, lastly, to consider whether the proposed action by the state is necessary to arrest the process of destruction, and restore to the scenery its natural character." In pursuance of these objects, the commissioners instructed Mr. James T. Gardiner, director of the State Survey, to make an examination of the premises, and prepare for their consideration a project. He was assisted in this work by Mr. Frederick Law Olmsted, the distinguished landscape-architect.

The examination showed that the destruction of the natural scenery which forms the framework of the Falls was rapidly progressing: unsightly structures and mills were taking the place of the beautiful woods that once overhung the rapids; the fine piece of primeval forest remaining on Goat Island was in jeopardy from projects looking to making a showground of the island; and every point from which the Falls could be seen on the American side was fenced in, and a fee charged for admission. It was found that, owing to the topography of the main shore, it was practicable to restore its natural aspect by clearing away the buildings from a narrow strip of land 100 to 800 feet broad and a mile long, and planting it with trees which would screen out from view the buildings of the village. When these trees should be grown, and the mills removed from Bath Island, and trees planted there, the falls and rapids would be again seen in the setting of natural foliage which formed so important an element in their original beauty. Every point from which the Falls could be seen would also become free of access by the plan proposed. A map was made showing just what lands should be taken to carry out these purposes. The commissioners adopted the plan of Mr. Gardiner

[1] From *Science*.

and Mr. Olmsted, and recommended to the legislature of 1880 the passage of an Act to provide for acquiring title to the necessary lands by the exercise of the right of eminent domain, leaving it to a future legislature to consummate the purchase by appropriating the amount for the payment of the awards, if the sum should seem a reasonable price for the property. Such an Act passed the Assembly, but was defeated in the Senate, although the movement was supported by petitions signed by the most distinguished men of this and other countries. The report of the State Survey, with its complete descriptions, illustrations, and maps, then became the basis of a systematic effort on the part of a few determined friends of the Falls to educate and arouse public opinion to save the scenery of Niagara. Early in 1883 this movement ripened into the organisation of an association to promote legislation for preserving the scenery of the Falls of Niagara, Mr. Howard Potter of New York being president, and Hon. J. Hampden Robb, chairman of the executive committee.

Through the efforts of this Niagara Falls association an Act was passed, in 1883, providing for a commission, entitled "The commissioners of the state reservation at Niagara," and giving them power to proceed through the courts to condemn the lands needed. Ex-Lieut.-Gov. William Dorsheimer is the president of this board; and the other members are President Anderson of Rochester University, Hon. J. Hampden Robb, Hon. Sherman S. Rogers, and Andrew H. Green. With some modifications made necessary by changed conditions, they adopted the plan proposed by the State Survey. The lands selected were then surveyed, and their value appraised by a commission of very high character, appointed by the court, the total value of the lands being $1,433,429.50. The report of the commissioners of the reservation was made to the present legislature, and a Bill to appropriate this sum was introduced. The Niagara Falls association worked in every part of the state to arouse public opinion to the importance of making this appropriation, and the commissioners laboured most earnestly among the legislators and the people. The battle was a hard one against ignorance and narrow-minded selfishness; but the victory is complete. The legislature, by more than a two-thirds majority, has appropriated the $1,433,429.50, and the governor has approved the Act.

After six years of almost continuous effort on the part of the active friends of this enlightened project, it is secured by a law which declares that the lands are purchased by the state in order that they may be "restored to, and preserved in, a *state of nature*," and that every part of them shall be for ever free of access to all mankind.

NOTES

We understand that on the receipt by the Science and Art Department from the Foreign Office of a despatch from Her Majesty's Minister at Washington forwarding communications concerning the proposed change in the time for beginning the astronomical day, as recommended by the recent International Meridian Conference at Washington, the Lords of the Committee of Council on Education requested the following Committee to advise them as to what steps should be taken in the matter. Prof. J. C. Adams, F.R.S., the Astronomer-Royal, Capt. Sir F. Evans, K.C.B., R.N., the Hydrographer of the Navy, Gen. Strachey, R.E., C.S.I., F.R.S., Dr. Hind, F.R.S., and Col. Donnelly, R.E. In accordance with their recommendations copies of the Report of the Delegates to the International Prime Meridian Conference at Washington, together with the resolutions adopted by that body, have been sent to various departments of the State, and to the following Societies, &c. : Society of Telegraphic Engineers, Royal Astronomical Society, Royal Society, Submarine Telegraph Company, Eastern Telegraph Company (Limited), Eastern and South African Telegraph Company (Limited), Eastern Extension, Australasia and China Telegraph Company (Limited), Railway Clearing House. They have been informed that these resolutions of the Prime Meridian Conference appear to my Lords of the Committee of Council to be such as commend themselves for adoption. But before informing the American Government to that effect their Lordships would be glad to receive the opinion of the various societies on the subject.

The annual meeting for the election of Fellows of the Royal Society was held at Burlington House on Thursday, June 4, the President in the chair. The following were elected:—Major A. W. Baird, R.E., Philip Herbert Carpenter, D.Sc., Sir Andrew Clark, Bart., M.D., Andrew Ainslie Common, F.R.A.S., Staff-Commander Ettrick William Creak, R.N., Prof. Edward Divers, Henry Hicks, M.D., William Mitchison Hicks, M.A., Francis R. Japp, Ph D., Arthur Milnes Marshall, M.D., Prof. Henry Newell Martin, D.Sc., Cornelius O'Sullivan, Prof. John Perry, Prof. Sydney Ringer, Sidney Howard Vines, D.Sc.

The Davis lectures upon zoological subjects will be given in the Lecture Room in the Zoological Society's Gardens, Regent's Park, on Thursdays, at 5 p.m. The first was given on Thursday, June 4, the subject being "Rhinoceroses and their Extinct Allies," by Prof. Flower, LL.D., V.P.R.S. The others are:—Thursday, June 11, "Apes and Lemurs," by Dr. St. George Mivart, F.R.S.; Thursday, June 18, "The Structure of the Swan," by Prof. W. K. Parker, F.R.S.; Thursday, June 25, "The Domestic Cat," by J. E. Harting, F.L.S.; Thursday, July 2, "Recent Advances in Zoology," by Prof. F. Jeffrey Bell, M.A.; Thursday, July 9, "The Ancestors of Birds," by F. E. Beddard, M.A.; Thursday, July 16, "The Animals of New Guinea," by P. L. Sclater, F.R.S.

In the second edition of his work, "Sur l'Origine du Monde," M. Faye has promulgated the following hypothesis regarding the relations between the geological epochs and the stages of the terrestrial cosmogony. The history of the earth he divides into six stadia. The first is that in which the earth was a glowing ball. The second he calls the *Antezoic period*, in which total darkness supervened on the extinction of the earth's glow. The third is the *Primary period*, during which there was a feeble illumination from the sun, which was then just coming into existence. During the *Secondary period* the sunlight went on increasing as the sun itself grew larger and assumed its proper shape. In the fifth stadium, which is that of the *Tertiary period*, there was complete solar illumination, and the sun soon attained the maximum of its activity; while in the last stadium, that of the *Quaternary period*, there has been a slight diminution of the solar activity (rather surmised than demonstrated), accompanied by the diappearance of every cosmogonic influence and the establishment of perfect stability in almost all directions. Oscillations in the earth's crust and feeble volcanic manifestations are almost the only instances of cosmogonic change still observable.

We have received from MM. Fol et Sarasin a copy of a paper by them on the depth to which the light of the sun will penetrate into the sea. It will be remembered that in November last they recounted the results of their experiments on the same subject in the Lake of Geneva. The present paper describes similar experiments made in the Mediterranean off the zoological station and harbour of Villefranche. By means of photographic plates they have proved that in the month of March, in the middle of a sunny day, the rays of the sun do not penetrate beyond 400 metres below the surface of the Mediterranean. This is established by seven separate experiments, at varying depths and different hours of the morning. At 380 metres, shortly before 11 a.m., the impression on the plate was less than that which would have been left on exposure to the air on a clear night, without a moon. Between 1.20 and 1.30 p.m., at a depth of 405 to 420 metres, there was no trace of any impression whatever on the plate. Light clouds do not appear to cause any notable diminution in the depth to which the light penetrates. In the Lake of Geneva the writers also undertook a new series of investigations to determine the effect of the season on the penetration of light. They give 200 metres as the extreme limit for winter in the lake; but they found that there is as much light at 380 metres in the Mediterranean as at 192 metres in the Lake of Geneva; and by a comparison of these with previous experiments, it appears the light penetrates from 20 to 30 metres deeper in March than in September; in the month of August, perhaps the difference is a little more. Compared with the series of plates exposed in the lake, those of the Mediterranean are characterised by a slower and more regular gradation. This gives rise to the idea that while in the lake the light would be promptly intercepted by the deeper layers, more or less disturbed or muddy, in the Mediterranean the absorption proper to pure water would be the principal, if not the sole factor in arresting the luminous rays.

IN a communication to *Ausland* on the causes of the Andalusian earthquakes, A. Rzehak, of Brünn, maintains that they are clearly referable to the "tectonic" class of terrestrial disturbances—that is, those which are connected with the process by which mountains are elevated. Evidence of this connection is furnished by the manner in which the disturbed areas are influenced by lines of fault. The entire area of disturbance in the case of the earthquakes of December last is divisible into three zones: (1) the littoral zone in the south, where the shock was most severe; (2) Andalusia proper, which was likewise the seat of pretty severe disturbances; and (3) the central plateau of Spain as far as the Carpetena chain (a section of the Sierra Guadarrama), where, as already pointed out by M. Noguès (NATURE, xxxi. p. 417), the shocks completely died out. These three zones are separated by lines of fault. A great fault can be traced not only along the northern slopes of the Serrania de Ronda, but also further eastwards to the district lying north of Malaga. To the north of this line scarcely any places suffered greatly from the earthquake—except those which, like Antequera, Loja, and Archedona, lie close to or immediately beside transverse faults. Elsewhere the degree of shock was tolerably uniform as far as the fault of the Guadalquivir, which bounds the central plateau on the south. A third great fault passes along the south of the Sierra Guadarrama, and there the disturbance seems to have ended.

THE honour of C.I.E. has been conferred upon Mr. Francis Day, Deputy-Surgeon-General (Retired), Medical Department, Madras, and on Mr. J. B. N. Hennessey, late Deputy-Superintendent, Indian Survey Department.

THE Meteorological Society of Vienna has resolved to erect a meteorological station on Mount Sonnenblick, near Tauern, in the central range of the Tyrolese Alps, 3100 metres above sea-level, and thus the highest station of the kind in Europe.

THE Royal Institute of British Architects, on Monday evening, presented to Dr. Henry Schliemann, F.S.A., their Royal Gold Medal. In acknowledging the medal Dr. Schliemann said that our knowledge of prehistoric architecture was very deficient, for our sole informant was Homer, whose scanty information as to the construction and arrangement of the heroic palaces we did not even understand.

THE latest official report of the earthquake in Cashmere states that much damage was occasioned in the north western portion of the valley. The ground opened, and the villages of Dubgaon, Jamalapar, and Ovan were swallowed up, while sulphurous dust and hot water issued from the cracks. The fort at Gurais and the grain store-houses were buried. A telegram sent from Serinagur on Friday last says:—"The shocks continue every three hours, with much preliminary noise, but a comparatively slight motion." The great shock appears to have travelled in a southerly direction, and to have been felt at several places in Northern India, although it did no damage there.

THE death is announced, at the age of fifty-two, of Robert von Schlagintweit, Professor of Geography and Ethnology at the University of Giessen. He was the youngest of the three brothers Schlagintweit who, on the recommendation of Alexander von Humboldt, and under the special care of Lieut.Col. Sykes, were sent by the British East India Company to explore that country, and especially the mountain regions in the north-west. The results of their researches, which lasted for several years, are recorded in comprehensive works of the highest scientific value.

IMPORTANT experiments in aërial navigation are now being made by Mr. A. F. Gower, well known in connection with the Gower-Bell telephone. The operations being carried on are, it is understood, within the cognisance of the Government, and are more particularly directed towards the adaptation of balloons to war purposes. Several ascents have already been made, and in carrying out his arrangements Mr. Gower appears to have recognised the advantages offered by the position of the town of Hythe, which he has made the centre of his operations. On Sunday week the wind being favourable, one of the automatic pilot balloons invented by Mr. Gower, with appliances for giving out its own gas and ballast, one compensating for the loss of the other, was filled with 2300 feet of gas, and ascended at about 11 o'clock. In the car a written statement was, of course, placed, explaining the ownership of the machine and its object, with the result that it was next heard of at Dieppe, having made a rapid passage of about seventy-two miles in a straight direction and descended at 2.30 in the afternoon. On Monday, another pilot balloon, with a capacity of 4300 feet, was started, and immediately followed by Mr. Gower in his own balloon (containing 23,000 feet of gas). The object of Mr. Gower in ascending was to watch the action of the pilot; but the smaller machine made such rapid progress that it got out of his observation and came down in the vicinity of Paris. Meanwhile Mr. Gower, who ascended about noon, took the French coast at Boulogne at 2.15, and then taking a northerly curve travelled overland to Calais, where he made a smooth descent at 4 p.m. A still more important undertaking was, however, entered upon on Wednesday, when Mr. Gower, Capt. Lane, and Mr. Dale, the aëronaut, ascended in a balloon of 40,000 feet capacity. A good start was made, and the aërial voyagers sailed away in a northerly direction. After a journey of rather more than an hour, they were compelled to descend, owing to the wind taking a slight turn towards the North Sea, and with much difficulty landed on the Isle of Sheppey, having travelled twenty-three miles.

A VERY laudable effort at teaching the general public practical astronomy is being made in Christiania. An optician, Herr A. Olsen, has erected a great refractor in the Royal Park—in size said to be the fifth in the world—through which the celestial bodies can be observed by the public for a small fee, while explanations are given of their nature, &c. The interior of the pavilion in which it is mounted is hung with celestial charts and diagrams, as well as views of the planets, the sun, and the moon, for the purpose of facilitating the object in view. The cost of the instrument is very nearly 2000*l*.

INTELLIGENCE has been received at New York, June 9, stating that a waterspout has burst near Lagos, in Mexico. One hundred persons are reported to have perished, and it is feared that the loss of life will prove even greater.

A WATERSPOUT passed over a portion of the town of Hagenau (Alsace) on May 23 last, doing very great damage to houses and trees.

AT Stendal (Prussian Saxony) a Committee for the erection of a monument in memory of Dr. Gustav Nachtigal has been formed, and contributions towards this object are solicited.

THE Austrian Central Tourist Club has addressed a petition to the Assemblies of all Austrian alpine provinces to pass a law prohibiting the wholesale uprooting of *Edelweiss* now carried on. The petitioners point out that hundreds of thousands of the plants are dug up and sent abroad, even to America, so that there is a fear that the favourite plant of all lovers of the Alps will be totally exterminated, except in a few remote plac s. In Switzerland, it is stated, for several years past there have been stringent laws in the several cantons against uprooting and selling the *Edelweiss*.

THE *rôle* of wind in fertilising the ground is remarkably illustrated, according to M. Alluard, by the very fertile valley of Limagne, in Auvergne. The prevalent winds there are west and south-west, and traverse the chain of the Dômes, where are vast deposits of volcanic ashes. Much of this dust is thus carried to the Limagne valley, and settles there of itself, or is carried down by rain or snow. As it contains a large amount of phosphoric acid, potash, and lime, it is highly fertilising, and its very fine state favours rapid assimilation. From observations on the Puy de Dôme, M. Alluard estimates the annual deposit at 348 to 400 grammes per square metre.

WE have received the Calendar of the University of Virginia for the academical year 1884-85. The science department appears to be exceptionally strong and well organised.

ONE result of the recent visit of the Ameer of Afghanistan to India is that his palace at Cabul is to be lit by the electric light. He ordered the necessary apparatus when at Rawul Pindi, and three Cabulese have for some time past been studying its manipulation at Bombay.

WE have received a copy of a lecture by Mr. Thomas Fletcher, delivered before the Parkes Museum of Hygiene, on "Smokeless Houses and Manufactories." It deals mainly with the lecturer's personal experiences of the employment of gaseous fuel in his private residence and manufactory at Warrington, the appliances which he has used, a comparison of the cost with that of coal, the work done, &c. In reply to a question, Mr. Fletcher expressed the opinion that radiant heat is the only possible comfortable way of heating a living-room, and that it is therefore better to mix gas with air to prevent smoke, and heat as large a surface as possible to incandescence.

ACCORDING to a report by the Director of Public Instruction in Tunis, there are at the present moment twenty primary schools in the Regency—eight in Tunis, and twelve in other towns—Susa, Monastir, Sfax, Goletta, &c. In this number are included three schools of the Israelite alliance at Susa, Tunis, and Mehdia. The number of pupils is 3974, composed of 2291 boys and 1683 girls. The report states that there are in addition a certain number of primary schools in which the instruction is religious. Of these there are 113 in Tunis, and about 500 in the whole Regency. For secondary instruction there are three establishments, all in Tunis. These contain 23 classes with 38 masters, giving instruction to 416 pupils, of whom 78 are French, 27 Italian, 26 Anglo-Maltese, 74 Jews, 193 Arabs, and 18 of various nationalities.

A MEETING of the National Fish Culture Association was held on Thurday last to consider the question of instituting sea temperature observations with a view to gaining independent and fresh knowledge with respect to our marine food-fishes. The subject of marine stations was discussed together with other matters relative to log-books to be issued to suitable investigators.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Demerara, presented by Mr. T. C. Edwards-Moss; a Common Badger (*Meles taxus*) from Derbyshire, presented by His Grace the Duke of Devonshire, K.G., F.Z.S.; a Common Badger (*Meles taxus*) from North Wales, presented by Mr. T. W. Proger; two Common Hedgehogs (*Erinaceus europæus*), a Common Viper (*Vipera berus*) from Norfolk, presented by Mr. T. E. Gunn; a Chattering Lory (*Lorius garrulus*) from Moluccas, presented by Mr. H. D. Astley, F.Z.S.; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss Hyrzan; a White-tailed Eagle (*Haliaetus albicilla*) from Perthshire, presented by Mr. H. Tennent Tennent; a Manx Shearwater (*Puffinus anglorum*), a Puffin (*Fratercula arctica*), British, presented by Mr. W. Graham, F.Z.S.; an Egyptian Monitor (*Varanus niloticus*) from West Africa, presented by Mr. H. Denny; an African Lepidosiren (*Protopterus annectens*) from African Rivers, presented by Mr. Cornelius Alfred Malony, C.M.G.; two Slowworms (*Anguis fragilis*), British, presented by Mr. F. J. Guy; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Jamaica, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), an Axis Deer (*Cervus axis* ♀), a Hybrid Luhdorf's Deer (between *Cervus luehdorfi* and *Cervus canadensis* ♂), a Burrhel Wild Sheep (*Ovis burrhel*), two Triangular-spotted Pigeons (*Columba guinea*), a Variegated Sheldrake (*Tadorna variegata*), a Herring Gull (*Larus argentatus*), twenty Spotted Salamanders (*Salamandra maculosa*), thirty Pleurodele Newts (*Molge walti*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JUNE* 14-20

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 14

Sun rises, 3h. 44m.; souths, 11h. 59m. 59·9s.; sets, 20h. 16m.; decl. on meridian, 23° 18′ N.: Sidereal Time at Sunset, 13h. 49m.

Moon (at First Quarter on June 19, 14h.) rises, 5h. 46m.; souths, 13h. 38m.; sets, 21h. 25m.; decl. on meridian, 17° 37′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	2 58 ...	10 56 ...	18 54 ...	20 45 N.
Venus ...	4 26 ...	12 48 ...	21 10 ...	24 11 N.
Mars ...	2 18 ...	10 7 ...	17 56 ...	19 17 N.
Jupiter ...	9 28 ...	16 37 ...	23 46 ...	12 32 N.
Saturn ...	4 7 ...	12 16 ...	20 25 ...	22 28 N.

Phenomena of Jupiter's Satellites

June	h. m.		June	h. m.	
14 ...	20 15	III. tr. ing.	18 ...	23 17	II. occ. disap.
	22 37	I. ecl. reap.	20 ...	20 33	II. tr. egr.
16 ...	22 24	IV. ecl. disap.			

The Eclipses of Jupiter's Satellites are such as are visible at Greenwich.

June	h.	
17 ...	15 ...	Jupiter in conjunction with and 3° 44′ north of the Moon.
18 ...	23 ...	Saturn in conjunction with the Sun.

GEOGRAPHICAL NOTES

AFTER having lost, in December last, their director, Prof. W. G. Erofeeff, and in January one of their most active members, W. A. Domzer, the Russian Geological Commission has again sustained a heavy loss in the death of the distinguished G. P. Helmersen. According to the notice in the last issue of the *Izvestia* of the Commission he began his scientific career more than sixty years ago, at the Dorpat University, and when less than twenty-two years of age. Throughout his life he has had the opportunity of exploring nearly all the surface of Russia in Europe, from Olonetz to the Crimea and from Poland to the Ural, penetrating also into the Kirghiz Steppes in the Asiatic dominions of the empire. The results of his varied explorations are embodied in 130 monographs, some of which are bulky works. His first work of importance, the "Exploration of Southern Ural," was published in 1831, in connection with Hofmann. Five years later it was followed by a description of the Kirghiz Steppes and by a short paper on the Ural and Altay Mountains. In 1838 he began to publish the results of his explorations of the Baltic provinces, which were thenceforth continued throughout his life. In 1840 he studied the lake region of North-west Russia and of the Valdai Hills, and next year made the first attempt to embody all that was known regarding the geological structure of Russia by publishing the first geological map of the country. The coal-fields of the Moscow basin then attracted his attention, and in 1845 he published the results of his researches into the structure of the Ust-Urt and its slopes towards the Sea of Aral. In 1850 he published an interesting sketch of the Devonian Rocks of Middle Russsa. In 1857 there appeared his notice as to the rising of the Baltic shore and the action of ice and water on it, being the first of a series which led him afterwards to investigate the subject of boulders. After having spent four years in the exploration of the Olonetz region, he embodied the results of his observations in a work published in 1860. His researches into the physical conditions of St. Petersburgh, the artesian well bored in that capital, and the Alexander monolith, made his name popular even among unscientific readers. A work on Lake Peipus and the Narova river appeared in 1864, and completed his researches in the lake region of North-west Russia. Next year a second revised edition of his geological map of Russia, including the Ural and Caucasus, and a map of the Russian coal-basins, were published by the indefatigable geologist. The supposed drying up of the Sea of Azov was the subject of several papers and reports presented by him to the Academy of Sciences, as also the extension of the coal-fields from the Don, through Tula and Kaluya, to Courland and Eastern Prussia. In 1870 he published his "Studies on Boulders," the second part of which appeared only three years ago. In 1879 he issued a geological and physico-geographical description of the Aralo-Caspian region. A paper, written together with M. Yakovleff on the same subject, in 1883, was his last contribution to the Memoirs of the Academy of Sciences. In all these works, Helmersen appeared as a follower of the school of geologists represented by Leopold von Buch and Alexander Humboldt. Instead of merely describing the fossils of a given formation, and minutely studying its various stratigraphical and palæontological horizons, he tried to discover the leading physical and geographical features of the country he explored, and devoted great attention to dynamical geology. His works are as valuable to the geographer as to the geologist. For twenty-five consecutive years Helmersen was Professor at the Mining Institute of St. Petersburg, and since 1844 he was one of the most active members of the Academy of Sciences. In 1851 he was elected a foreign member of the Geological Society of London – an honour well bestowed on one of the most industrious and distinguished geologists whom Russia has produced.

THE last issue of the *Izvestia* of the Russian Geographical Society contains a map showing M. Potanin's last journey in China, from Peking to Kookoo-koto and Lang-tcheou (73° 30′ E. long.), to illustrate M. Potanin's letters dated Boro-balgasun and Lang-tcheou, September and November 13th, 1884. The Ordos, described with so dark features by Huc, looked more attractive than might have been expected. True, the whole of the country between the Yellow river and Boro-Balgasun is covered with sand; but moving sand is rare, the *barkhans* being usually fortified by vegetation. The *shiabyk*—a species of *Artemisia*—is the most frequent growth in the *barkhans*, the cavities between them being thickly covered with bushes of Caragana, *archa*, and *jashil*. Water is found wherever the subsoil appears from beneath the sand; numerous sweet water ponds make there their appearance, and they are surrounded with moist pasture-grounds. The dry grounds between the sands are covered with Steppe vegetation, the *Calimeris* colouring sometimes wide spaces in white. Sarrazin, millet, and hemp are cultivated on these dry grounds. Altogether, the eastern Ordos may be considered as a rich country for cattle breeding, if supported by some agriculture. Two old towns, now in ruins were passed on the borders of the Ordos. Boro-balgasun, too, was formerly a town, within the ruined walls of which there are now but a few Mongolian huts, and the house of the Belgian missionaries. In the Van principality M. Potanin visited the Edjen-khoro place, on the Tchamkhak river; it consists of two tents where the bones of Chengiz-khan are said to be preserved. On Sept. 22, the expedition left Boro-balgasun. They visited the salt lake Baga-shikyr, and for five days crossed a region covered with low hills and almost uninhabited, notwithstanding the good pasturage which spread between the *barkhans*, these last becoming more thinly spread than in the east. Ruins of Mussulman villages destroyed during the last insurrection are not uncommon. Lin-tcheou, on the Hoang-ho, is surrounded by fruit-gardens. South of it numerous villages extend for some fifty miles along a canal which runs parallel to the Hoang-ho and crosses on aqueducts its tributaries. Its banks offer an uninterrupted fruit garden, with a few rice-fields. All this richness is, however, of recent origin, the former gardens having been all destroyed by Chinese after the last insurrection. Altogether, the region bears traces of desolation; whole towns have been quite destroyed. The town Tsin-tsi-pou was the centre of the insurrection. South of this town, M. Potanin left the valley of the Hoang-ho, and crossed the series of flat ridges which reach towards the south, 6,000 feet to 7,000 feet above the sea-level. Still they have gentle slopes, owing to their covering of Loess which reaches a thickness of from 200 to 300 feet. The hills are formed of red sandstone, with some layers of pudding-stone north of the Tao-tsoui river, while south of Tsin-youang the ridge consists of silicious and clay-slate. The sandstone contains beds of salt, which impregnates also the soil and is worked to some extent; it is raised also from a number of small lakes. The Loess covers the whole of the country from Ping-yang-sia to Lang-tcheou, spreading also over the summits of the higher ridges. The population is of Turk origin, and though it has assumed Chinese customs it maintains its Mussulman religion. In the hilly tracts dwellings, and even inns, are dug out in the Loess. Lang-tcheou is a great city, picturesquely built on the right bank of the Hoang-ho at the foot of a high mountain ridge. A floating bridge crosses the great river. The plants collected for the herbarium by the expedition were but few, owing to the late season; but altogether in the whole region there are no trees excepting those which are cultivated; even the higher ridges are devoid of trees and but scarcely clothed with grass. From Lang-tcheou, where the astronomer, M. Skassy, remained with the scientific collection, M. Potanin went to the west to visit the Salors and Shorongols, who inhabit that region, while M. Berezovsky proposed to advance further south to Hoy-sian, situated on the water-divide between the Yellow and the Blue Rivers. The scientific results of the expedition promise to be very interesting. The astronomer, M. Skassy, has determined the position of fifteen places and mapped the route. M. Berezovsky has collected 140 samples of birds, and M. Potanin brings back collections of plants, insects, and reptiles, as also a geological collection.

A RECENT number of the *Japan Gazette* contains a series of notes on each of the islands forming the Kurile group, which stretches from Jeso northward to Kamtschatka, and which for the past ten years have belonged to Japan. The notes are arranged by Prof. Milne, from his own notes and those of Mr. Snow, who has spent many consecutive summers amongst the islands. They refer mainly to the numerous volcanoes among the Kuriles, but much information on other points relating to this little-known group is given. The name applied by the Japanese to the chain is "Chishima," or "the thousand islands," but there are really not more than thirty or forty. Of these, Iturup and Kunashiri, the most southern members of the group, are the largest. They "form the first links of the chain which volcanic agencies have built up whilst attempting to join Japan and Asia." Iturup is 113 miles long and 77 in greatest width; Kunashiri is 62 miles by 17. They are all very desolate, and sparsely populated in summer by Japanese and Ainos, who come to fish. In Iturup, between the coast and the mountains, there is a kind of jungle composed mainly of bamboo grass, which is impassable. The explorer has therefore to follow the bed of a stream or the bear tracks. Prof. Milne thinks it not unlikely that the Iturup bear may be a species new to science. From the specimens seen in cages it seems to resemble the grizzly bear of North America.

ANNIVERSARY OF THE ROYAL GEOGRAPHICAL SOCIETY

THE Anniversary Meeting of the Royal Geographical Society was held in the theatre of London University on Thursday, the Right Hon. Lord Aberdare, F.R.S., President, in the chair. In his address, Lord Aberdare referred to Mr. Keltie's report on the position of geographical education in England and on the Continent. The Report, Lord Aberdare stated, contains statements and recommendations of the highest interest and importance. Of the state of geographical education in Great Britain Mr. Keltie draws a very dismal picture. "There is no encouragement to give the subject a prominent place in the school curriculum; no provision, except at elementary normal schools, for the training of teachers in the facts and principles of the subject, and in the best methods of teaching it; no inducement to publishers to produce maps, globes, pictures, reliefs, or other apparatus of the quality and in the variety to be found on the Continent; while our ordinary text-books are, as a rule, unskilful compilations by men who have no special knowledge of their subject." This neglect is attributed to the "exigencies of examination." Geography, as a class-subject, "does not pay." It is not recognised at the Universities by either professorship or readership; it does not find a real place at any of their examinations; while in the Army and Navy examinations it is at a discount; and such geography as is given is of a very partial character, and is merely left to crammers. These unsatisfactory statements are justified by a large amount of evidence. In striking contrast to this picture is that which Mr. Keltie presents of the state of geographical education in Germany, France, Italy, Switzerland, and several other countries of Europe. Germany, as might be expected, takes the lead, and does its work most thoroughly. But the systematic study of geography is even there of recent creation. It prevails in twelve out of the twenty-one universities of Germany; and nearly all the twelve existing professorships of geography have been founded within the last twelve years. "The ideal aimed at, and being rapidly carried out, is to have one continuous course of geographical instruction from the youngest school-year up to the university." And Mr. Keltie deals with these ascending courses, showing in detail the teaching from the elementary to the higher schools, and in the universities. His examples of lessons he himself heard at some of these schools are most graphic, and suggest their high value in any course of intelligent education.

Lord Aberdare then briefly referred to the conclusions at which Mr. Keltie arrives. These, he stated, are clear, sensible, practical, but by no means encouraging. In all these European countries the curriculum is defined and imposed by the State, which, keeping the purse-strings, dictates the course of instruction. Except over our elementary schools, the State in this country exercises no such power, direct or indirect. We must be content to bring the force of public opinion to bear upon our schools and universities; for with them, and especially with our universities, rests the solution of this great question. Mr. Keltie's Report will be duly considered by the Council; it will doubtless be published; and means, Lord Aberdare ventured to prophesy, will be taken to bring home to our educational authorities, with fresh power and urgency, the necessity for not allowing Great Britain to lag behind our political and commercial rivals, our rivals in human culture, in the systematic study of geography. In the meantime, during the course of the autumn, an exhibition will be formed of the results of Mr. Keltie's labours in collecting specimens of the best text-books, maps, globes, diagrams, models, and other apparatus used in teaching the various branches of geography. This done, it remains for me, Lord Aberdare said, only to express the fervent hope that this latest effort of the Society to promote the studies which it was founded to extend, may meet with a large measure of success and tend to lay the basis of a sound and thoroughly national system of instruction in geography in all its branches, physical, political, and historical.

Lord Aberdare then gave a brief *résumé* of exploring work since his address in November last. He specially referred to the four years' explorations in Eastern Tibet of the Pundit Krishna, and to the geographical work done in connection with the Afghan Boundary Commission.

The preliminary map sent home by Major Holdich rectifies in many important points the erroneous topography in all pre-existing maps, and gives us a clear idea of the surface-configuration and physical condition of one of the most interesting districts in Central Asia.

Further east the indefatigable Colonel Prjevalsky has been recently again heard of from the centre of the continent, at Lob Nor.

In and around the Zhob valley, areas of about 5500 square miles of reconnaissance on the ¼-inch scale, and of 400 square miles of topography in the ½-inch scale are reported to have been completed; thus going far to fill in a reproachful hiatus in our present maps of Afghanistan. The ascent of certain peaks in the Himalaya by a member of the Alpine Club, Mr. W. W. Graham, an account of which was read by him at one of the Society's meetings in June last, has attracted considerable attention in India. The classical lands of Asia Minor have again this year been the subject of topographical investigation. In the winter of 1882–3 a fund was raised by public subscription in order to effect explorations that might throw light on the antiquities and early history of the region. Mr. W. M. Ramsay was entrusted with the execution of this scheme, and travelled with this view, May to October, 1883. He invited a scholar of the American School of Athens, Mr. J. R. S. Sterrett, to accompany him during great part of the summer. During that year's work the conviction grew up that no adequate study of the history of Asia Minor was possible till the ancient topography was better known and that no advance in the study of the ancient topography could be made till a better map of the country had been compiled. It was therefore found necessary, week by week, to pay a growing attention to the natural features of the country, the natural routes of communication, and the natural boundaries separating district from district. Lord Aberdare referred to the work done in New Guinea by Mr. Van Braam Morris, Dutch Resident at Tidore, who has examined this part of the coast, and ascended the Amberno, which had always been reported by passing navigators, on account of its numerous supposed mouths, to be a large river with an extensive delta, and to the journeys into the interior of the Rev. James Chalmers. Mr. Chalmers has visited many parts of this coast along a line of about 500 miles, and penetrated, at various places further inland, by land, than any other European, and his descriptions of the country and the habits of the vivacious, excitable, and pugnacious race of savages with which it is peopled, merit careful attention at the present time. An attempt is about to be made by the experienced traveller Mr. H. O. Forbes to penetrate to the summit of the ranges, or plateaux, which extend along the centre of this part of the great island. Since he left England on this arduous mission some weeks ago we learn that the Sydney and Melbourne branches of the Geographical Society of Australasia have offered to contribute to the expenses of this expedition, which is supported by grants by our Society, the Scottish Geographical Society, and the British Association. In other parts of Australasia the chief additions to our knowledge have been a survey of a large tract of new country in Central Queensland by Mr. C. Winnecke, and the exploration of the King Country in the northern island of New Zealand by Mr. Kerry-Nicholls, of which the explorer himself gave us an account at one of our evening meetings.

In Africa Lord Aberdare referred to the work done by Mr. H. H. Johnston at Kilimanjaro. Since then the brothers Denhardt, who had previously done excellent work in surveying the course of the River Dana, which flows from the southern slopes of Mount Kenia, have left again for East Africa. They have been commissioned, as we are informed by the German African Society, to take up a line of exploration similar to that adopted with so much success by Mr. Joseph Thomson, but to follow it much further to the north than the point reached by our English traveller, namely, to the reported great lake Samburu, north of Lake Bahringo. Further north still the year has witnessed the accomplishment of what may be termed one of the most interesting and difficult feats of all recent African travel. This is the journey of Messrs. F. L. and W. D. James, the authors of the well-known book on the "Wild Tribes of the Soudan," who with three English companions, Messrs. G. P. V. Aylmer, E. Lort Phillips, and J. Godfrey Thrupp, organised an expedition and started last December to cross the north-eastern angle of Africa from Berbera to Mogadoxo. The hostile disposition and uncertain temper of the Somali tribes who inhabit this wide region have hitherto offered invincible obstacles to its exploration by Europeans. Mr. James and his party, however, succeeded in penetrating 400 miles to the south, as far as Barri on the River Webbe, a point about 215 miles distant from Mogadoxo. The interior was found to be a plateau of an average elevation of about 4000 feet.

With regard to the more southerly parts of Eastern Africa, and more especially the region between the Mozambique coast and Lake Nyassa, our knowledge has lately increased by leaps and bounds. The increase has been principally due to the systematic explorations of Mr. Consul O'Neill. The general remark may be permitted that, thanks chiefly to Mr. O'Neill, we now have for the first time a fairly satisfactory knowledge of a region varied in its physical configuration, well watered, and fertile, which has hitherto remained a blank on our maps, notwithstanding the occupation of the coast by the Portuguese for nearly four centuries.

M. Giraud has returned this spring from his exploration of Lake Bangweolo and its outlet, and his unsuccessful attempt to cross Africa by way of the Upper-Congo; Mr. Arnot has crossed from Natal to the Bihé plateau by way of the Upper Zambesi; Mr. Montagu Kerr has crossed Matabele-land and the Zambesi, and penetrated by a new route to the south-western shore of Lake Nyassa; and Mr. Richards has reached from Inhambane the southern districts of Umzila's kingdom. In Western Africa further additons have been made to our knowledge of the Congo, chiefly by the publication of Mr. Stanley's long-expected book and the maps which accompany it, and by Messrs. Grenfell and Comber's careful survey of the middle course of the Congo and the Bochini tributary to the junction of the great river Kwango.

The members of the French Expedition on the Ogowé and the northern tributaries of the Congo have also been doing good work in the survey of the territories newly acquired by France.

In South America a striking feat of exploration has been accomplished since my last address; the supposed inaccessible summit of Mount Roraima, on the confines of British Guiana and Brazil, was reached in December last by Mr. im Thurn and his companion, Mr. Perkins, accompanied by a small party of Indians.

In conclusion Lord Aberdare gave the following brief summary of the Admiralty surveys of the year 1884, for which he was indebted to the hydrographer, Capt. Wharton, R.N.: The continuous prosecutions of marine surveys in different quarters of the globe has been well maintained during the past year. The two home-surveying vessels have been employed, one on the west and the other on the east coast of Great Britain. On foreign surveys 60 officers and 500 men have been employed in four steam ships of war and five other smaller vessels. These ships have been at work in Newfoundland, the Bahama Islands, Magellan Straits, South Africa, Red Sea, Malay Peninsula, coasts of China and Korea, north-west coast of Australia, and amongst the Pacific islands. The most important additions to our hydrographical knowledge are as follows:—The survey of the Little Bahama Bank will be shortly finished, and the same may be said of the southern shore of Newfoundland. The survey of the main strait of Magellan, to which reference was made in the last address, was completed early in the year. Many useful additions have been made to ports and salient parts of the coast of south-east Africa. In the Red Sea the intricate approaches to Sawakin have been well laid down. On the west coast of the Malay Peninsula, Penang harbour has been re-surveyed and the positions of the islands lying to the north-west and forming the eastern boundary of the ordinary route of vessels to Malacca Strait have been accurately determined. The unknown western shores of Korea, south of the approach to Seoul, for two degrees of latitude have been explored, and the main features of this island-studded shore laid down. New rivers and harbours have been entered, notably, the large river Yeun-san-gang, at the entrance to which stands the considerable town of Mokfo. There appears, however, to be little chance of immediate trade with Korea, in consequence of the absence of any valuable products and the scanty needs of the population. The southern approach to Haitan Strait on the Chinese coast, much used by British trade, has been re-charted. On the difficult shores of Western Australia such progress has been made as the small means at the disposal of the surveyors has permitted. In the Solomon Islands the Bougainville Strait has been charted. This Channel will in the future be most probably a highway for traffic between Eastern Australia and Japan. Many additions have been also made to the charts of various groups of other Pacific islands. The survey of the coasts of India carried on by officers of the Royal Navy and India Marine has been actively progressing. Surveys of Rangoon, Cheduba, and other ports in the Bay of Bengal, as well as harbours on the west coast of Hindostan, have been made. A re-survey of the great Canadian lakes has been commenced in Georgian Bay, where trade by water is on the increase.

Lord Aberdare then intimated his resignation of the Presidency of the Society, the Marquis of Lorne having been elected to succeed him.

PROF. REYNOLDS ON THE STEAM INDICATOR[1]

THE object of this paper was to define the causes and extent of the disturbances in indicator diagrams. The theory, as given, had been taught for several years in Owens College; but the publication had been deferred to enable an extensive series of experiments to be made. These experiments had now been carried out by Mr. A. W. Brightmore, Stud. Inst. C.E., late Berkeley Fellow in Owens College. In the first place it was shown that there were five principal causes of disturbance, namely: the inertia of the piston of the indicator and its attached weights; the friction of the pencil on the paper, and its attached mechanism; varying action of the spring; inertia of the drum; friction of the drum.

The effect of the inertia of the pencil and its attached mechanism presented a mathematical problem, by the solution of which it was shown that there were two disturbances from this cause: one, a general enlargement of the mean indicated pressure, depending on the weight of the moving parts of the indicator, the stiffness of the spring, and the square of the speed. The other disturbance was a vibration of the pencil. Every indicator piston vibrated when disturbed, so that the period of vibration depended on the stiffness of the spring.

The error which these oscillations caused in the area of the diagram depended on their magnitude, and, to a greater extent, on the smallness of the number in a revolution. But the evil of these oscillations was not so much an effect on the area as in the disfigurement and the confusion they produced in the diagram. So long as there were thirty of these oscillations in a cycle, the necessary fluid friction of the indicator piston would so far reduce them as to render a fair diagram possible, but when the number was as low as ten it was all the pencil could do to prevent them upsetting the diagram.

The friction arising from the pressure of the pencil always acted to oppose the motion of the pencil, and therefore rendered it too large during expansion and exhaust and too small during compression and admission, and thus the general effect was to increase the size of the diagram. This friction consisted of that of the pencil on the paper; and that of the mechanism, caused by sustaining the pressure of the pencil. The effect of the friction of the pencil was greatly reduced by the motion of the paper. The magnitude of these effects taken together on the area of the diagram depended on the construction of the instrument and on pencil-pressure. From numerous experiments it would appear possible to make a difference of as much as five per cent. in a locomotive in mid-gear by pencil-friction.

The couclusions, as regarded the motion of the pencil, were that the general effect of inertia and friction were both to increase the size of the diagram; that so long as the speeds were such that the number of vibrations of the pencil during a revolution of the engine was not greater than fifteen, the effect of inertia was less than one per cent., but that, if the number was greater than thirty, oscillations would show themselves unless the pencil-friction was increased. They might, by this, be kept down till the number of vibrations was equal to fifteen, but not farther, and then the necessary friction would affect the area of the diagram about five per cent. For the diagrams to be sensibly accurate, and free from oscillation, the speeds must not be greater than would make the number of vibrations equal to thirty. These speeds were given in the paper for Richards' indicators.

The effect of the inertia of the drum with an elastic cord was shown to be a nearly uniform elongation of the diagram. The result of the varying stiffness of the drum spring was a nearly uniform contraction. With Richards' indicator these two latter disturbances neutralized each other at a speed of 150 revolutions per minute. At other speeds the effects were apparent in the length of the diagram; but, except when the expansion was great and the connecting rod short, they did not affect the indicated pressure. The friction of the drum with an elastic cord caused the cord to be longer during the forward stroke than during the

[1] A Paper read at the Institution of Civil Engineers, May 19, "On the Theory of the Indicator and the Errors in Indicator Diagrams," by Prof. Osborne Reynolds F.R.S.

backward stroke, so that the diagram was distorted and shortened, the drum being uniformly behind its proper position during the forward stroke, and before its position during the backward stroke. This distortion diminished the area of the diagram according to the rate of expansion and the length and elasticity of the cord used. This was definitely expressed by a formula. This disturbance, the influence of which was very great in cases of high expansion, large engines, and ordinary cords, appeared to have been unnoticed. The circumstances on which it depended were the elasticity of the cord and the friction of the drum, and the question was how far these existed in the ordinary indicators. It might be said that the diagrams which led to the discovery of this effect were taken with an indicator which had been in constant use for several years. It was in apparently perfect condition, and the diagrams did not differ essentially from those which had been previously taken. The cord was one which had been supplied by the maker. The manner of the discovery was described: For years the author had pursued in the class the method of testing the vibrations of the indicator pencil by projecting them on to the crank-circle, and he had noticed that the first oscillation fell short, and shorter in the back diagram than in the front. The cause of this was not obvious, and it was partly with a view to determine this cause that Mr. Brightmore's investigation was commenced. A slight error in the reducing rod, which had a fixed centre and a slot in which a stud in the slide-block worked, was altered. This, however, did not get rid of the effect. A new cord was substituted for the old one, and the effect was found to be much enhanced, the new cord being more elastic than the old one. This reduced it to the stretching of the cord, but it was only after carefully working out the effect of the inertia of the drum, and it was seen this was to lengthen the first oscillation at the back end that the friction was examined. The indicator was taken to pieces, cleaned and oiled; then the effect was much reduced. Several new wires and cords were used, and eventually steel wire was adopted as the best. The test supplied by the oscillations could only be applied to diagrams taken at high speeds, and the test furnished by the influence upon area was vague. What was wanted was an independent means of determining the simultaneous positions of the drum and the engine-piston. As the best method of meeting this, it was decided to arrange an electric circuit through the pencil to the drum, with sufficient electromotive force to prick the paper, making the engine-piston close this circuit at eleven definite equidistant points in the motion backwards and forwards. This was successfully carried out, and the stretching of the cord during the backward and forward strokes was definitely ascertained. Taking the smallest results obtained with a cord, it appeared from these experiments that the least difference of stretching was to make this difference in inches 5 per cent. of the length of the cord in feet. Examples of this effect in diminishing the mean indicated pressure were given. Thus, in a locomotive cutting off at one-quarter it was 8 per cent.; in a condensing engine having 3·5 feet stroke, cutting off at one-tenth, 20 per cent.; and the same compounded, 10 per cent.

These would seem to be the smallest results that could have occurred in ordinary practice. The conclusion, however, that hitherto the normal indicated power from engines had been from 10 to 20 per cent. too small must wait for verification. Yet there were not wanting independent evidences of such an effect. In diagrams taken from engines at high speeds the admission line would not but for this effect be vertical. It would show a certain amount of detail, and the first oscillation would not have a sharp top. Moreover, it was commonly found that the expansion line, allowing for clearance, was above the true expansion line for the steam. This apparent rise in the curve of expansion was exactly what would result if the apparent cut-off was too early, and this was the result of the effect that had been considered. The author had tried several diagrams, and found that after correction the expansion line came out very close to the true curve.

In making these comparisons the explanation of another feature of diagrams became apparent. When the two diagrams were traced on the same card, there was sometimes a want of symmetry about them, and in this case the cut-off was shorter on the back than on the front diagram. This the author attributed to the friction of the drum when the cord for the back diagram was longer than that for the front. When this was the case the relative lengths of the cord were about 1 to 1·8. These observations were illustrated in a diagram from "Richards' Indicator." To test this diagram a tracing was taken, and reversed so that the front diagram was superimposed on the back. It was observed that the diagrams were of different lengths, and the difference was about the same as the difference in cut-off; that notwithstanding the apparent cut-off in the back diagram was to that in the front in the ratio of 2 to 3, the expansion line of the back diagram was the same shape as that in the front; and that if the diagrams were restored, supposing the lengths of the cords used to have been 5 feet and 9 feet, the diagrams became exactly similar, and, allowing 2 per cent. clearance, the expansion line came to be the true expansion line for that cut-off. The mean pressure was 14 per cent. larger than from the original diagram.

Such instances as these seemed to sufficiently establish a case against the blind faith which appeared to be at present placed in the accuracy of the indicator diagrams. But, in conclusion, the author stated that he should be very disappointed if anything in this investigation should have the effect of diminishing reliance on the indicator itself. He would have the instrument treated fairly, and instead of being the object of unthinking worship he would have it the object of careful study and experimental investigation, so that the limits of its wonderful perfection might be known exactly, and that reliance placed on it which sprang from knowledge.

THE VISITATION OF THE ROYAL OBSERVATORY, GREENWICH

THE visitation of the Royal Observatory took place on Saturday last, when, in spite of bad weather, there was a numerous attendance. The following extracts (condensed in some cases) from the Report of the Astronomer-Royal to the Board of Visitors indicate the work of the past year. It will be gratifying to all to know that a considerable increase in the optical power of the Observatory is in contemplation.

Transit-Circle.—A reversion-prism made by Messrs. Troughton and Simms has been used since last June in observations with the collimators as well as with the transit-circle to reverse the apparent direction of measurement or of motion, a movement towards the left (as in transits of south stars) being converted into a movement towa ds the right, or upwards, or downwards, according to the position of the plane of reflection of the reversion-prism. The collimation-observations show no sensible personality depending on the apparent direction of measurement; it has, however, been considered well, in order to eliminate any possible effect of the kind, to take half the measures in each determination of collimation with the direction of movement of the wire reversed as regards right and left. In the transits the practice is to observe on each day two clock-stars and also circumpolar stars with the direction of motion reversed. A comparison of the results from the reversed and ordinary observations of clock-stars shows sensible differences in the case of some observers, who, however, have probably not yet settled down into a definite habit of observing stars which appear to move in the reverse direction.

In order to determine absolute personal equations in the observation of slow-moving as well as of quick-moving stars of various magnitudes (whether the motion be from right to left or the reverse) and of limbs of the sun, moon, or planets, the Astronomer Royal has arranged, in concert with Mr. Simms, a personal equation instrument to be used with the transit-circle. In this instrument, which is on the point of completion, and was seen at work on Saturday, a vertical plate with a circular aperture, 6 inches in diameter, to represent the sun or moon, and several small pinholes, to represent stars of different magnitudes, is placed in the focus of an object-glass of about 7 inches aperture and of about 50 feet focal length (which is attached to the dew-cap of the transit-circle, when horizontal and pointing north), and is carried smoothly by clockwork from east to west or west to east at a rate which may be varied at will from that of a very close circumpolar star to three or four times that of an equatorial star by an ingenious but simple mechanical contrivance devised by Mr. Simms. The apertures in the vertical plate are illuminated by direct sunlight or moonlight reflected by a plane mirror towards the object-glass, and the times of transit of the artificial sun, moon, or stars, which are to be observed over the wires of the transit-circle, are also registered automatically on the chronograph by means of insulated platinum studs, corresponding to the artificial objects, which make contact with other studs, corresponding to the wires in the field of view of the transit-circle.

Since last October transits of the close circumpolar stars have been taken at the middle wire set to successive revolutions of the R.A. micrometer, thus virtually introducing a system of very close equidistant wires for the slow-moving stars. It is thus found that a larger number of separate observations can be obtained in a moderate time, a point of special importance in changeable weather. The equality of successive intervals of the R.A. micrometer-screw was tested last January for each revolution through a range of twelve revolutions, and also for every tenth of the three middle revolutions, and the errors of the screw appear not to exceed the errors of observation. The determination was made by means of the south collimator, the eye-piece of the transit-circle having been turned through 90°. The observations of close circumpolar stars have also been discussed with a view of testing the equality of successive revolutions of the R.A. micrometer screw, the results being very satisfactory. The screws of the microscope-micrometers also were examined by means of the south collimator on March 27 and following days, successive intervals being measured for each revolution and third of a revolution from -1^r to 6^r. Though there is evidence of considerable wear in the individual screws, which have been in constant use since 1875, the method of using them (the action of the spring being in opposite directions for the micrometers of each pair) entirely eliminates this effect from the mean, and the resulting errors (which are probably casual errors of observations) do not exceed 0″·05 at any part of the screws.

The subjects of meridian observations in the past year have been as usual the sun, moon, planets, and fundamental stars, with other stars from a working catalogue, which now contains about 2,750 stars. About 380 stars have been lately added to the list from the "Harvard Photometry," with a view of making the forthcoming Greenwich Catalogue of stars down to the sixth magnitude as complete as possible. It is hoped that all of these stars will have been sufficiently observed by the end of 1886, when it is proposed to form a Ten-Year Catalogue, epoch 1882·0. The annual catalogue of stars observed in 1884 contains about 1,370 stars.

The following statement shows the number of observations with the transit-circle made in the twelve months ending 1885, May 20:

Transits, the separate limbs being counted at separate observations...	5523
Determination of collimation error	299
Determinations of level error	376
Circle observations	5321
Determinations of nadir point, including the number of circle-observations	294
Reflection-observations of stars (similarly included)	619

The discordance between the nadir observation and the mean of the results from reflection observations of stars north and south of the zenith has recently become very small, the correction deduced for the first four months of the present year being only −0″·07. The mean correction indicated by the observations of 1884 was −0″·36, whilst those of 1883 gave the value −0″·45. The steady increase of this discordance from 1878 to 1883 and its subsequent decrease remained unexplained, no change having been introduced into the method of observation of the nadir point or of stars by reflection during the last two years.

The apparent flexure of the transit-circle, as found by means of the collimators, has again changed sign. From six determinations made on 1884 June 3, Sept. 9, Sept. 29, Oct. 5, Oct. 20, and May 20 (the reversion-prism being used on each occasion except the first) the resulting values (found by four different observers) are −0″·47, + 1″·00, + 0″·03, + 0″·10, and +0″·08, the mean of which is +0″·17, agreeing closely with the value + 0″·13 found by nine accordant determinations in the period 1879 to 1882, whilst the mean of five determinations by three different observers in 1883 gave the value − 0″·49. No correction for flexure (as distinct from the R − D correction) has been applied to the observations since 1879.

The correction for R − D, the error of assumed colatitude, and the position of the ecliptic, have been investigated for 1884. The computation of the geocentric and heliocentric errors for the planetary results is not yet complete.

The correction for discordance between reflection and direct observations of stars, deduced from observations in 1884 which extend from Z.D. 69° north to Z.D. 70° south is − 0″·02 + 0″·66 sin Z.D. The assumed formula $a + b \sin z$ represents the observations of 1884 satisfactorily throughout the whole range of zenith distance.

The value found for the colatitude from the observations of 1884 is 38°. 31′.21″·91, differing only by 0″·01 from the assumed value; the correction to the tabular obliquity of the ecliptic is + 0″·57; and the discordance between the results from the summer and winter solstices is − 0″·99.

The mean error of the moon's tabular place (computed from Hansen's Lunar Tables with Prof. Newcomb's corrections) is +0s·02 in R.A. and + 0″·29 in longitude as deduced from 104 meridian observations in 1884.

Altazimuth.—The observations with this instrument have been restricted to the period from last quarter to first quarter in each lunation, the total number of observations of various kinds made in the 12 months ending 1885 May 20 being as follows:—

Azimuths of the moon and stars	321
Azimuths of the azimuth-mark	181
Azimuths of the collimating-mark	192
Zenith-distances of the moon	178
Zenith-distances of the collimating-mark	196

Since last December a "reversion prism" has been used to reverse the apparent direction of motion in the observation with lamp right and in that with lamp left on alternate nights.

Clocks.—On Jan. 1 the public clock at the Observatory entrance and the other mean solar clocks were put forward 12 hours so as to show Greenwich civil time, starting at midnight and reckoning from 0h. to 24h., which would correspond with the universal time recommended by the Washington Conference. The change from astronomical to civil reckoning has also been made in all the internal work of the Observatory, and has been carried out without any difficulty. Greenwich civil time is found to be more convenient on the whole for the purposes of this Observatory, but its introduction into the printed astronomical observations has been deferred to allow time for a general agreement amongst astronomers to be arrived at. It is proposed, however, to adopt the civil day without further delay in the printed magnetical results, thus reverting to the practice previous to 1848, and making the time-reckoning harmonise with that used in the meteorological results, the reckoning from 0h. to 24h. being for the future adopted in both cases.

Reflex Zenith Tube.—The observations of γ Draconis for determination of the temperature correction have been continued, and about 45 transits over the 30 wires have been observed at temperatures ranging from 46° to 72°. Seven transits of θ Aurigæ were also observed last February at low temperatures ranging from 42° to 56°.

Equatorials.—The work on the Lassell equatoreal has occupied a great deal of attention during the past year, a number of repairs and alterations having been required in order to get the instrument into proper working order. The driving clock, which was found to drive the instrument at only three-fifths of the proper speed, has been altered, a slow motion in R.A. (to be worked from the observing stage) has been contrived, a new slide of improved construction has been made for gearing the driving-screw into the hour-circle, the teeth of the hour-circle have been re-cut, a firm declination clamp has been applied, an improved edge suspension for the large mirror (consisting of a steel band which encircles the mirror and is supported by brackets at six equidistant points of the circumference) has been contrived, a new and firmer mounting of the small mirror has been made, and the eye-piece has been mounted firmly on a plate which allows it to be tilted in any direction, for optical adjustment. The framed iron base which supports the instrument has been bricked up and filled with concrete, and this, with the other alterations, has greatly increased the stability of the telescope, which is now quite satisfactory. Difficulty is, however, still experienced from want of stability of the optical axis of the large mirror, which requires to be readjusted continually, as the telescope is moved. When the mirrors have been properly adjusted the definition appears to be very good, the companion to Vega being shown with remarkable distinctness without any trace of scattered light from the large star.

The south-east and Sheepshanks equatorials are in good order, as also is the Simms' six-inch equatorial mounted in the south ground.

With one or more of these equatorials, or with the altazimuth, 30 occultations of stars by the moon (19 disappearances and 11 reappearances, including 7 disappearances and 9 reappearances during the lunar eclipse of October 4), and 57 phenomena of

Jupiter's satellites, have been observed in the twelve months ending 1885 May 20, and the observations have all been completely reduced to the end of 1884. Comet (*c*) 1884 has been observed on four nights, the Lassell reflector or one of the other equatoreals being employed, and some measures of distances and position-angle of double stars, as well as a large number of observations for determining the value of 1rev. of the screw in different parts of the field of view have been made with the Airy double-image micrometer mounted on the Sheepshanks' or Simms' equatorial.

Micrometer measures of some of the satellites of Saturn (including Enceladus) were made on seven nights with the Lassell equatorial.

Spectroscopic and Photographic Observations.—The solar prominences have been observed with the half-prism spectroscope on only two days, the photographic reductions having pressed very severely on the spectroscopic assistant during the long continued maximum of sun-spots.

For the determination of motions of stars in the line of sight, 569 measures have been made of the displacement of the F line in the spectra of 47 stars, and 72 measures of the *b* lines in 14 stars, besides measures of the displacements of the *b* and F lines in the spectra of the east and west limbs of Jupiter, and of the east and west ansæ of the rings of Saturn, and comparisons with lines in the spectrum of the moon, or of the sky, made in the course of each night's observations of star-motions, or on the following morning, as a check on the general accuracy of the results for star-motions. The observations of the last twelve months confirm the change in the motion of Sirius, which now appears to be approaching the sun at the rate of about 20 miles a second. As there is great difficulty in the use of a pointer or cross-wires for measuring both the broad dark line in the star's spectrum and the narrow bright comparison line, Mr. Maunder has suggested the use of a reversion spectroscope (on the double-image principle) for these observations, and Prof. Pritchard has kindly lent the reversion spectroscope of the Oxford University Observatory, in order that the suitability of that form of instrument may be tested. The spectroscopic observations of all kinds are completely reduced to the present time.

In the twelve months ending 1885 May 20 photographs of the sun have been taken on 173 days, and of these 431 have been selected for preservation, the record being not so complete as usual, owing partly to the loss of several days during the adjustment of the instrument after the adaptation of the secondary magnifier, and partly to a failure of the supply of dry plates in July last during the absence of Mr. Maunder. There were only two days on which the sun's disk was observed to be free from spots.

The mean spotted area of the sun was slightly less in 1884 than in 1883 and slightly greater than in 1882, whilst the faculæ in 1884 showed a slight increase as compared with 1883, and a slight falling off as compared with 1882. It would seem that the maximum both of sun-spots and faculæ occurred about the end of 1883 or beginning of 1884.

For the year 1884 Greenwich photographs are available for measurement on 152 days, and Indian photographs filling up the gaps in the series on 159 days, making a total of 311 days out of 366 on which photographs have been measured. In 1883 the total number of days was 340, viz., Greenwich series 215 days, supplemented by Indian photographs received from the Solar Physics Committee on 125 days.

Magnetic Instruments.—The following are the principal results for magnetic elements for 1884:—

Approximate mean westerly declination	18°.8′.
Mean horizontal force ...	3·931 (in English units). 1·812 (in Metric units.)
Mean dip	67° 29′ 8″ (by 9-inch needles). 67.29.32 (by 6-inch needles). 67.30. 9 (by 3-inch needles).

In the year 1884 there were only five days of great magnetic disturbance, but there were also about 20 days of lesser disturbance for which it appears desirable to publish tracings of the photographic curves. It may be interesting to add the tracings for a few quiet and nearly quiet days in order to exhibit the characteristics of the ordinary diurnal movement.

Commencing with 1883 the magnetic diurnal inequalities of declination, horizontal force, and vertical force have been discussed by the method of harmonic analysis, the harmonic expressions for these inequalities being obtained for each month and for the year with arguments expressed in apparent solar time as well as in mean solar time.

Meteorological Observations.—The mean temperature of the year 1884 was 50°·7, being 1°·4 higher than the average of the last 43 years. The highest air temperature (in the shade) was 94°·1 on Aug. 11, and the lowest 24°·5 on Nov. 25. The mean monthly temperature was above the average excepting in the months of April, June, Oct. and Nov.

The mean daily motion of the air in 1884 was 286 miles, being 3 miles greater than the average of the last 17 years. The greatest daily motion was 891 miles on Jan. 23, and the least 78 miles on Feb. 8. The only recorded pressure exceeding 20 lbs. on the square foot in 1884 was 22·7 lbs. on Jan. 23, after which the connecting chain of the pressure plate broke, as mentioned in the last report. It is probable that greater pressures occurred afterwards on the same day, and also in the gale of Jan. 26, at which date the chain had not been renewed.

During the year 1884 Osler's anemometer showed an excess of about 25 revolutions of the vane in the positive direction N, E, S, W, N, excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1884 was 1115, which is about 100 hours less than the average of the seven preceding years. The aggregate number of hours during which the sun was above the horizon was 4465, so that the mean proportion of sunshine for the year was 0·250, constant suushine being represented by 1.

The rainfall in 1884 was 18·0 inches, being about 7 inches below the average of the last 40 years.

Chronometers and Time Signals.—The number of chronometers now being tested at the Observatory is 151, and of these 103 (79 box-chronometers, 13 pocket-chronometers, and 11 deck-watches) belong to the Navy, 40 are placed here for the annual competitive trial, and 8 are on trial for purchase by the Austrian Government.

The first six chronometers in the competitive trial of 1884 were rather above the average of the last ten years as inferred from the trial numbers. As much difficulty is experienced in maintaining the chronometer oven at a nearly constant temperature, an apparatus has been procured from Mr. Kullberg which is designed to effect this automatically, by the action of a compensation-bar, which, as the temperature rises, gradually closes a small hole through which the supply of gas to the gas burners passes. The apparatus has not yet been brought into use, as the chronometer oven has been constantly required for testing chronometers since it has been received.

The automatic drop of the Greenwich time-ball failed on 6 days through the clock-train stopping. The ball was not raised on 3 days on account of the violence of the wind.

As regards the Deal time-ball, which is now dropped by current passing through the chronopher of the Post Office telegraphs, there have been fourteen cases of failure owing to interruption of the telegraphic connections, and on one day the current was too weak to release the trigger without the assistance of the attendant.

In connection with the establishment of hourly time signals at the Start or Lizard, which was long advocated by Sir G. B. Airy, I have received from the Committee of Lloyds', in answer to my inquiry, an assurance that that corporation would be willing to undertake the maintenance of hourly time-signals at any of their signal-stations, provided the Government would supply the necessary apparatus. After consultation with Capt. Wharton, it has been thought better that, before taking further steps, some preliminary trials should be made of a collapsible cone as an hourly time-signal, facilities for doing which exist at Devonport. As regards ball-drop or other time-signal, I would propose that it should be made automatically by a local clock, to be corrected daily by the help of a time-signal from Greenwich at 10 a.m., which should automatically start an auxiliary seconds pendulum, suspended freely just behind the clock pendulum. The attendant would then accelerate or retard his clock pendulum (by electro-magnetic action as in the Greenwich mean solar clock) so as to make it pass through the middle of its vibration at the same time and in the same direction as the auxiliary pendulum, and thus to indicate accurately Greenwich mean time. A return signal to Greenwich sent by the local clock at the next hour (11 A.M.) would show that this clock had been properly corrected, and would be a guarantee for the general accuracy of the time-signals. Preliminary trials have shown that the observation of coincidence of vibration of two pendulums can be made with great certainty, and Messrs. E. Dent and Co. are now arranging for the mounting of an auxiliary pendulum on one of the transit of Venus clocks, and for adapting it to give hourly time-signals.

The errors of the Westminster clock have been under 1s. on 50 per cent. of the days of observation, between 1s. and 2s. on 29 per cent., between 2s. and 3s. on 10 per cent., between 3s. and 4s. on 7 per cent., and over 4s. on 4 per cent.

During the past year the Observatory has lost the valuable services of Mr. Dunkin, who retired on August 25, after an honourable service of forty-six years, which has been throughout characterised by remarkable zeal and ability, and has contributed largely to maintain the credit of the Observatory. Mr. Dunkin has been succeeded in the post of Chief Assistant by Mr. H. H. Turner, B.A., of Trinity College, Cambridge.

The report concludes as follows:—

During the past year the various classes of work carried on in this Observatory have been somewhat extended. The meridian observations are more numerous than usual, and various subsidiary investigations involving considerable labour have been undertaken with a view to increase their accuracy. A large number of spectroscopic determinations of star-motions have been obtained, and the long continued maximum of sun-spots has made the photographic measurements and computations much heavier than in any previous year. Extensions have also been made in the magnetic and meteorological branch, which appeared very desirable, but which have pressed rather severely on Mr. Ellis and his staff.

Turning to the future, I wish to invite the attention of the visitors to the circumstance that an increase in our optical means is required to enable us to carry out satisfactorily the determinations of proper motions of stars in the line of sight with the spectroscope, a work which peculiarly belongs to this Observatory, as supplementing the determinations of proper motions from meridian observations.

The aperture of our largest refractor (12⅘ inches) is too small to allow of our observing successfully with the spectroscope any but the brightest stars, and though the Lassell reflector is somewhat more powerful, its mounting and clock-work are not adapted to carry a heavy spectroscope with the necessary steadiness and accuracy of motion. The firmness of the mounting of the south-east equatorial and the perfection of its clock-work would make it peculiarly suitable for this class of work if it carried a much larger object-glass.

After careful consideration of the conditions I have satisfied myself that an object-glass of 28 inches aperture and of 28 feet focal length could be mounted on the south-east equatorial, in place of the present object-glass of less than half that aperture; and I have ascertained that Mr. Grubb would be prepared to undertake the construction of such an object-glass with a tube suited to the special requirements of the case, so that the telescope would be equally available for eye-observation or for use with the spectroscope. With Mr. Grubb's assistance, I have prepared a model showing how this may be arranged.

While a large refractor is required specially for spectroscopic observations, it seems desirable also on other grounds that this Observatory should possess an equatorially mounted telescope comparable with those of other first-class observatories, so that we may no longer be prevented by deficient optical means from obtaining complete series of observations of comets and faint satellites.

VIVISECTION

A RETURN has been issued by the Home Office containing the reports of inspectors showing the number of experiments performed on living animals during the year 1884 under licences granted according to the Act 39 and 40 Victoria, c. 77, distinguishing painless from painful experiments.

The former of the two reports deals with England and Scotland, the latter with Ireland. They are as follows:—

"(1) The names of the 49 persons who held licences during any part of the year are given in the subjoined tables, in one of which are entered the names of those licensees who performed any experiments, 34 in number; and, in the other, the names of those who performed none.]

"(2) The total number of experiments of all kinds performed during the year was about 441.

"Of these, 140 were done under the restrictions of the licence alone, 78 under the same restrictions, but under certificates in column 1 (lecture illustrations); 145 under certificates in column 2; 76 under those in column 3; and 2 under a certificate in column 4.

"(3) With regard to the infliction of pain, as in all the experiments, except those under special certificates in columns 2, 3, and 4, the animals are rendered insensible during the whole of the experiment, and are not allowed to recover consciousness, no appreciable suffering would be caused if the provisions of the Act are faithfully carried out, as there is not the least reason to doubt they were.

"With respect to experiments under certificates in columns 2, 3, and 4, which dispense either wholly or partially with the use of anæsthetics, it should be stated:—

"(*a*) That of the 145 experiments performed under certificates in column 2, 99 consisted in simple inoculation with a morbid virus, in which no operation beyond the prick of a needle was required, and for which the administration of an anæsthetic would only have entailed needless annoyance and distress to the animal. In these experiments any appreciable suffering would be felt only in those cases in which the inoculation took effect, involving about the same amount of pain as ensues on ordinary vaccination, before the brief period the animals were allowed to survive. Of such cases, according to the returns I have received, about 16 occurred. Of the remaining 46 experiments under these certificates, 24 were performed for the purpose of medico-legal inquiries in cases of suspected poisoning, resulting in the death by tetanus of three frogs and six mice, which survived, however, only a few minutes; 10 other cases under the same head were experiments on the infection of fish with a species of fungus, very destructive in certain rivers and streams; and five on the effects of immersion of fish in distilled water, which proved fatal to about thirty minnows and sticklebacks. In none of these cases could it be said that any appreciable suffering was inflicted. In seven cases, in which salts of ammonia were hypodermically injected, two are returned as having suffered pain, but of a very trifling character.

"(*b*) Of the 76 experiments under certificates in column 3, 47 required a simple operation, but this being done under anæsthesia, was unfelt, and the after-effects, though in many of the cases resulting in partial paralysis, are reported as having been unattended with actual pain in any case. The remaining 29 were by simple inoculation, and none were attended with pain.

"(4) In conclusion, therefore, it may be stated that the amount of direct or indirect actual suffering, as the result of physiological and therapeutical experiments performed in England and Scotland, under the Act in the year 1884, was wholly insignificant. "GEORGE BUSK, Inspector

"The Right Hon. the Secretary of State."

"16, Harcourt Street, Dublin, May 17

"SIR,—In accordance with your instructions I beg to submit the following table, showing the licences in force in Ireland during the year 1884 under the Act 39 and 40 Vict., c. 77. No certificate has been allowed during the year.

"Several of the licences in force during the previous year have expired, and renewals have not been sought for.

"Under the licences in force thirteen experiments have been made; they were all painless. I am of opinion that the experiments in question were useful ones; eleven of them were intended to elucidate the actions of drugs, and the remaining two to assist the investigation of certain circulatory phenomena which have a bearing upon the treatment of disease.

"I have, &c.,
"W. THORNLEY STOKER

"To the Right Hon. the Chief Secretary for Ireland."

In each case the report is followed by a list of all persons who hold such licences, the places where they are permitted to make experiments, and the nature of the certificate held.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Annual Report of the Museums and Lecture-Rooms Syndicate, recently published, contains the reports of all the professors, lecturers, and heads of departments connected with natural science.

Prof. Thomson (Cavendish Professor of Physics) reports that during the Lent term ninety students attended the demonstrations, and there were ten persons doing original work in the laboratory. Lord Rayleigh states that during the last five years about 2500*l*. has been spent on the Cavendish Laboratory in addition to the University expenditure. This has come partly from fees, partly from the apparatus fund raised by subscription.

The Chemical Laboratory has been much over-crowded and improvements are scarcely possible until the new laboratory has been completed.

The register of the mineralogical collections is completed. The number of students increases; fifteen attended Mr. Solly's demonstrations in the Michaelmas term and nineteen in the Lent term.

The department of mechanism has continued to grow rapidly. During the year two new woorkrooms and a new foundry have been added and have met the most urgent requirements. Upwards of 1000*l*. worth of new machinery has been added at Prof. Stuart's expense during the last two years to meet immediate wants; and during that time the pupils have doubled in number. The lecture-rooms have become over-crowded, and new ones are much wanted. Prof. Stuart urges that the University should now purchase the machinery and apparatus used in teaching, which is his property. The undertaking is now wholly self-supporting, paying interest on the capital involved, and providing an adequate sinking fund.

The classes of practical morphology and elementary biology are now much better accommodated in the new rooms. One hundred Zeiss's microscopes have been purchased. The Balfour library has been enlarged, and proves of great value to students. Seven demonstrators have been fully occupied in the classes, in addition to two ladies who have superintended the women students. In the May Term, 1884, in which two years of students were combined, 206 men and 12 women went through the course of elementary biology. In the Lent term of 1885, 128 men and 7 women attended. In Elementary Morphology there were 68 students in last October term, and 87 in the recent Lent term.

Prof. Macalister has utilised the services of seven assistant Demonstrators, in addition to Mr. Hill, whose labour has been unremitting. Subjects for dissection have been secured from a wide area. Prof. Macalister has presented a series of models of the viscera of the body showing their proper relative positions, casts of frozen sections, 26 crania, and 160 specimens of bones showing peculiarities. No department of University work is so badly housed as the Department of Anatomy; but much good work is done in the limited space.

In the Museum of Comparative Anatomy and Zoology 72 additional species from Dr. Dohrn's collection have been remounted and displayed. An extensive collection of marine invertebrata from the New England coast has been forwarded from the National Museum at Washington, through the kind offices of Prof. Baird. The work of the Curator in Invertebrate Zoology has been principally expended upon the MacAndrew collection of shells. Mr. Cooke has published two extensive papers, and progressed with the rectification of the nomenclature and the catalogue.

A fine adult Echidna from New Guinea has been presented by Dr. Guillemard. Both skin and skeleton have been mounted. A complete skeleton of the red deer in a sub-fossil state has been procured from Burwell Fen by Mr. W. Stubbings, Assistant in the Museum; a complete skeleton of an African elephant, shot by Mr. W. Heape near Port Elizabeth, has been presented. Many other interesting acquisitions are named in the report.

Dr. H. Gadow, the Strickland Curator, has been forming a manuscript catalogue of the skins of birds in the Museum. An exhibited series of specimens is being placed systematically, with the important anatomical parts, nests and eggs, in an educational series. Twenty maps have been placed in the cases to illustrate the geographical distribution of birds. The University collection now consists of 9653 specimens of 3290 species. The Strickland collection, in addition, contains 600 specimens of 3125 species; and, with Mr. E. Newton's collection, there are in all 17,000 specimens, representing probably 4500 species.

Prof. Foster reports that the number of students of elementary physiology has risen from 77 in the Easter term, 1884, to 141 in the recent Lent term, exclusive of women students. Twenty-eight have attended advanced lectures also. Several important additions, such as a gas-engine, a centrifugal machine, recording and other apparatus, have been made to the Laboratory, by the aid of a gift of 500*l*. by an anonymous donor. The inadequacy of accommodation, both for practical work and for lecturing, is severely felt.

Prof. Ray has been successful in organising extended practical courses, as well as systematic lectures. The *post-mortem* examinations at Addenbrooke's Hospital have been placed under his superintendence. At present the only laboratory space available is obtained by encroaching on Dr. Foster's already overcrowded rooms.

Prof. Babington reports that the arrangement of the general Herbarium is now complete. The plants have been placed in orders and genera, according to Bentham and Hooker. The arrangement of species has not as yet been attempted. Mr. Potter and Mr. Gardiner have commenced the formation of a small Botanical Museum similar to that of Comparative Anatomy. Mr. Vines finds the new rooms very suitable both for class purposes and for research. Last term there were 29 advanced and 30 elementary students working in the laboratory.

The Geological Museum has acquired a fine collection of fossils from the Oolites of Dorset, chiefly by the liberality of Prof. Henry Sidgwick. Messrs. Roberts and Small brought useful additions from the Jura. Mr. Marr has added largely to the Cambrian and Silurian series. Mr. Keeping has collected and restored many specimens from Pliocene and Pleiostocene deposits. Mr. J. Robarts has worked most energetically as Prof. Hughes' assistant, in the museum, in teaching and collecting. Work is much hindered by the want of a lecture room and class-room.

Mr. Walter Gardiner, whose original work in vegetable histology is so well known, has been elected to a Fellowship at Clare College.

SOCIETIES AND ACADEMIES

London

Royal Society, May 6.—"On charging Secondary Batteries," by William Henry Preece, F.R.S.

Mr. Preece said he had for some months past been experimenting with secondary batteries with a view of getting an efficient, uniform, and constant source of current for electric lighting his house. The cells are of the Planté type, manufactured by the Elwell Parker Company of Wolverhampton. Each cell contains fourteen plates of plain sheet lead 17" × 11", which are suspended in well-insulated wood boxes filled with diluted sulphuric acid in the proportion of about 1 to 19. These plates are grouped in two groups of seven, each group being soldered to a lead strip, forming alternately the positive and negative poles of the cell. The plates of the respective poles are prevented from touching each other by ebonite grids or separators introduced by Mr. Charles Moseley to prevent short-circuiting through the buckling of the plates. Each plate offers a surface of 1·3 square feet, so that the total surface of lead of each group opposed to each other is 9·1 square feet; that is, 9·1 square feet of peroxidised lead is opposed to 9·1 square feet of spongy lead. Mr. Preece employs 24 of such cells. The charging current varies from 3 to 3½ amperes per square foot, while the current of discharge used in lighting his house varies from 1 to 1½ ampere per square foot. The total weight of each cell is 120 lbs. The plates are prepared by the Parker-Planté process before insertion in the cell, those forming the positive pole being well peroxidised, while those forming the negative pole are well coated with spongy lead. This process consists in immersing for a few hours the lead plates in a solution of nitric and sulphuric acids in the proportions—

Nitric acid	1
Sulphuric acid	2
Water	17

before fixing in the cells. This not only chemically cleans the lead surfaces, but it favours the formation of sulphate of lead in such a way as to be readily converted into lead peroxide and spongy lead on the passage of a strong current through the cells. The formation of the cells is thus expedited. They are thus, when put together, prepared at once to be charged. If they are not at once charged, local action sets in, and lead sulphate is injuriously formed.

A hydrometer, having a scale graduated from 1·050 to 1·150, is used to indicate the density of the liquid while the cells are being charged and discharged. Mr. Preece puts into his battery a charge of about 120 ampere-hours twice a week. Hourly measurements of E.M.F. current and density of liquid have enabled him to know the condition of his battery at any period of charge or discharge. These measurements have been plotted out into curves, the ordinates showing volts, amperes, and specific gravity, and the abscissæ hourly observations. When each magnitude reaches its constant, bubbles of gas are freely given forth and energy is being wasted. The variation of the electromotive force and current strength is clearly due to the counter-electromotive force of the cells, which becomes a maximum only when the plates are fully formed. The counter-electromotive force partakes of the character of a higher resistance opposing the charging current, and increasing the proportion of the current through the shunt of the dynamo. Hence the changes of electromotive force are more marked than those of the current. Indeed, the changes in the electromotive force, as given by the voltmeter, are sufficient alone to indicate the progress and completion of the charge. They are more reliable than the evolution of gas.

The electrical leakage of Mr. Preece's cells is obviated by standing each cell on three porcelain supports, having cups half filled with resin oil on Messrs. Johnson and Phillip's plan.

Mr. Preece gives the E.M.F. of the battery at its terminals as—

When charging	2·25 per cell
When idle...	2·05 ,,
When discharging	1·90 ,,

and the internal resistance per cell as—

When charging	·0060 ohm
When discharging	·0017 ,,

But the latter is said to vary very markedly within the strength of current of discharge. This is shown by the following experiment, made with 23 cells of a smaller type than those described above, which are used in the Post Office :—

Current of discharge in amperes	Internal resistence in ohms
4·39	0·7608
7·25	0·4607
15·84	0·2816
25·07	0·1969

Thinking that this remarkable diminution of internal resistance might be due to the evolution of heat, Mr. Preece measured the temperature with a delicate thermometer.

Normal temperature of cell 12½° C. current of discharge :—

5 amperes	No alteration of temperature perceived
10 ,, ...	An exceedingly slight change
16 ,, ...	About 12¾°
20 ,, ...	Barely 13°

The current in each case was kept on for twenty minutes, hence the diminution, Mr. Preece says, is not due to heat.

Since the internal resistance varies in this way Mr. Preece now always takes the internal resistance with the same current, viz., 10 amperes.

The author of this paper asserts that the capacity of these batteries certainly improves with age, and up to the present time he has seen no sign of decay or deterioration.

M. Planté informed him that, though in course of time the peroxidised plate becomes very brittle, it is impossible to peroxidise it completely through ; there always remains a metallic core to give it strength. Mr. Preece finds that this is so. Up to the present moment he has made no careful measurements of the efficiency of his battery. He puts in about 240, and takes out about 200 ampere-hours weekly, and does not observe any change or fall in the electromotive force. When the electromotive force of these cells falls, it falls rapidly, indeed almost suddenly. Occasionally one plate of a group becomes inactive from undue local action, or from bad connection (shown by the colour). This plate is removed and put in a "hospital" cell, where it is brought into order either by a greater density of current or by reversal.

Reversing has a great beneficial action on a cell ; it not only improves its capacity, but it removes any cause of irregular working. It is advisable to do this periodically. Mr. Preece has two extra cells, which enables him to have two cells always under reversal by means of the charging current. It takes from 1,000 to 1,200 ampere-hours to reverse a cell, so that at this time of year it takes a month or more to complete the operation, and it will take a year to reverse the whole battery. Sixteen cells have been reversed during the past twelve months.

Chemical Society, May 21.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. E. G. Amphlett and E. G. Hogg were formally admitted fellows of the Society.—The following papers were read :—A colorimetric method for determining small quantities of iron, by Andrew Thomson, M.A. —On some sulphur compounds of calcium, by V. H. Veley. —Spectroscopic observations on dissolved cobaltous chloride, by Dr. W. J. Russell, F.R.S. The characteristic absorption-spectrum given by cobaltous chloride after dissolution in such media as pure and dry potassium chloride, sodium chloride, calcium chloride, alcohol, glacial acetic acid and in chlorhydric acid, is seen also in an aqueous solution. Hydrated cobaltous chloride gives an entirely different spectrum. If a somewhat faint indication of the spectrum of the chloride be taken as a standard, it is found possible to determine with tolerable accuracy when the amount of anhydrous chloride in solutions of varying strength and temperature is identical with that in the standard solution. A solution containing 4·18 grams of cobalt chloride in 10 c.c. of water at 0° C., when observed through a thickness of 7 mm., forms a convenient standard. If to 10 cc. of such a solution 2·9 cc. of water be added, then on raising the temperature to 33° an amount of anhydrous chloride is re-formed identical with that existing in the standard solution at 0° : this rise of temperature exactly counteracts the effect of adding 2·9 cc. of water. A series of determinations were made in this manner, and it was found that the number of c.c. of water added to the 10 cc. of standard being as given in the upper line, the temperature at which the spectrum appeared was as given in the lower line in the table :—

2·1		2·9		4·3		7·4		8·9
26°		33°		43°		55°		63°
	10·3		12·1		15·0		16·0	
	70°		75°		87°		95°	

Again, taking the most dilute solution, in which 16 cc. of water had been added to 10 c.c. of the standard solution, it was found that the same change was effected—*i.e.* that the chloride spectrum could be developed in it, by the addition to the solution of either 0·864 gram of hydrogen chloride gas. or 5·26 of sulphuric acid, or 2·47 of calcium chloride ; but that the addition of sodium chloride would not develop the bands, although on heating the solution after saturating it with this salt a temperature of 34·5° was sufficient, instead of 95°, to develop the bands. Zinc chloride was found to act in a different manner. Notwithstanding its power of combining with water, on adding it to the cobalt solution no banded spectrum shows itself, and even when added to a solution in which the spectrum is visible it causes its disappearance. The explanation is that it must have combined with cobalt chloride, forming a new and stable compound. On evaporating the solution this was found to be the case, and a new salt, a compound of cobalt and zinc, crystallised out. Cobalt bromide, both as a solid and in solution, gives a spectrum very similar to that given by the chloride, but the corresponding bands are nearer the red end of the spectrum. The salt is far more soluble in water than the chloride, and has a stronger affinity for water, as is shown by the much higher temperature required to neutralise the power with which water combines with it. The following determinations similar to those made with the chloride show the increase of temperature necessary to counteract the combining power of giving quantities of water with cobalt bromide :—

Standard 10 c.c.	+	Water	Temp. 0° C.
10 ,,	+	3·0	51
10 ,,	+	4·3	57
10 ,,	+	7·4	91

—The sulphides of titanium, by Prof. T. E. Thorpe, F.R.S.—Note on the formation of titanous chloride, by Prof. T. E. Thorpe, F.R.S.

Zoological Society, June 2.—Prof. W. H. Flower, V.P.R.S., President in the chair. Mr. Sclater exhibited drawings of and made remarks upon the specimens of various species of Coly living in the Society's Collection. Mr. Beddard, on behalf of himself and Mr. Treves, read a paper on the anatomy of the Sondaic Rhinoceros (*Rhinoceros sondaicus*) which had died in the Society's Gardens in January last. A communica- was read from Dr. Julius von Haast, F.R.S., C.M.Z.S., on *Megalapteryx hectori*, an extinct gigantic representative of the *Apteryx*, of which the remains had recently been discovered in New Zealand. Dr. Guillemard, F.Z.S., read the fourth and fifth parts of his report on the collection of birds formed during the voyage of the yacht *Marchesa*. The present communications treated of the birds collected at Celebes and on the Molucca Islands. Mr. J. Bland Sutton, F.Z.S., read a paper on the development and morphology of the human sphenoid bone, in which he attempted to show that the basi-temporals of the bird are not homologous with the *lingulæ sphenoidales*, but with the so-called pterygoid bones of the crocodile, and that the human *lingulæ* are homologous with the sphenotic of the bird.—Mr. Edgar A. Smith, F.Z.S., read a report on a collection of shells, chiefly land and fresh water, obtained by Mr. H. B. Guppy, R.N., Surgeon H.M.S. *Lark*, during a recent visit to Solomon Islands.

Paris

Academy of Sciences, June 2.—M. Bouley, President, in the chair.—Human locomotion: stereoscopic images of the trajectories described in space by a point of the body while walking, running, or otherwise moving (two illustrations), by M. Marey.—Remarks on the "Registres d'expérience," a collection of sixty-nine volumes in MSS. by Henry Victor Regnault, dealing with a great variety of questions in chemistry, physics, thermodynamics, hygrometry, &c., presented to the Academy by M. Reiset.—On the treatment of nervo-pulmonary asthma and cardiac asthma by inhaling certain vapours all containing a special substance known as pyridine (C_5H_5N), by M. Germain Sée.—Account of a species of anæsthesia unattended by sleep, and with the perfect preservation of the intellect, the voluntary movements, the senses and sensibility to the touch, by M. Brown-Séquard. From numerous experiments made on the dog, monkey, and man, the author shows that, under the influence of an irritation set up in the laryngeal mucous membrane, sensibility to pain may disappear or be diminished for many hours without the least disturbance of the mental faculties, the senses, or the voluntary movements in man and animals.—Remarks on M. Lucien Biart's work on "The Aztecs, their History, Manners, and Customs," presented to the Academy by M. de Quatrefages. It was stated by the Secretary that this volume forms one of a series entitled "The Ethnological Library," to be edited by MM. de Quatrefages and Hamy, and to comprise, besides a general history of the races of mankind, a number of monographs devoted to the detailed study of the various branches of the human family.—Observations of the solar spots, faculæ, and protuberances made at the Observatory of the Roman College during the first quarter of the year 1885, by M. Tacchini. Compared with the corresponding period of the previous year the spots appear to have been more numerous, but of relatively smaller size, while little difference was observed in the recurrence of the faculæ. The same peculiarity was again noted of a maximum of faculæ coinciding with a minimum of spots.—Remarks on the physical appearances of the planet Uranus in the months of March, April, and May of the present year, by Père Lamey.—On a method of measuring the magnetic rotatory force of solid, fluid, and gaseous bodies in absolute unities, by M. Henri Becquerel. The numbers determined in various ways by other observers correspond very closely with that of the author as shown by the subjoined table:—

Gordon	0'·0433
Lord Rayleigh	0'·0430
L. Arons	0'·0439
Becquerel	0'·04341

—An optical method for the absolute measurement of short distances, by M. Macé de Lépinay.—On the spectrum of bodies in "radiant matter," in which many substances emit a phosphorescent light, by M. W. Crookes.—On the velocity with which prismatic sulphur is transformed to octahedric sulphur, by M. D. Gernez.—On the presence of sulphurous acid in the atmosphere of towns, by M. G. Witz. From the analysis of the ozone made at Montsouris and elsewhere the author finds that sulphurous acid exists in the air of towns where coal is consumed, its presence causing a considerable diminution of atmospheric ozone, accompanied by the formation of sulphuric acid; further, that by the slow but continuous action of sulphurous acid, and under the influence of the frequent changes in the degree of humidity, the peroxide of red lead used in colouring certain placards, is destroyed and sulphated. At the same time the protoxide of lead thus liberated is transformed to an insoluble sulphite. This salt being easily analysed, a new and certain means is thus obtained for determining the condition of the atmosphere in large cities.—The arsenic present in the soil of cemeteries considered from the toxicological standpoint, by MM. Schlagdenhauffen and Garnier.—Classification and anatomy of the Tectibranchea, a family of mollusks abounding in the Bay of Marseilles, by M. A. Vayssière. Of this family twenty-two species are grouped under the sub-order Cephalaspidea, six under Anaspidea, and nine under Notaspidea. All belong to the order of Opistobranchea, the exceptions indicated by Hering being based on erroneous data.—On the spores and reproductive processes in *Sphærocarpus terrestris*, *Targionia hypophylla*, and other plants of the same order, by M. Leclerc du Sablon.—On the problem of repetitions and symmetry in the mineral kingdom (one illustration), by M. P. Curie.—On an apparatus adapted for the comparative study of opaque minerals, which cannot be easily examined under the microscope, by M. A. Inostrauzeff.—On a unique specimen of hydrous silex belonging to the quaternary formation of the Loing Valley, department of Seine-et-Marne, by M. Stan. Meunier.—On the upper Miocene formations of the Cerdagne district, a lacustrine basin on the southern slope of the Eastern Pyrenees, by MM. L. Rérolle and Ch. Depéret.—Description of a self-registering calorimeter adapted for recording the temperature of the human body, three illustrations, by M. A. d'Arsonval.—On electric alcoholic fermentation, by M. Em. Bourquelot. From his experiments the author finds that this fermentation, as originally determined by Dubrunfant, may be modified by the temperature, by dilution, and by the alcohol formed during the fermentation itself.—On the uniformity of the process of spermatogenesis in the order of mammals, by M. Laulanié.—Action of cocaïne on the invertebrate animals, by M. Richard.—A contribution to the study of antiseptics: action of the antiseptics on the higher organisms, iodide and chloride of mercury, by MM. A. Mairet, Pilatte, and Combemal.—Influence of the lunar declinations on the displacement of the atmospheric currents, a reply to M. de Parville, by M. A. Poincaré.

CONTENTS

THURSDAY, JUNE 18, 1885

BÜTSCHLI'S "PROTOZOA"

Bronn's Classen und Ordnungen des Thierreichs. New Issue. (Leipzig: C. F. Winter, 1883-4 5.)

THE important work on the lowest division of the animal kingdom which Prof. Bütschli, of Heidelberg, has undertaken for the publishers of the well-known series of zoological treatises originated by the late Prof. Bronn, is so far advanced as to enable us to form some estimate of its merits and to call for an extended notice. The separate parts of Prof. Bütschli's work which have appeared at intervals during the last two years have now accumulated so as to form a large octavo of 900 pages and 50 plates. The whole of the Protozoa have been discussed with the exception of the Ciliata, the Dino-flagellata (formerly called Cilio-flagellata), and the Acinetaria. The work does not comprise in its scope the Mycetozoa, which should, in the opinion of the present writer, be included in the animal kingdom. This is the less to be regretted, since an excellent work on this group has been recently published by Dr. Zopf, of Berlin, in the "Encyklopädie der Naturwissenschaften," and may be obtained separately of the publishers, Trewendt, of Breslau.

That the Mycetozoa are to be considered as animals rather than as plants is the opinion of no less an authority than the botanist De Bary, who has done more than any other observer to elucidate their life-history and structure.

Bütschli divides the Protozoa into classes as follows—the Sarkodina, the Sporozoa, the Mastigophora, and presumably the Ciliata and the Tentaculifera, though of the last two he has not yet written.

The Sarkodina are divided into the sub-classes Rhizopoda, Heliozoa, and Radiolaria.

The class Sporozoa contains the sub-classes Gregarinida, Coccidia, Myxosporidia, and Sarcosporidia.

The Mastigophora are grouped in sub-classes as Flagellata, Choanoflagellata, Cystoflagellata, and Cilioflagellata (now altered to Dinoflagellata).

Each of the sub-classes is treated of in turn in the thoroughly systematic and comprehensive manner which the readers of Bronn's "Thierreich" know so well and have so long appreciated. The treatment commences with a "Historical Review of the Development of our Knowledge of the Sub-class," which is no formal repetition of familiar commonplaces, but a really critical statement of the share contributed by various earlier naturalists to the building up of our present conceptions on the subject. This is followed by a wonderfully complete list of memoirs and papers relating to the group—under the heading "Literature." We have in many instances tested the completeness of these lists, and have found that even short papers in obscure periodicals which happen to contain facts of real importance have been duly hunted up and recorded by Prof. Bütschli.

Then follows a "Short Survey of the Morphological Characteristics of the Sub-class and its Chief Divisions," and after this each prominent morphological factor is taken separately and its variations in the group very thoroughly discussed, references being given to the widely scattered writings of the numerous microscopists who have advanced this or that view or added this or that quantum of fact to our knowledge. Thus in the portion of the work relating to the Rhizopoda we find—

(1) The shell-structure of the Rhizopoda. A. Material of the shell—(*a*) chitinous shells; (*b*) calcareous shells; (*c*) shells built up of foreign particles; (*d*) siliceous shells. B. The morphological structure of the Rhizopod shell—(*a*) homaxonic shells; (*b*) monaxonic shells; (*c*) polythalamous shells; (*d*) abnormal shell-formation.

(2) The structure of the soft body of the Rhizopoda—(*a*) general characters of the soft body; (*b*) properties of the protoplasm of the Rhizopod-body in general; (*c*) differentiation of the protoplasm into special zones or regions; (*d*) coloration of the protoplasm; (*e*) peculiar bodies enclosed by the protoplasm, namely, non-contractile vacuoles, gas-bubbles, and peculiar products of metabolism, contractile vacuoles, nuclei; (*f*) pseudopodia, movement and inception of nutriment in the Rhizopoda; (*g*) gelatinous investment of the soft body.

(3) Relation of the soft body to the shell and formation of the shell by the soft body.

(4) Reproductive phenomena, colony-formation, and encystment of the Rhizopoda—(*a*) reproduction by simple division or budding; (*b*) colony-formation in connection with the division or budding of the Rhizopoda; (*c*) encystment in connection with or without reproduction; (*d*) copulation and conjugation in the Rhizopoda; (*e*) review of the attempts made to prove the existence of a sexual reproduction in the Rhizopoda.

(5) Biological relations of the Rhizopoda—(*a*) habitat; (*b*) nutrition; (*c*) dependance on external life-conditions.

(6) Taxonomy of the Rhizopoda—(*a*) historical development; (*b*) review of the system of the Rhizopoda, with brief characterisation of the divisions, inclusive of genera.

(8) Geographical distribution of the Rhizopoda.

(9) Palæontological development of the Rhizopoda.

This exhaustive discussion of the Rhizopoda occupies about 250 pages and 13 plates, in which the most important forms are figured: the figures being selected from all sources, and showing not only shell-structure but all that is known with regard to the protoplasmic body.

In the same thorough manner the subsequent groups of Sarkodina, of Sporozoa and Mastigophora are dealt with.

One point, however, to which we have not yet alluded gives Prof. Bütschli's work an altogether exceptional value. From what we have hitherto said it might appear that the work is simply a well-digested and critical survey of other men's work. This is not the case; the discussion of each group possesses a special value and importance from the fact that Prof. Bütschli has made very extensive researches himself in regard to the Protozoa, and has especially given attention to doubtful points, so that he is able to speak with the authority of a specialist in nearly every case. Portions of these researches, for instance those on the Radiolaria, on the Gregarinida and Myxosporidia (Psorosperms), and on the Flagellata have been already published from time to time during the past five years by Prof. Bütschli in various scientific journals. They have everywhere excited the greatest interest and have been recognised as most important additions to knowledge. In the present work they appear in due place aad enable Prof. Bütschli to give a decisive opinion upon many points on which authorities have hitherto differed. Many of the illustrations in the admirably engraved plates are also original.

We may perhaps remind our readers that it is to Prof. Bütschli that we owe the first important paper in the recent development of our knowledge of the karyokinetic figures of dividing cell-nuclei. It is his investigation which demonstrated the identity of the changes in the nuclei of Ciliate Infusoria with the curious fibrillation of normal tissue-cells when in course of division, and more than any others have given a wide basis to the recent generalisations on this subject.

Our author is not only extremely fair and scrupulous in citing all discoverable authorities for the facts which he sets forth as to the structure, &c., of Protozoa (our English microscopists of all ranks will find themselves cited and fairly considered), but he exhibits admirable judgment, temper, and caution in his treatment of vexed questions. He has wisely withheld his full discussion of the classification of the Radiolaria until such time as Haeckel's *Challenger* work on the group is published. In the meantime his analysis of the various forms of skeleton which occur in that group is a masterly essay on a very difficult subject.

With regard to the question of the chlorophyll corpuscles of some Protozoa—considered by Brandt as parasitic Algæ—we gather that Prof. Bütschli leans to the acceptance of that view; but we shall look for a more definite judgment from him in relation to that question when he has to discuss such forms as the Ciliata, *Stentor*, *Bursaria*, and *Ophrydium*.

It is noteworthy that Prof. Bütschli includes the Volvocina and the "Protococcus" forms in the Flagellata, being convinced of their relationship here in spite of their "holophytic" nutrition.

It would be impossible here to point out the numerous new views of importance which are advanced in Prof. Bütschli's work. It must be sufficient to say that the book is absolutely invaluable to every student of microscopic life, and is perhaps the most remarkable attempt yet made by a distinguished original observer to coordinate and render available for use the entire series of works of his predecessors in a large and important field of study.

E. R. LANKESTER

PHÆNOLOGY

Resultate der wichtigsten pflanzen-phänologischen Beobachtungen in Europa, nebst einer Frühlingskarte. Von Dr. H. Hoffmann, Professor der Botanik in Giessen. Anhang, Dr. Egon Ihne, *Die Norwegischen, Schwedischen, und Finnländischen Beobachtungen.* (Giessen: J. Ricker'sche Buchhandlung, 1885.)

THIS work, the results of forty years' labour, forms a most important contribution to the literature on the subject of phænology.

The work begins with an introduction, in which is explained the importance of phænological observations, particularly with regard to comparative climatology and biology. Then follows an investigation of the degree of accuracy to be obtained by this kind of observation, succeeded by a discussion as to how many years such observations ought to be continued for obtaining useful and trustworthy information for comparative investigation. A table is then given of those plants and their phases which the author, after forty years' observations, thinks the most proper for adoption with a view to international reception. The number is fifty-three, and they are arranged according to the calendar, to facilitate observation; which system appears with regard to accuracy preferable to an alphabetical arrangement.

A short notice follows of the most important general results of the work with respect to climatology and biology, abstracted from the observations from the whole of Europe. At the end of the introduction the author points out the next tasks for phænological researchers.

The remainder of the book contains an alphabetical list of all phænological stations throughout Europe (about 2000), with the geographical situation and elevation above sea-level. Under each station are given in an alphabetical arrangement the mean dates of the simple phases known from the place, with the number of years of observation.

It is to be seen that from a great number of these but one or two years' observations have been published, whereas others extend to above thirty years. These dates are to be employed for comparing any single place with all the others. The mean dates are given as completely as possible, because such comparisons are the chief object of the author for publishing this work. They are extracted and calculated from a vast number of lists published in a great many periodicals and works of all nations.

With regard to spring flowers, the author himself has followed the plan of comparisons, giving under each station an indication of the number of days the single species open their flowers, sooner or later than at Giessen, the residence of the author, from which place, generally speaking, the most comprehensive observations have been published. In a "spring map" of Europe at the end of the book the results of these investigations are entered, by which the mean progress of spring through different countries may be seen at a glance.

OUR BOOK SHELF

Louis Pasteur, his Life and Labours. By his Son-in-Law. Translated from the French by Lady Claud Hamilton. (London: Longmans, Green, & Co., 1885.)

THE name of M. Pasteur, owing to his many brilliant and eminently practical discoveries, has been for some years so prominently before the general public that a popular and connected account of his life and labours cannot fail to be interesting and instructive reading to every educated member of the community. In this respect the present volume must be considered a signal success and a valuable addition to popular scientific literature. But the importance of the book reaches a step further, for it gives to the scientific world an authentic account of the development and progress of M. Pasteur's discoveries, since it is written by one who has been and is still living with M. Pasteur in the bonds of intimate friendship, and who has received his information directly from M. Pasteur himself. While to the general reader the achievement of a discovery is the only and great point of interest, to the scientific reader it is only one of many, the history of a discovery being one of them, and not the least important one, for it reveals methods and manner, and it gives us a true insight into the working of the mind, more so than the contemplation of the actual results. Looking at the book in this sense, we must consider it of inestimable value to every worker in the same field of research.

The many and great researches of M. Pasteur—amongst which may be mentioned his discoveries that every one of the many kinds of fermentations depends on the growth and activity of a definite and specific microbe; his long-continued controversy and final refutation of the doctrine of spontaneous generation, his immensely practical discoveries on the silkworm diseases, on the attenuation of the virus of splenic fever and of hydrophobia are described with great lucidity and their history and progress rendered in a very spirited and fascinating manner. Reading the volume, one does not know what to admire more in M. Pasteur's life and labours — the way in which a problem is stated, worked, and solved in all its theoretical and practical bearings; the energy and perseverance with which he forces nature to yield up her secrets; the fertility and resources of his genius, or the ready way in which he goes to work to set at rest by direct experiment all objections and to remove possible sources of error. His is a truly grand life and his labours grander still!

The translator is to be congratulated on the admirable way in which she has fulfilled her task. Prof. Tyndall's preface forms an interesting and valuable part of the book. E. KLEIN

The Microtomist's Vade-Mecum. A Handbook of the Methods of Microscopic Anatomy. By Arther Bolles Lee. (London: J. and A. Churchill, 1885.)

IN the preface the author tells us that the aim of the book is to put into the hands of the instructed anatomist "a concise but complete account of all the methods that have been recommended as useful for the purpose of microscopic anatomy," and also "that it is to serve as a guide to the beginner." After a perusal of the book we venture to say that, although the book will prove useful, it is neither a concise, still less a complete, account of all the methods, nor will it serve as a guide to the beginner. As far as we can see, it is a collection of formulæ, published by various authors in various journals and archives, and particularly reported in the *Journal* of the Royal Microscopical Society. The formulæ are more or less promiscuously given, and without an attempt of intelligible selection. For many formulæ references to their authors are given, but in some places these references are incomplete, in others they are wrong, since methods discovered by one are ascribed to another. Nor can we see the use of describing a host of minute and sometimes quite insignificant modifications of a certain method, as A's, B's, C's, &c., method.

As regards the beginner, we venture to say that the book will fail to come up to the expectations of its author. What the author for this purpose ought to have done is to give us a list of ready methods which he himself has tried and found useful in the examination of the various tissues.

The important branch of the examination of living issues, the methods used for the application of reagents, heat, gases, electrical currents, &c., on fresh and living tissues are not included in the book; their treatment, and a few illustrations of apparatus used in microscopic *technique*, would prove a useful addition. E. KLEIN

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. No notice is taken of anonymous communications.*

The Late Prof. Clifford's Kinetic

PROF. TAIT, in his notice of Clifford's "Common Sense of the Exact Sciences" (NATURE, vol. xxxii. p. 124) has brought so prominently forward the statement made in Prof. Pearson's footnote—"the manuscript of the 'Kinetic' was left in a completed state," that I think it is fitting I should somewhat anticipate what will ultimately be stated when the manuscript in my hands has been printed. All the manuscript bearing upon the "Dynamic," after having, I think, passed under Mr. F. Pollock's eyes, was handed over to me, and with it Mrs. Clifford gave me, for use,[1] nine German text-books in case I should need them to fill up any gaps in the manuscript. It is needless to say that there have been "reasons" why this manuscript has not hitherto seen the light; suffice it now to say that the *continuous* portion has been received by Messrs. Macmillan, and the printing is to proceed forthwith. But of what does the *continuous* part consist? I have a draught before me of the work as originally contemplated by the author: Books i., ii., iii., form the "Kinematic"; Book iv., entitled "Forces," is broken up into ten or eleven sections. It is this portion which is *continuous*, and which takes up about forty pages of manuscript. Book v. was to treat of "Stresses;" Book vi., of "Heat;" and Book vii., of "Waves and Vibrations." Of these latter books I have only stray leaves here and there. It is said "Fools rush in where angels fear to tread." I certainly do not propose to try to supplement Clifford's work, but what I do propose is to get out all the *continuous* part in continuation as approximately as I can of the "Kinematic" and to relegate the odds and ends to an appendix. If any mathematician thinks some other course preferable, I shall be glad to let him see the "slips," and will hope to profit by his advice. I am in the receipt of letters from distinguished teachers which express a hope that the lectures I referred to (NATURE, vol. xxvii. p. 4) may see the light; but this point is still, I believe, under consideration. R. TUCKER

University College School, June 13

[1] These books are to be presented to University College Library after I have done with them.

Sky-Glows

A MAGNIFICENT display of red sky-glow has been seen here. The last observed was in September last (the 17th, the 27th, and the 28th), and only feeble ones have been noticed since up to June 11. At that date the sky glowed with a magnificent grayish pink on the whole of the northern horizon until 9 o'clock p.m. Yesterday the glow was still brighter, and at 9 15 p.m. it extended over the whole of the northern and north-eastern horizon. It was brighter than even last year, but acquired its maximum of brilliancy at a later hour than last summer.

Clairvaux-sur-Aube, France P. K.

Flying Fish

AN excellent opportunity of observing the aerial means of propulsion in the flying fish was afforded me during a six days' calm lately when crossing the Bay of Bengal. This must be my excuse for again touching this subject. I watched day by day some hundreds rise under the bows of the ship. The water surface was a glassy calm. As each fish rose it spread its wings at once, apparently beating the surface with them two or three strokes before they steadied out. I say apparently, for it was not a definite beat so much as a struggle to rise. The tail which, of course, under water was in rapid motion, to escape from the ship, now gave ten or a dozen rapid beats, which could be counted by the ripples on the still surface, and the fish was off in aerial flight. As each fish lost the impetus of the first rise, which generally happened at about forty yards, the binoculars showed us the anal fins, which had till now been fully extended, drooping to feel the water. As soon as the surface was felt the tail was quickly introduced, and five or six smart strokes, also indicated by ripples, brought the impetus up again and carried the fish about another thirty yards, when another droop sent it on again, and so forth, some of the older fish travelling in this way 400 to 500 yards. The younger fish frequently fell awkwardly in this attempt to regain impetus. Where waves are running it requires a clever fish to gain impetus by a few judicious strokes on the crest of a wave, and many a fish tumbles over in the attempt.

I once saw a fish rise close to the ship's quarter, and it flew parallel with the ship, pursued below by a dolphin or bonita. The latter followed every sway of the flying fish, keeping almost under it. At the first dip of the tail the pursuer made a dart forward, but missed it, and again dogged its pray by keeping just under it. On the second dip the tail went into its pursuer's mouth, and there was an end of the flyer. It always struck me that it seemed a strain on the fish to keep the wings extended.

May 15 ALFRED CARPENTER

THE UNIVERSAL MERIDIAN[1]

AFTER some preliminary historical matter Dr. Janssen proceeded:—The question as to which of all the meridians encircling the earth ought to serve as the starting line in the general numeration of the longitudes, is the question known as that of the *prime meridian*—a famous question oftentimes taken in hand, never definitively settled, and which the Congress of Washington was charged to decide. Such was at least its intention.

The ancients, who had just ideas in all matters, perfectly understood that a prime meridian ought to be placed at the origin of the lands to be measured. Marinus of Tyre, and after him Ptolemy, chose quite naturally, as the point of departure for their longitudes, the extremity of the world which was best known to them. What was this extremity? It was the islands which navigators encountered beyond the pillars of Hercules in an enchanting climate, where the inhabitants, freed from every toil, lived in peace and happiness on the abundant spontaneous fruits of a prodigal soil, the Fortunate Isles, as they were called, which people pleased themselves with assigning, as a final resting place (Elysian fields) to the souls of heroes!

Homer, Hesiod, Pindar, Plutarch, speak to us of these Fortunate Isles, which were then regarded as the extreme limit of the western dependencies of Africa. Afterwards they were the unknown solitudes of the ocean.

It is from these isles, then, that the great heir of the geography of the Greeks starts his numeration of longitudes. Here again, however, the ignorance of the ancients in the matter of measures did not allow the maintaining of so natural a point of departure. The indifferent knowledge of the position of the Fortunate Isles damaged the whole system, and people later on were compelled to revert to the continent where the measures were less uncertain.

Following Greek science came the middle ages, when the scientific idea disappeared, and was replaced by a religious or political idea. The first line of longitudes was taken anywhere. People took their meridians from capitals, or remarkable places; every one chose his own centre, and the confusion grew to be intolerable. It is noteworthy how it was France which gave the signal for the resuscitation of the scientific idea in this question, and that it is to the great Richelieu we owe it.

It is, however, a false idea of Richelieu's action to consider it as directed by a pure intention of scientific reform, and by the desire alone of serving the general interests. Richelieu is above all a political spirit, and political interests dominate his preoccupations. At the same time, however, he is a unifying and innovating genius, who feels the necessity of order and serves that necessity by general, great, and elevated measures, for such is the form of his spirit.

What, in fact, was the point of departure of a reform such as science disengaged from all personal interest would alone dictate at the present day? A jealous quarrel among maritime nations in reference to commerce!

At the commencement of the seventeenth century France made a trial of commerce in distant parts, particularly in the Indies and America.

The navigation and traffic of these countries were then in the hands of the Spanish and Portuguese, who, however little they agreed on the division of these rich spoils among each other, were nevertheless wonderfully united when there was a question of interdicting others from sharing in them. The French ships appearing in the seas either of the East or West Indies were, in point of fact, chased by the Spaniards and the Portuguese! Awaiting the time till he had rendered the French navy strong enough to dispute with these nations a property which on the whole was the right of all the world, Richelieu sought to draw around France a maritime zone of protection. He accordingly negotiated and obtained that on this side of the prime meridian fixed on this occasion and to the north of the tropic of Cancer every French ship, whencesoever it may have come and whatever its cargo, should be safe from the pursuit of foreign vessels. Beyond these limits the argument of the strongest was to have force. France was at peace with Spain and Portugal on this side, at war on the other. A curious state of affairs, recalling to some extent the word of Pascal: "Vérité en deçà, erreur au delà!"

And yet have we really the right at this day to look on an arrangement of this kind as such a strange one? Have we not now what the casuists of international law call the *état de représailles*—a state in virtue of which one may blockade the ports of a nation, burn its arsenals and destroy its armies, without being in declared war, and without ceasing diplomatic relations with it?

The object of the great Minister was evidently to secure a refuge for our marine till such time as it was able to contend with others—a goal for which he laboured with such admirable success that before his death our navy was constituted and the basis laid of that colonial greatness which came with Louis XIV. and Colbert.

Such, then, was the political motive at work. But in pursuing this question of colonial commerce the mind of Richelieu was for a moment turned to geography. He needed a pure line of demarcation, not liable to be disputed, and found it in the ancient meridian of the Canaries. He resumes the geographical idea of Marinus of Tyre and of Ptolemy. He places his meridian as far to the west as possible in the archipelago of the Canaries—in the island of Ferro, and the longitudes are to be counted east of it. All the other meridians of the continent are excluded.

Accordingly, and I insist on the fact, all the qualifications of a universal meridian, such as science might be able to establish at this day, were combined in Richelieu's meridian.

(1). It is universal and fit to be so, seeing it personifies no nation, but is, on the contrary, the determination of a purely geographical idea; namely, the position farthest to the west of the ancient world.

(2). The numeration of the longitudes is very natural. It brings the numerical augmentation of the longitude into harmony with that of the local time. It sets forth no negative longitude—a system which, in our opinion, is defective, when there is a question of universal numeration of longitudes.

(3). It places the first meridian in the sea, as geographers have always desired.

The appointment of Richelieu had but one fault: it was in advance of its time—not in respect of its utility and urgency, but of its means of realisation.

In order to establish a meridian at any point it is necessary to be able to connect this point exactly with all well-known points which are to be brought into relation to it. Now, by reason of various circumstances, chief amongst which was the state of war then prevailing, the longitude of this island of Ferro was not known till a century later, when P. Fouillée, astronomer and naturalist, proceeded to the Canaries by order of the King and the Academy, and there made observations on the occultations of the satellites of Jupiter, whence he determined the position of Orotara in Teneriffe, and consequently, by means of a triangulation, the position also of the island of Ferro.

[1] Lecture by Dr. Janssen at the Paris Geographical Society.

In the meantime a conventional position had been arranged for the island of Ferro. In fact, at the beginning of the seventeenth century our geographer Delisle is found placing the meridian of the island of Ferro on his maps 20° W. from Paris.

The grand geographical idea of Richelieu was, accordingly, not maintained in its integrity. Paris, in fact, gave the point of departure.

Delisle was a geographer of very great merit, and accomplished a real reform in the science by always seeking to establish astronomical determinations as the basis of geography. Delisle and d'Anville placed France in the seventeenth century in the front rank in geography. Be it added that, while France had thus an undisputed superiority in geography, she at the same time took the initiative in inventing hydrographic methods, and producing the most beautiful hydrographic works, as I had occasion to call to remembrance at the Congress.

In thus speaking of the labours of France shall we not be allowed to recall our present activity in the branches which engage us? I shall say but a word in passing. But in fine, are we not accomplishing great things even at the present day? The creation of the port of Rochelle, established on new and profound scientific principles; the geodetic junction of Spain and Africa; the great geodetic labours of France resumed; the publication of the astronomical and nautical ephemerides, the most complete and perfect in existence; the fair series of determinations of longitude of high precision, undertaken under the auspices of the Bureau of Longitudes; those sublime cosmogonical theories which are being elaborated at this very moment; finally, and without passing beyond the domain of geography, let us not forget the great enterprises of our president, who everywhere vindicates the genius of France, and whom age seems to spare in the interest of our glory—have we not in all that a sum of sterling substance, and is it not proper to call it to mind at a moment when every one is putting his claims forward?

These preliminary explanations made, we may now, with your permission, address ourselves to an analysis of the labours of the Washington Congress.

This Congress, assembled by the zeal of the United States Government, was formed by the diplomatic and scientific representatives of the different States invited. It was officially charged with the task of studying the question of a universal meridian and of cosmopolitan time, and of formulating propositions, which, it is true, were not to be binding on the Governments represented, but were yet to serve as a basis for further negotiations and definitive resolutions.

When the invitation of the American Government reached the Government of France, the latter applied to the Academy to name the delegates which should represent France scientifically at the Congress. This step was followed by the appointment of a Grand Commission comprising representatives of all the sciences and services interested, and in which the Academy of Sciences was largely represented.

This Commission, presided over by the Dean of our Astronomical Section, held numerous meetings, at which they discussed with the greatest care and with high authority the questions composing the programme of the Washington Congress. The resolutions which this Commission adopted, formulated in a remarkable report of M. Gaspari and fully accepted by the Government, formed the basis of the instructions given to the French delegates.

The Congress opened on October 1 in the Diplomatic Hall of the Department of State.

On the formal demand of the French delegation the Congress allowed that the motions and speeches delivered in the English language should be translated into French, and that the *procès-verbaux* should be drawn up in the two languages. To secure the accuracy of the French version M. Janssen accepted the duties of secretary.

The Congress invited certain learned men present at Washington to assist at the sittings, and to take part in the discussions. Among them may be named Messrs. Newcomb, Asaph Hall, Sir William Thomson, and Prof. Hilgard.

On examining the composition of the assembly it will be seen how largely England and America were represented, and yet, to add to the force which such a numerous and eminent representation was calculated to give them in the discussion, there was joined to it, under the form of invitation, the support of the most eminent men of learning of America or England present at Washington.

Finally, without at all wishing to call in question the independence of any one present at the Congress, it is yet difficult not to be struck by the fact of invitations being addressed to all the small States politically allied with the United States.

Such was the arena on which France was called to defend her interests.

Luckily, however, we had no personal interest to contend for. The France of the nineteenth century does not, any more than the France of the eighteenth and seventeenth centuries, deem herself entitled to consider national interest in questions of a scientific and universal character.

In conformity, therefore, with the spirit which ruled the institution of the metrical system the French representation at the Washington Congress solely maintained the principle of a meridian such as science would designate and such as would be most advantageous for the general interest.

At the opening of the sittings a member of the American delegation, expressing, no doubt, the sentiment of his colleagues, at once proposed the meridian of Greenwich as the international meridian. If this proposition had been adopted the main question which called the Congress together would have been decided, and that, so to say, without discussion, and without the questions of principle and general interest, which we wished to defend, being so much as entered on.

The delegate of France raised his voice against this summary and inadmissible method of procedure. He pointed out that, before proceeding to choose any meridian in particular, it was necessary to come to a decision on the question as to whether a universal meridian should be fixed upon or not, and, if this question were settled in the affirmative, according to what principles they should choose this meridian.

The legitimacy of this demand was evident. It was accepted, and the proposition of the American delegate was temporarily withdrawn.

The question of fixing a single meridian of departure for all nations having been submitted to the Congress, it was unanimously agreed to choose such a meridian.

It next remained to be decided according to what principle this meridian should be chosen—whether, namely, the choice should be made among the observatories already existing, or whether the choice should be made with a view exclusively to geographical conditions, and to the service which the meridian was destined to render.

On this question the French scientific delegate begged permission to speak, and delivered the following discourse:—

"If after so many fruitless attempts recorded by history to arrange a single universal system of longitudes this question is now again resumed, then in our opinion it has no chance of definitive success unless it is established on a purely geographical basis to the rigorous exclusion of all national rivalries.

"We do not, therefore, come here to support a candidature, we put ourselves completely outside the arena of debate, and are consequently infinitely freer to express our opinion and discuss the question from the one point of view of the interests of the projected reform.

"The history of geography shows us very numerous attempts at the unification of longitudes, and on searching into the causes of the failure of those attempts, many of them very happily conceived, one is struck by the fact that they seem reducible to two main causes, one of a scientific, the other of a moral nature. The cause of a scientific nature lies in the inability of the ancients to determine exactly the relative positions of points taken on the globe, particularly in the case of an island removed from a continent, where the distance between the two was not determinable by itinerary measures.

"It was thus, for example, that the first meridian of Marinus of Tyre and of Ptolemy, placed in the so-called Fortunate Islands, could not continue to be used, notwithstanding the advantage belonging to the choice of a position in the extreme west of the then known world, on account of the uncertainty attaching to this point of departure.

"This very regrettable reverse served to give a wrong direction to the question. People were obliged to revert to the continent. Instead of regarding a common origin of longitudes indicated by nature, people took their first meridian from a capital, from remarkable places, from observations. The second cause to which I referred, the cause of a moral kind—namely, national jealousy—led to the multiplication of geographical origins, whereas the nature of things would have demanded their reduction to one single origin.

"In the seventeenth century Cardinal de Richelieu, seeing this confusion, wanted to resume the idea of Marinus, and assembled at Paris learned men of France and foreign countries. The famous meridian of the island of Ferro was the result of their conferences. Here is a lesson which we ought not to lose sight of: the meridian of the island of Ferro, which had at first the purely geographical and neutral character alone able to render it, and maintain it as, a first international meridian, was displaced from its primary position by the geographer Guillaume Delisle, who, to simplify the figures, placed it in round numbers 20° west of Paris. This unhappy simplification completely changed the principle of impersonality. It was no longer an independent meridian, but the meridian of Paris disguised. Nor were the consequences slow in making themselves felt. The meridian of the island of Ferro, from that time regarded as a purely French meridian, wounded national susceptibilities, and thus lost the future which was certainly in store for it had it remained true to its first intention.

"This was a real misfortune for geography. Our maps in their process of improvement ought to have maintained the unity of departure, instead of confusing it ever more and more.

"If from the time when astronomical methods were sufficiently advanced to allow the fixing of relative positions with the degree of precision required for general geography (a state obtaining from the end of the seventeenth century), the idea of Marinus of Tyre, so just and so geographical, had been resumed, the reform would have been effected two centuries sooner, and we should now have been in the full enjoyment of it. But people fell into the error of losing sight of the very principles of the question, an error to which the foundation and multiplication of observatories at that time greatly contributed. Furnishing relative positions, as they of course did, with great precision, each of these establishments was chosen by the nation possessing it to give it a point of departure for longitudes, so that the intervention of astronomy in these questions of a geographical nature—an intervention which, properly understood, should have been so advantageous—served only to remove us further from the object to be attained.

"The study of these questions leads us to establish a very necessary distinction between the meridians of a geographical or hydrographical nature, and the meridians of observatories.

"The meridians of observatories must be regarded as essentially national. Their office is to enable observatories to depend on each other for the unification of their observations. They also serve as a basis for geodetic and topographical labours executed in connection with them. Their functions, however, being of an entirely special character, ought in general to be limited to the country possessing them.

"The first meridians in geography, on the other hand, do not require to be fixed with a precision quite so delicate as that exacted by astronomy; but in return their domain ought to be comprehensive, and while it is serviceable to multiply observatories, it is necessary to reduce to the utmost the origins of longitude in geography.

"It may further be said that if the site of an observatory ought to be chosen under considerations of an astronomical description, a meridian of departure in geography ought to be fixed on grounds of a geographical description.

"Have these two so different functions always been well comprehended, and a distinction of such vital moment properly observed? By no manner of means.

"Seeing the observatories, by reason of the labours of high precision executed by them, furnish admirable data, each nation in a position to do so has assigned to its principal observatory not only the geodetic or topographical works undertaken at home—a task very proper to it; but likewise the general works of geography or hydrography executed abroad—a confusion of functions comprising in it the germs of all the difficulties under which we now labour.

"In proportion, therefore, as cartographic labours accumulated, the necessity of establishing unity in all that relates especially to general geography became more and more felt. This explains how the question of a single meridian of departure has been so often raised in recent times.

"Among the assemblies occupied with this question that principally deserving our attention is the one held at Rome last year. For many even of our colleagues the conclusions adopted by the Congress of Rome settle the matter. Those conclusions must, therefore, very particularly engage our attention.

"On reading the reports of the sittings of that assembly I was struck by the fact that in a meeting embracing so many men eminent for their learning and speculations, it was the *Utilitarian* side of the question which was especially considered, and which finally dictated the sense of the resolution taken.

"Thus, instead of laying down the great principle that the meridian which should be offered to the world as a point of departure for all the longitudes of the earth ought, above everything else, to have an essentially geographical and impersonal character, the question was simply asked, which among the meridians of observatories was the one possessing—permit me the expression—the largest following (*la clientèle la plus nombreuse*).

"In a question of a geographical, much more than of a hydrographical, interest, as almost all mariners confess (seeing that, in fact, there exist but two prime hydrographical meridians, Greenwich and Paris), a primary meridian is taken, the dominating character of which is marine. And this meridian, instead of being chosen according to the configuration of the continents, is claimed for an observatory. That is to say, the prime meridian is chosen for a mere chance spot on the globe, and one which, moreover, is very inconvenient, for the function the meridian is intended to perform. Instead, finally, of profiting by the lessons of the past, an element of national rivalry is introduced into a question which ought to unite the votes of all interested.

"Well, I say that considerations of economy and of use and wont ought not to blind us to the principles which should govern this question, and which can alone render its settlement universally acceptable and permanent.

"But further, this argument of economy, and use, and wont, which is advanced as a reason of determinative force, has validity, it is true, for the majority for whom it is brought forward, but for them alone, and leaves for us exclusively the burden of change in habits, publications, and maps.

"Seeing the report holds us of so light account in the balance, allow me briefly to recall the past and the present of our hydrography, and for this purpose I cannot do better than cite a few passages from a work communicated to me, and emanating from one of our foremost hydrographers. 'France,' says he, 'created more than two centuries ago the oldest nautical ephemerides in existence. She was the first to conceive and execute the great geodetic operations having for their object the construction of maps civil and military, the measure of meridional arcs in Europe, America, and Africa. All these works were and are regulated by the meridian of Paris. Almost all the astronomical tables which the astronomers and mariners of the entire world make use of at this day are French, and calculated in reference to the meridian of Paris. As regards oceanography, more particularly marine surveying, the precise methods employed at the present day by all the nations are of French origin, and our maps, all based on the meridian of Paris, bear names such as those of Bourgainville, La Pérouse, Fleurieu, Borda, d'Entrecasteaux, Beautemps Beaupré, Duperrey, Dumont d'Urville, Daussy—to mention but a small number of those who are no more.

"Our existing hydrographical collections count more than 4000 charts. Deducting from this number those which the progress of exploration has rendered no longer available, there remain about 2600 charts in use.

"Of this number more than a half represent original French surveys which foreign nations have in great part reproduced. Of the remainder the general maps are the result of the labours of discussion carried out at the marine depôt where all documents, French as much as foreign, were utilised, and relatively few of them are the expressions pure and simple of foreign labours. Our surveys are not limited to the coasts of France and its colonies. There is hardly a region on the globe for which we do not possess original labours: Newfoundland, the coasts of Guiana, of Brazil and La Plata, Madagascar, numerous points of Japan and China, 187 original charts relative to the Pacific Ocean. We must not omit mentioning the fine work of our hydrographical engineers on the West coast of Italy, which was honoured by the International Jury with the grand medal of honour at the universal exhibition of 1867. The exclusive use by mariners of the meridian of Paris is grounded on considerations of a past of 200 years such as we have briefly recalled.

"The adoption of another prime meridian would involve a change in the graduation of the 2600 charts of our hydrography, would involve a similar change in our maps for nautical instruction numbering over 600, and would of necessity entail a corresponding change in the *connaissance des temps*.

"These are considerations deserving to be pondered. Well, if under these conditions the projected reform, instead of being inspired by the high principles which should govern this subject, is to take for its basis simply a regard for the use and wont of the largest number and their exemption from all sacrifice, reserving for us exclusively the burden of change and the abandonment of a dear and glorious past, are we not, then, justified in saying that a proposal formulated in this sense would not be acceptable?

"When at the end of the last century France established the metre, did she proceed in this way? Did she, as a measure of economy, and not to change anything in her habits, propose her foot-rule to the world? You know the facts. The truth is, we turned everything at home topsy-turvy—habits and material. And the measure chosen related, as it is, only to the dimensions of our globe, is so well disengaged from every French tie that in future ages the traveller who will trample on the ruins of our cities will be able to ask himself by what people was invented the metrical measure which his feet may chance to light on.

"Permit me to say that it is in this way a reform is established and rendered acceptable. It is by setting oneself the example of self-sacrifice and by completely effacing oneself in his work that resistance is disarmed and that a sincere love of progress is attested.

"I hasten to say that I am persuaded that the proposal voted at Rome was neither made nor suggested by England, but I doubt whether, if accepted, it will render a true service to the English nation. An immense majority of the sailors of the globe navigate with English charts, it is true, but it is a homage of fact rendered to the great maritime activity of this nation. The day, however, when this supremacy, freely accorded, is changed into a supremacy official and imposed, it will undergo the vicissitudes of every human power, and this institution, which by its nature is of a purely scientific order, and to which we desire to assure a long and peaceable future, will become an object of keen and jealous rivalry among the nations.

"All this shows how much wiser it would be to take for the origin of terrestrial longitudes a point determined by purely geographical considerations. On our globe nature has so distinctly separated the continent on which the great American nation are now developing themselves that from a geographical point of view there are but two possible solutions, both very natural.

"The first solution would consist in returning to the solution of the ancients with a little modification, by placing our first meridian towards the Azores; the second in relegating it to the immense straits separating America from Asia, towards the confines of the north, where the New World reaches out a hand to the Old.

"These two solutions may be discussed, as they have often and again quite recently been by one of our ablest geologists, M. de Chancourtois.

"Each of these meridians unites in it the fundamental conditions required by geography, and on which people have always been agreed, when national meridians were eliminated from the debates. As to the determination of the point adopted, the astronomical methods which are now so perfect would furnish it with as a great a degree of exactness as geography would require.

"But what need of a special and costly determination of longitude for a point which may be placed arbitrarily provided it is comprised within certain limits, such as to satisfy the condition, for example, of passing by a strait or traversing an island? It is enough to mark out approximately the point adopted. The position thus obtained will be referred to each of the great observatories, which will be related to one another and chosen for this purpose, and this list of relative positions will constitute the definition of the first meridian. As to a material sign on the globe, should such be wanted, a point by no means necessary, it will have to be placed in conformity with this definition, its place would have to be shifted till such conformity was obtained.

(*To be continued.*)

GUESSINGS AT TRUTH

I.

OLD SPENSER, in his wondrous Allegory, tells us—

"... he, that never *would*,
Could never :—"

We are constantly reminded that we must creep before we can walk. So that we cannot look coldly or sarcastically on

"... budding Genius' earliest essàye,"

provided always that we are sure of the earliness. For there often is a strange resemblance between the erratic first flights of the scientific fledgeling and the habitual evolutions of the time-hardened Paradoxer or of the Paper-Scientist.

Besides the mere dozen or so of really successful Physicists, all that the world seems able to produce at any one time, even in these later years, and whose efforts can at the best be rarely called more than *Guesses*, there is an untold multitude whose *Guessings* are irrepressible. These, unlike some at least of the former, never hide their light under a bushel. From week to week we view with curious awe the increasing piles of pamphlets under which our shelves and table sag, groan, and crack! Let us make an effort, and get rid of some of them. Not to the waste-basket—at least not at once—for there is something in almost every bundle of hay (in the Soudan it is not needles, but bricks and slag), and this is usually worth searching for, were it only in the interests of justice to those who have thus (unconsciously?) hidden them. We take the bundles as they come; many are rotten and can be tossed aside at once, others require more careful scrutiny.

The first we light upon is by our particularly modest contributor John O'Toole.[1] [He does not seem to be aware of the powers of Peroxide of Hydrogen, which (though we did not proclaim the fact) enabled us on a former occasion easily to penetrate his *incognito*. But his secret is safe with us.] His present work is a singularly quaint protest against the modern abuse of elementary dynamical terms, and as such is well worthy of careful perusal. There can be little doubt that, of all physical subjects, as presented in an elementary form to the beginner, Dynamics is the most repulsive. And it stands at the very threshold. Mr. O'Toole shows the natural working of a clear, logical, mind in the middle of the present chaos. His pamphlet is one which should be read by all; for, though he hits all round and sometimes attacks the very giants of Science, he invariably hits fair as well as hard. It would take a whole article to discuss fully the questions he raises: suffice it to say that the root of the confusion which he so justly exposes is that little, but much-abused word *Force;* and to quote the following pregnant sentence as showing his point of view :—

"When we behold . . . a group or sequence of phenomena, we *insert* force among them of ourselves, because we know from experience that if our organism were substituted for the acting or resisting body, we should have the sensation of pressure."

Next we take a couple of smaller, but more ambitious, pamphlets[2]:—in each of which the Past, Present, and Future of the Universe are promptly settled, though the terms of settlement are by no means identical. When we find, however, that Herr Zehnder, in the second sentence of his pamphlet, says that insuperable objections can be raised against the hypotheses of Helmholtz as well as against those of Kant, Herschel, and Laplace, *because they take too little account of the existing laws of mechanics*, we begin to understand him; and we have only to turn over a few pages to find him thoroughly revealed. His bugbear is the Dissipation of Energy:—and he informs us that the "Eternal Circulation of Matter"—in virtue of which all aggregations such as the sun will ultimately explode into their former nebulous condition, to recommence their condensation, &c.,—is an immediate consequence of THE PRINCIPLE OF THE CONSERVATION OF LIGHT!

Our rival author sums up *his* Kreislauf as follows :—

"... life, matter, and all things, are the necessary and inevitable outcome of the existence of Space. Space or Room, in any form whatever, must of necessity be a form of force or energy, and all things are just phases or manifestations of the working of this force or energy; the Earth is dissolving in Space like a lump of Salt in Water, but New Worlds are being formed in Suns; this dissolving and forming process will go on for ever; and consequently life will be eternal; . . ."

This is a step in advance even of Descartes, with whom Space and Matter were the same. We leave to the reader to judge which of the two has the more grotesquely grinned through the horse-collar, the German Swiss or the Scotsman.

Our next step is a large one, no less than from the Universe to the Atom.[1] The work now before us is a very curious one. The author has hunted widely for his materials, and (very naturally) selects such only as suit his theory. So long as he can utilise Sir W. Thomson or Clerk-Maxwell he does so; but, when he finds their statements incompatible with his theory, he has no difficulty in picking up what he wants from Zeuner, Rühlmann, Deschanel, &c. He seems, however, not to be acquainted with the elaborate work of Athanase Dupré. This is unfortunate, for in it he would have found little difficulty in obtaining whatever he might require. The object of the essay, briefly stated, is to frame a theory of the liquid and solid states, somewhat on the lines of the kinetic gas-theory:—only it seems we must have a mutual force between particles, whose law is something between the inverse 4th and inverse 5th powers of the distance. But somehow the law itself seems to vary with the distance; so that "we must apply the theory of probabilities to determine the potential at any centre due to the surrounding atoms." As a striking instance of Mr. Whiting's extensive range of quotation, we note that he refers, for the sum of a common series (given everywhere in elementary text-books of Trigonometry), to no less august an authority than Riemann in his *Partielle Differentialgleichungen!* We do not venture farther to criticise the work of a writer who can, as a matter of course, invoke such irresistible authorities.

We now come to a whole series of memoirs, tracts, letters, and pamphlets:—usually of American origin:—which deal specially with the vexed question of the Sun's temperature. From these we select one only, as the work of the most persistent, if not the most lucid or successful, of the many mere guessers on this subject.[2] For the others consult Van Nostrand's *Engineering Magazine, &c., passim*. Something, if not very much, has been done in this matter in Europe. Pouillet, J. Herschel, Crova, Rosetti, Violle, and others have at all events gone to work in a scientific way:—though (as is obvious from the results of Prof. Langley recently given in our columns) the values obtained by them can be but very rough approximations. A few of Mr. Ericsson's weightier sayings will pretty well show the value and character of his treatise. At p. 58 we are told that

"... the actinometer merely shows the thermometric interval of solar intensity on Fahrenheit's scale, without reference to the position of that interval on a scale which commences at the accepted 'absolute zero.' I regard this absolute zero, however, as an *ignis-fatuus*, retreating as fast as we approach it."

[1] *Ausa Dynamica.* Dublin: Hodges, Figgis, and Co., 1884.

[2] *Ueber die Entwickelung des Weltalls und den Ewigen Kreislauf der Materie.* Von L. Zehnder. Basel, 1885.

On the Future of Life and the Universe, according to Science. Dundee: W. A. Drummond, 1883.

[1] *A New Theory of Cohesion*, &c. By Harold Whiting. (Cambridge, U.S., University Press, 1884.)

[2] *Solar Heat (an Extract from a work on "Radiant Heat")*. By John Ericsson. New York, 1885.

The little kinematical, or rather quasi-corpuscular, *excursus* to which pp. 71–74 are devoted, is one of the richest pieces of *paradoxing* (in De Morgan's sense) that we have ever met with. Here is a little bit of it:—

"Pouillet, having ascertained the number of thermal units imparted to the water in his pyrheliometer of 3·93 ins. diameter, imagined that he had measured only the energy of the rays contained in a pencil of 11·9 square inches section; whereas, in reality, he had, at the end of his experiment of five minutes' duration, subjected his instrument to the action of the entire number of rays contained in a passing pencil or sunbeam, the section of which we ascertain by multiplying the orbital advance of the earth during five minutes, 28,836,000 ft., by the diameter of the pyrheliometer, 0·305 ft."

Thus it is the *number* of rays, not the time of exposure to one ray, which determines the result!

One more quotation, a very short one, must be given. It is from p. 136, and we put two words in italics:—

"In view of the fact that projectile force *diminishes inversely* as the square of the depth of the medium penetrated. . . ."

It is not easy to fix on the exact meaning of this very curious statement. Hence we must take it literally, whatever be the consequences. Discussion of penetration would obviously be useless in such a case, for the whole projectile force (even were it infinite) would be gone before penetration had commenced!

The immense expense which has been lavished on this volume, and on its truly wonderful illustrations, is calculated to produce reflections even more painful than those evoked by the perusal of the text itself. From the materials here given, *something* may yet be made, but certainly not on the lines chosen by the author.

We hope, shortly, to return to our store, and to select for the instruction and warning of our readers a few additional specimens, by no means inferior in quality to those just dealt with. G. H.

PROFESSOR FLEEMING JENKIN, LL.D., F.R.S.

ON Friday last, most unexpectedly and greatly to the grief of all his friends, died Prof. Fleeming Jenkin at Edinburgh, at the age of fifty-two. He had been in somewhat delicate health for a considerable time, but was, as usual, personally directing the engineering operations in connection with telpherage in London and Sussex, and seemed to have greatly gained in health and strength when he started for Edinburgh some days before his death. But blood-poisoning succeeded a slight surgical operation, and his death rapidly followed.

He was born in Kent in 1833, and was the son of the late Capt. Charles Jenkin, R.N. His school-days were spent at Jedburgh, Edinburgh, and Frankfort-on-the-Maine, while he took his M.A. degree at the University of Genoa, and began his engineering career in Marseilles, thus acquiring a wide knowledge of languages and of peoples which was most valuable to him afterwards in his scientific and social life.

In 1851 he returned to England, and was apprenticed to Messrs. Fairbairn's in Manchester, from which time his progress was rapid. We hope that the interesting and highly creditable history of his subsequent introduction as a well-trained mechanical engineer to submarine telegraphy (then in its extreme youth) and to Sir William Thomson, which led to his soon taking charge of the testing of the first Atlantic cable in 1858, and to a friendship and partnership with Thomson and Varley, will yet be told by some one who can do full justice to it. Our grief at Varley's loss is yet fresh, and we deeply sympathise with Sir William Thomson at the close of this partnership, the existence of which has been synonymous with the progress of submarine telegraphy.

On the appointment of the Committee of the British Association on Electrical Standards Jenkin's services were solicited, and the good work that he did as a member of this Committee is amply shown by his large contributions to the Reports on Electrical Standards, and which contain an account of his absolute measurement of the capacity of a condenser, the first such determination ever made; and the chapters that he wrote in connection with these Reports on the subject of "Absolute Units" formed the only available text-book for the student of mathematical electricity before about the year 1872. Appended to these reports are the Cantor lectures which he delivered on the construction, laying, and testing of submarine cables, and these lectures showed as wide an acquaintance with the practice of electrical science as do the other chapters referred to with the theory of the subject.

In 1865 he was elected a Fellow of the Royal Society and Professor of Engineering in University College, London, and in 1868 he became Professor in the University of Edinburgh, where he created a School of Engineering to which considerable numbers of prominent Engineers and Professors of Engineering acknowledge their indebtedness. In the following year the Royal Society of Edinburgh elected him a Fellow, and subsequently he became a Member of the Institution of Civil Engineers, having been made an Associate of that Institution as early as 1859. In 1883 the honorary degree of LL.D. was conferred on him by the University of Glasgow.

Jenkin's book on Electricity and Magnetism, published in 1873, was a revelation to non-mathematical and even to many mathematical men, of the ideas which had until then been wrapped up in the mystery of mathematics or in the practice of the submarine cable testing-rooms. Sir William Thomson had been publishing many detached papers on electricity in the mathematical journals, and had been applying his knowledge in practice, so that an exact science of electrical quantities had been growing up among submarine cable engineers; but the electricity of the text-books remained as unscientific and primitive as of old: the knowledge of the practical men had become indeed far more scientific than the knowledge of the schools.

Fully recognising this, Prof. Jenkin made in his book a totally new departure, and presented electricity and magnetism for the first time in a text-book as subjects capable of quantitative study. To understand the great effect produced by this book, which has now passed through many editions, it must be remembered that neither Clerk-Maxwell's treatise, nor Thomson's reprint of his Mathematical Papers appeared until 1873, and that at that time "electric potential," which to-day has its commercial unit, was to every one, except the engineers of submarine telegraphy, a mere mathematical function.

In 1882 a lecture was delivered at the Royal Institution on Electric Railways, and the system devised by Profs. Ayrton and Perry for effecting an absolute block, and thus enabling any number of electric trains to be run without the employment of drivers, guards, or signalmen, was described and exhibited by a working model. An account of this was read by Prof. Jenkin, and he at once saw that it contained the solution of a plan that he had been thinking over for doing on a large scale by electricity what had previously been done on a small scale with pneumatic tubes. *Telpherage*, or the automatic electric transport of goods, was the outcome, and the development of practical methods of running carriers electrically along a steel rod suspended in the air from wooden posts, occupied him, with the other two inventors, during the last three years of his life, the system being one which needed new invention in every one of its details. His inventive power is described by his assistants as wonderfully active and prolific, and he had energetic characteristics which only seldom accompany inventive genius, and which made his cooperation invaluable to the other directors of the Telpherage Company. It is deeply to be regretted that, having busied himself so actively in the long series of telpherage experiments carried out in Hertfordshire, he did not live to see the completion of the first commercial "telpher line" now being erected at Glynder in Sussex.

The building of houses on sanitary principles interested him largely, and the Sanitary Protection Associations in Edinburgh and in London owed their existence to his initiation, and their success was largely due to his constant exertions. His article on "Bridges" in the "Encyclopædia Britannica," his book on "Healthy Houses," and his primer on "Magnetism and Electricity," are well known to scientific readers, but not perhaps to the readers of his numerous articles in the quarterly reviews and monthly magazines, the last of which was his recent article on "Telpherage" in *Good Words*. His numerous scientific papers published since 1864 are to be found in the *Proceedings* of the British Association, the *Philosophical Magazine*, the *Proceedings* and *Transactions* of the Royal Societies of London and Edinburgh, the *Journal* of the Society of Arts, the *American Journal of Science*, and the *Journal* of the Society of Telegraph Engineers.

Technical education much interested him long before it acquired its present interest for the public, and he presided at meetings of the Society of Arts and other societies when papers on that subject were brought forward. As a director of the Watt Institute in Edinburgh for several years he helped to advance technical education in Scotland.

He was an enthusiastic admirer of ability in other men, and he was especially warm in his encouragement of beginners, whether they were his own pupils or not. To gain his help it was only necessary to let him see that it was anxiously wished for, and that the recipient was not likely to make a mean use of it. He had marked dramatic power, and the plays acted in his drawing-room will long be remembered by his friends; while to his conversation, his general reading and wide sympathies gave a charm which was as powerfully felt as it is now regretfully remembered by all who were fortunate enough to know him.

THE GEOLOGICAL SURVEY OF BELGIUM

ALL who are interested in the careful and methodical investigation of the geological structure of the European continent will be sorry to learn that the Belgian Chamber of Representatives has cut down the vote for the prosecution of the detailed Geological Survey of Belgium so seriously as practically to suspend the work. It is miserable to see personal dislikes, religious differences and political antagonism imported into the discussion of a scientific project. Every competent witness must bear testimony to the minute fidelity and conscientious labour with which M. Dupont and his staff have carried out their Survey. If any fault can be found with his maps it is that they are too complete. They give more information than any ordinary reader can assimilate. Each sheet, indeed, is a detailed treatise on the area which it depicts. There are certainly no such elaborately exhaustive maps published in any other country; and Belgium may justly boast that she has led the way in an important advance in the delineation of geological features. It is an open secret, however, that the official geologists have all along encountered the determined opposition of the "géologues libres" who were not so fortunate as to be entrusted with the control of the work. The Survey having been planned by the Liberal Ministry, and being stoutly supported by the authorities, has until now been able to hold on its course. Much time was, no doubt necessarily, spent by M. Dupont in perfecting his system of colour-printing, and the delay in the appearance of his maps, possibly also the difficulty found by the malcontents in understanding them, were used as arguments for a total reorganisation of the staff. The opposition has recently been renewed under the clerical Government now in power, and unfortunately with more success. From the published debate it is clear that the Minister in whose department the estimate for the Geological Map was prepared, and who was officially bound to support that estimate, sat still without speaking in its defence, and the House, taking this silence, no doubt, as an expression of the inclination of the new Government, cut down the vote. We are sure that this retrograde step will be regretted by all who wish well to the progress of science. Into the personal squabbles connected with the subject we have no wish to enter. But as a public act of unwisdom the vote of the House of Representatives will, we hope, be rescinded and the prosecution of the Survey will be again allowed to proceed. If any fault is found with the way in which the map has been prepared, surely the Commission contains talent and energy enough to inquire into this and set matters right without practically bringing the Survey to a stand.

THE CONGO[1]

THESE two welcome volumes from Mr. Stanley testify to the accelerated rate of events in these latter times. It is only twelve years since Livingstone died in the vain search for the sources of the Nile down by Lake Bangweolo, and under the belief that no river but the Nile could sweep past Nyangwe with such a breadth and volume as he found the Lualaba to have. He was not singular in cherishing such a belief; many geographers believed, like him, that the Congo could not fetch such a sweeping circuit, and that the Lualaba must make its way northwards in spite of differences of level and somehow add its waters to the Albert Nyanza. It is only eight years since Mr. Stanley dispersed the delusion, and solved the problem both of the Nile and the Congo; it is just about six years since he began operations as the agent of the International African Association. To judge from the narrative of his journey across the continent, there was no blacker part of the Black Continent than the river banks between Nyangwe and the Atlantic, and no more intractable people than many of the tribes through whom he and his men had to run the gauntlet. Yet already, almost solely by his exertions, this most unpromising region has become "A land of settled government," at least on paper. It has engaged the continued attention of diplomatists from all the great States of the world for months, and is the subject of as many treaties as if it had been founded a century ago.

In reality, however, it is something more than a paper State. No one can read Mr. Stanley's narrative without being convinced that all along the river from Vivi to Stanley Falls there already exists what may fairly be regarded as an organised Government, carried on from some twenty-four stations as centres. But with the merely political aspects of this successful undertaking we cannot deal here. It is certainly an interesting experiment, both from a political and social point of view, this attempt to raise into a State a region not yet redeemed from savagery. What the ultimate result will be it is hard to say; on the one side a great mass of savagery, and on the other the most advanced European influences in politics, in commerce, in industry, in religion. For already we find bands of missionaries everywhere, and as among them are many men of prudence, tact, and ability, Mr. Stanley acts wisely in encouraging their efforts; they will certainly be of service in helping him to accomplish the object he has in view.

Without the aid of the latest applications of science, Mr. Stanley could never have succeeded in accomplishing all he has done in the brief period of six years. Steam has been of infinite service to him, and engineer-

[1] "The Congo, and the Founding of its Free State." By Henry M. Stanley. Two Vols. (London: Sampson Low and Co., 1885.)

ing contrivances in many ways. His flotilla of steamers, some of them most ingeniously contrived for the special navigation of the Congo, may be said to have been everything to him in carrying out his work; and the Congo Free State may be fairly set down as another "triumph of steam." Mr. Stanley claims for the Congo Free State an area of over a million square miles and a population of 42,608,000. As to the area, that is probably not far out; but the population seems to us excessive. Mr. Stanley reaches this great figure by generalising the density which he finds on the banks of the river itself. Between Stanley Pool and Stanley Falls, a distance of about 1000 miles, and including part of the Biyerré and Kwa Rivers, he finds a population of 806,300, and takes for granted that a similar density will prevail throughout the whole of the Congo Basin. This is very unlikely. In uncivilised countries the population naturally crowds itself along the river banks, and it would be very unsafe to calculate on finding regions at a distance from rivers equally well populated. Throughout the whole of the million square miles claimed by the Congo State only a few lines of exploration have as yet been run, though we know that as a whole it is probably the best-watered region in Africa, and possibly therefore the most thickly peopled. But the tendency among African geographers recently has been to reduce previous estimates of the population of Africa, and instead of 200 millions it is thought that 170 millions is one more likely to be nearer the mark. But all estimates, except for districts that have been settled for some time, are necessarily conjectural; and even for Morocco the greatest difference exists between the estimates of different travellers.

On the Lower Congo the Free State has been able to secure only a comparatively narrow strip of territory on the north bank—enough, however, to give it the right of free navigation between the sea and Vivi, where the first series of cataracts begin. From Vivi upwards to Manyanga the State possesses territory on both sides, when France comes in and claims the whole of the right bank of the river to the Likona tributary in 1° S. lat. Thence the Free State expands into boundless and unknown regions, which we hope it will do its best to explore and open up to science as well as to commerce. The aim in the north has been evidently to draw the boundary of the

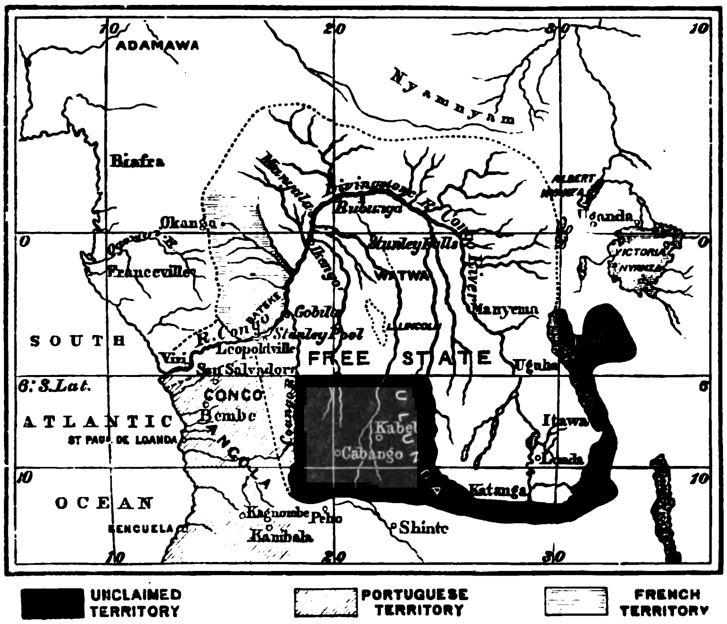


FIG. 1.—Political Divisions of the Congo Basin.

State between the basins of the Nile and the Congo. The western basin of the Upper Nile, no doubt, is fairly well known, but the region between that and the Upper Congo is just that part of Africa about which we know scarcely anything. The boundary on this side, therefore, has been drawn with the freedom of conjecture. All the rivers that are not known to send their waters to the Nile must, in Mr. Stanley's opinion, come down to the Congo, or, at least, ought to do so, and are made to conform with Mr. Stanley's idea of what is right and proper, in the large map which accompanies his work. In spite of Dr. Junker's discovery of the water-shed which separates the Nepoko from the Welle, they are both made to send their waters southward to swell the magnificent Aruwimi. This may be so; only actual exploration will decide the matter. It is mainly to settle this question that Dr. Lenz is preparing to proceed to the Upper Congo as leader of an expedition into the region that lies between that region and the Upper Nile tributaries. And here we have one very beneficial result of the work which Mr. Stanley has done on the Congo. His numerous stations form so many starting-points for further exploration. They can be easily and rapidly reached from the West Coast, and through the agencies at their command, all the men and goods obtained necessary for the conduct of an expedition into the interior. If every station on the river were made the basis of further exploring work, one of the greatest blanks in our knowledge of Africa would soon be filled up. In the interest of the enterprise itself this must be done. If the manifold products of the wonderful land over which Mr. Stanley is so enthusiastic are to be brought down to the river for shipment to the upper terminus of the future railway that is to convey them past the cataracts, it is evident that station after station must be pushed on into the interior. Among the white *employés* of the Association are many men of education and intelligence; and while their first duty is to look after the interests of the "Free State," these interests, instead of suffering, are likely to be advanced by a scientific knowledge of the country around the States. Already good meteorological work has been done at Vivi by Dr. Danckelmann, whose recently published

Fig. 2.—Yellala Falls from Left Bank.

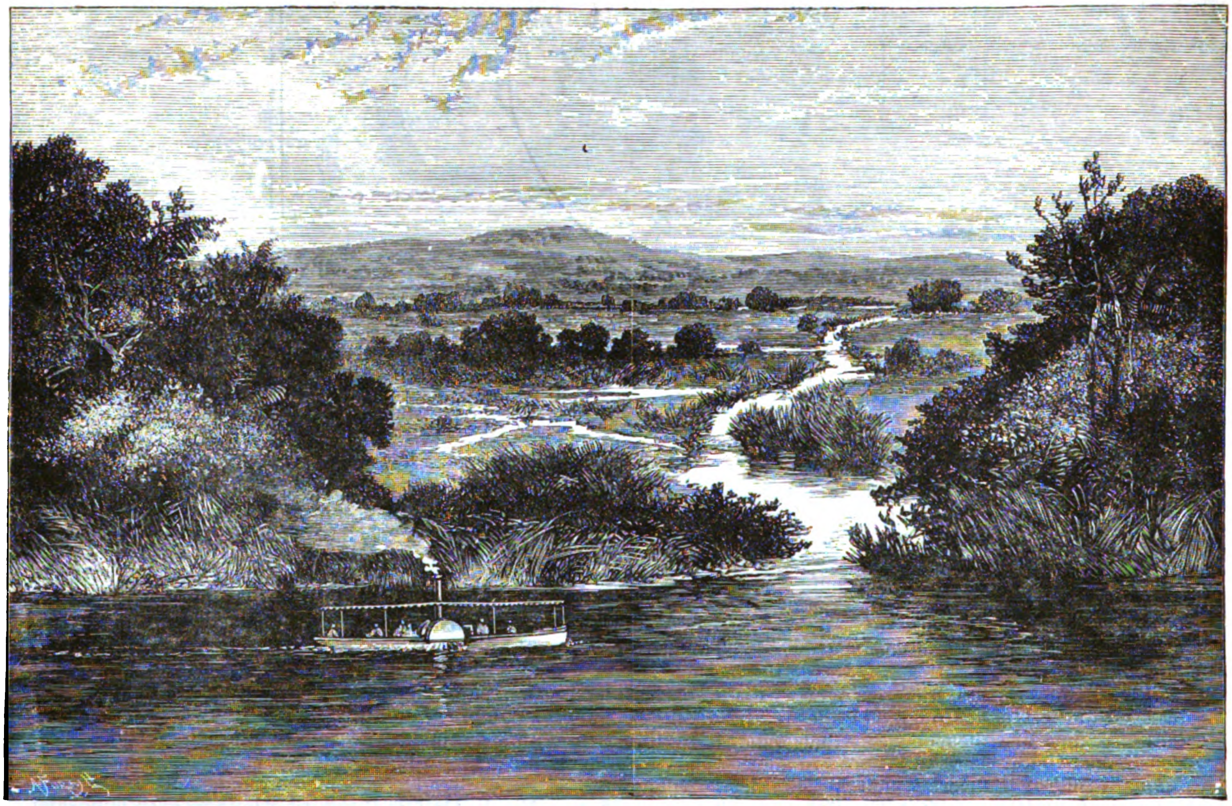


Fig. 3.—Head of Lake Leopold II.

observations we reviewed some time ago.[1] The utility of such observations is evident from the volumes before us. Mr. Stanley makes considerable use of them in his chapters on the Climate of the Congo. These chapters are of much interest; they are written mainly with a view to show that, with reasonable precautions, Central Africa ought to be perfectly tolerable to the European constitution. What these precautions are he describes in minute detail. At the same time he admits that a lengthened residence in such tropical regions must in the end tell on

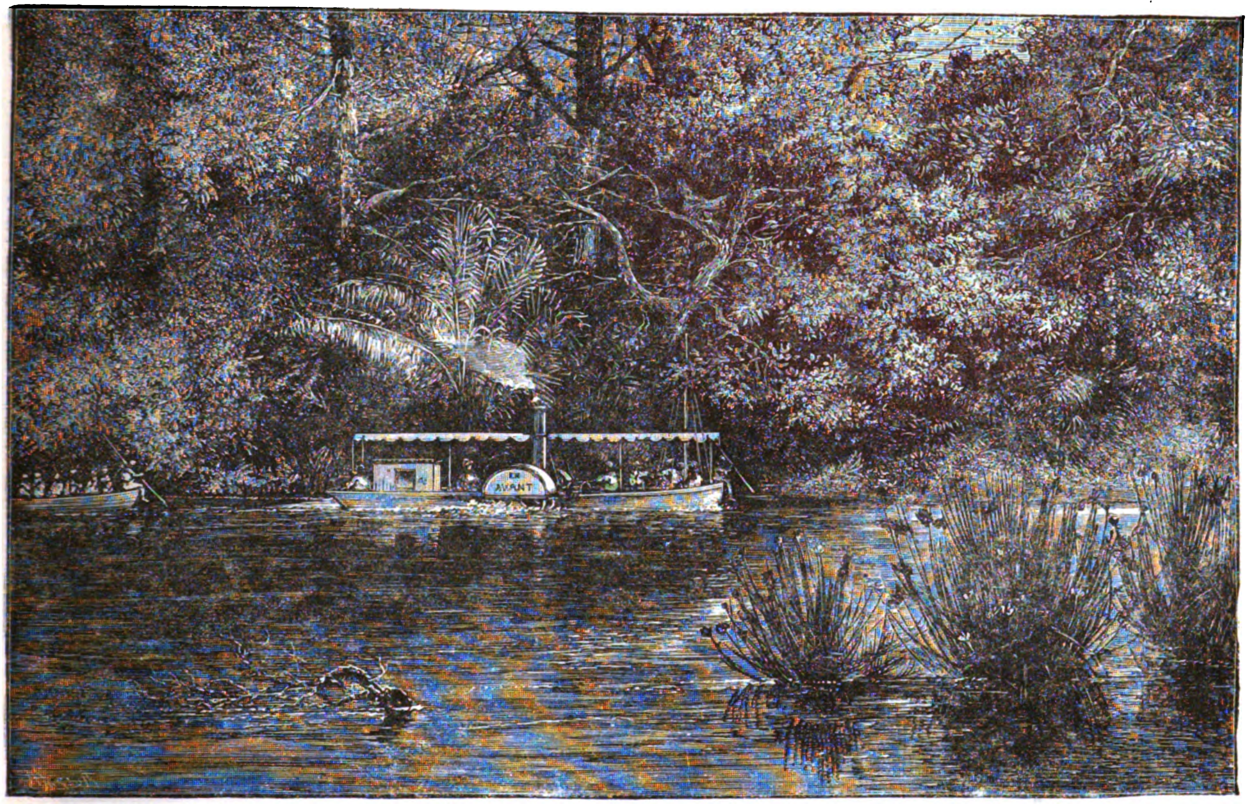


FIG. 4.—Banks of the Upper Congo.

the Europeans, and is only possible with a run home every eighteen months. Thus it is clear that if the resources of the Congo are to be developed, it must be by native labour, and there is therefore every inducement to treat the population humanely.

Of course, Mr. Stanley himself in his frequent journeys

Fig. 5.—A Type of the Basoko.

up and down the river has added considerably to our knowledge of it. His original sketch of its course, made in one rush downwards, seems, however, to have been wonderfully accurate; though the hundreds of observations as to direction, altitude, depth, and width has enabled him to lay it down with much greater precision. It is to be hoped that the geology of the basin will be well worked out, and even from a "utilitarian" standpoint it might be useful for the Association to engage one or two competent men to work out the geology. The numerous cataracts on the lower as well as on the upper river prove that there is much here to interest the geologist. On the lower river, just where the great central plateau begins to shelve down to the coast, they are to be expected; but what is the exact geological explanation of the numerous cataracts on the upper river and its tributaries, as far south as Bangweolo, let us hope, will ere very long be explained. The banks of the river itself are in many places remarkably picturesque; indeed Mr. Stanley would make us believe that he thinks no other river is equal to it in this respect. Magnificent bluffs, he tells us, are met with in many places, and gorges that are almost *cañons*. At Stanley Pool and elsewhere the river has broadened out into lake-like reaches studded with islands, and at one place a few miles south of the equator there is a complicated offshoot of lakes and streams which reminds one of what is observed in so many places on the Central and Lower Amazon. This stretch has not, however, been completely explored, though Mr. Stanley's account of his journey up the Kwa and Mfini to Lake Leopold is one of the most interesting chapters in the volume. The Kwa discharges at about 3° S. lat., and Lake Leopold, Mr. Stanley joins conjecturally to Lake Montumba, which is connected with the Congo at about fifty miles south of the equator.

With regard to the volume of discharge of the Congo, from careful observations made at Stanley Pool, Mr. Stanley calculated that it reached 1,436,850 cubic feet per second when the river at that point was at its lowest. During flood it rises, he believes, twelve feet higher, giving a volume of 2,529,600 feet per second. If these estimates are correct, then Mr. Stanley calculates that the river discharges into the sea three million cubic feet of water per second.

Mr. Stanley's new work is so fully occupied with the details of the founding of his numerous stations, his dealings with chiefs and people, his road-making and other engineering enterprises, and the general work of engineering the enterprise, that there is little space left for geographical details. He does give a list of the products of the Upper Congo region, but as this is entirely from a commercial standpoint, its value to science is not great. The various species of palms, as might be expected, abound on the banks of the river and its islands, the oil-palm being the most valuable from a commercial point of view. Then come the various species of india-rubber plants, besides other gum-producing trees. Ivory, Mr. Stanley reckons only fifth in rank among the natural products of the Congo. He presumes that there are

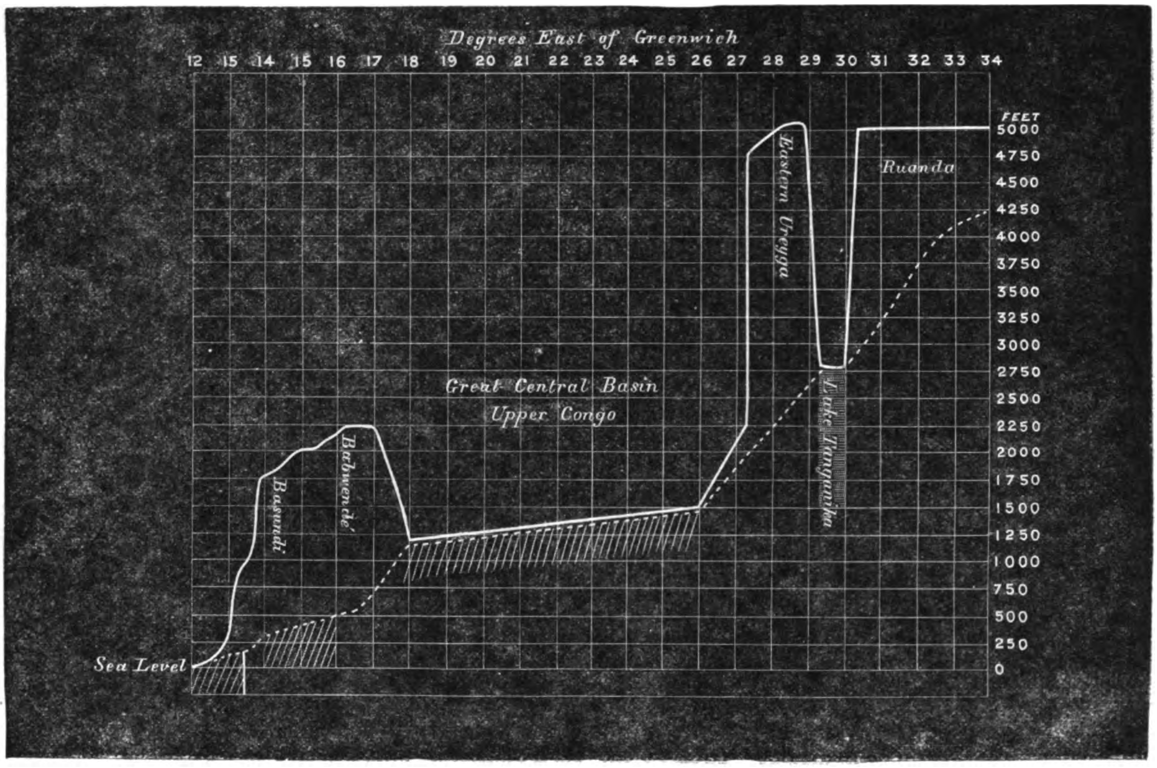


FIG. 6.—Profile of Country between the Sea and Ruanda, across the Congo Basin.

almost 200,000 elephants in about 15,000 herds in the Congo basin, each carrying an average of 50 lbs. weight of ivory in his head. Iron, he tells us, is abundant. The copper mines near Philippeville supply a large portion of Western Africa with their ingots. Plumbago is also abundant, and gold has been found in the beds of streams. Mr. Stanley gives a long list of tropical plants which abound in the Congo basin, while several European vegetables and fruits have been found to thrive. The Arabs, moreover, he tells us, are introducing the large-grained upland rice with extraordinary success. He adds many details concerning the trade, actual and possible, of the Congo region, his object, of course, being to show that here exists a magnificent field for the European trader, European capital, and European settlers.

Mr. Stanley's work is chiefly of value as telling the story of one of the most unique and interesting enterprises on record. This story he tells with abounding interest; there are many incidents throughout the volume told with the dramatic effect so well known to readers of "Through the Dark Continent." The work of founding the Free State has been well begun, but it is only the beginning; for the sake of its complete success it is to be hoped that nothing may occur to sever Mr. Stanley's connection with it until it has been firmly established.

NOTES

THE Royal Society's *conversazione*, held on the evening of June 10, was a very great success, and those who had the labour of bringing the various things together must have felt themselves amply rewarded by the great interest taken in them by the Fellows and guests, both ladies and gentlemen, who attended. Among the objects exhibited we may note the following:—Geological map (unpublished) of Palestine and Arabia Petræa, exhibited by Prof. Edward Hull, F.R.S.; original drawings of the skeletal, digestive, and vocal organs of birds, made in the years 1842-46, drawn and exhibited by Prof. W. K. Parker, F.R.S.; Sketches of the eclipse of the moon, October 4, 1884, and a very beautiful series of sketches of the wonderful sunsets and after-glows, painted and exhibited by Mr. W. Ascroft; star-charting by photography (enlarged prints rom negatives made in 1883 and 1884), exhibited by Mr. A. A.

Common, F.R.S.; electrical influence machine, exhibited by Mr. James Wimshurst; New microscope with novel fine adjustment and sub-stage arrangements, exhibited by Mr. Crouch; large Nicol prism polariscope, for projecting axes of crystals, &c., on the screen (improved form), exhibited by Messrs. Harvey and Peak; Tate's calculating machine, exhibited by the inventor. By means of this machine long operations in the fundamental rules of arithmetic can be performed with rapidity and unfailing accuracy. Eight figures can be multiplied by eight figures in about fifteen seconds. New forms of spectroscopes, exhibited by Mr. A. Hilger; photographs of fractures of railway carriage and waggon axles, tested to destruction by Mr. Thos. Andrews, Wortley Iron Works, near Sheffield, exhibited by Mr. Andrews; three cases of living animals: (1) Examples of the Tuatera (*Sphenodon punctatus*) from New Zealand. This reptile is remarkable as deviating from all the lizards in its osseous structure, and is considered by Dr. Günther (*Phil. Trans.*, 1867, p. 620) to constitute an order by itself—*Rhynchocephalia*. (2) Large bird-eating spider of the genus *Mygale* from Burmah—probably *M. fasciata*. (3) Butterflies and moths, showing the way in which living insects are exhibited in the Zoological Society's Insect House, exhibited by the Zoological Society of London. A series of microscopic sections of vegetable tissues, prepared and lent by Mr. J. E. Sunderland, of Hatherlow, near Stockport, showing remarkable effects of double and triple anilin staining; a series of botanical microscopic preparations, mounted by Charles Vance Smith, of Carmarthen, being part of a series prepared by him to illustrate the text-books of Julius Sachs and Otto Thomé, exhibited by Prof. Moseley, F.R.S. A series of slides with stained specimens of *Tænia echinococcus* of the dog, prepared and lent for the occasion by Dr. J. Davies Thomas, of Adelaide, Australia, in illustration of his paper on the artificial rearing of this parasite by feeding with human hydatids (to be read before the Royal Society, June 18); a slide showing the same species of tape-worm, reared by Mr. Edward Nettleship, F.R.C.S., by means of hydatids obtained from the lungs of a sheep (*Proc. Roy. Soc.*, 1866). To compare with the above:—Specimens, in bottles, of *Tænia serrata*, *T. marginata*, and *T. cœnurus*, &c., artificially reared by Dr. Cobbold, by feeding dogs with the scolices appropriate to each particular species. Also adult examples of *Tænia cucumerina* and of *T. canis lagopodis* (*T. littera a*), the latter from Iceland, prepared by Dr. Krabbe, *Bothriocephalus dubius*, and other species from the cat and dog, exhibited by Dr. Cobbold, F.R.S. Case of gems, including a great Indian diamond, the largest known opal, a series of cat's eyes, and allied mineralogical specimens, exhibited by Mr. Bryce Wright, F.R.G.S.; "Frith's Selenium Cells," showing the alteration of resistance and photo-electric currents due to the action of light on selenium, exhibited by Prof. W. Grylls Adams, F.R.S; a sulphur cell, the electrical resistance of which, like that of selenium, is reduced by light, exhibited by Mr. Shelford Bidwell. The sulphur has been heated while in contact with silver, and therefore contains some sulphide of silver. The electrodes are of silver. The original integrating machine, invented by Mr. C. V. Boys; engine-power meter which has been developed from the same, exhibited by Mr. Boys.

We give in another column, on the *audi alteram partem* principle, the first part of an address recently given by Dr. Janssen, putting before us the French view of the Prime Meridian question. It will be gathered from it that the feeling in France is strongly against the conclusion at which the Washington Congress arrived. Taking the world as it is, however, much as a strictly neutral prime meridian might be to be desired, the general opinion will probably be that the Congress arrived at the only *practical* solution.

We are glad to see that University College, Liverpool, is about to appoint a Professor of Engineering. An endowment of 375*l.* has been raised, and the advertisement of the Chair appears this week in our pages. We understand that a certain amount of professional work, such as is consistent with a due fulfilment of the duties of the Chair, will be permitted, and recognised as enabling the Professor to keep himself in touch with the life of the practical world. The College already has endowed Chairs of Mathematics, Physics, Chemistry, and Biology, in addition to the Literary and Medical Departments: it has lately become a part of the Victoria University, and in many ways it shows signs of health and vitality.

In the production of the first part of the Philological Society's new English Dictionary, the editor, Dr. Murray, was obliged to advance 150*l.* out of his own resources, and, further, to incur a debt of 500*l.* The delegates of the Clarendon Press, who are publishing the Dictionary, decline to contribute more than 100*l.* towards the payment of this debt, and the Council of the Philological Society deem it their duty, therefore, to appeal to the public to relieve Dr. Murray from a debt incurred on behalf of what is really a national undertaking. It is to be hoped that there will be no difficulty in obtaining the sum required; those of our readers who are inclined to help should send their subscriptions to Mr. Benjamin Dawson, the Mount, Hampstead, London, N.W.

The Spanish Commission of Medical Inspection has examined the composition of the liquids and virus employed by Dr. Ferran against cholera. The opinion of the majority of the members is that the presence of Koch's *Bacillus virgulus* cannot be questioned. After some opposition, the Spanish Government granted the necessary authorisations for inoculation, which has been practised on a number of doctors and four newspaper writers. It is said, moreover, that all the inoculated patients experienced during the first twenty-four hours after the operation all the symptoms of cholera with more or less intensity, but without any fatality having occurred. When twenty-four hours had elapsed, a favourable reaction took place. The question which remains to solve is the extent of the protection resulting from Dr. Ferran's system. The numbers given are in favour of the new theory, but all the documents coming from Spain on cholera must be received with caution, owing to the intense panic prevailing in that country since the last outbreak of the plague was noticed in Valencia. A fact curious to notice is the tendency of the rural populations of this province to congregate in the cities in spite of all the measures taken against this exodus. *El Imparcial* states that not less than 7000 people have located themselves in the chief city.

Prof. Pasteur, the *Standard* Paris correspondent states, has published an interesting letter from Dr. Ferran, concerning vaccination for cholera. In this letter Dr. Ferran asserts that the results obtained become every day more irresistibly eloquent. The experience of Alcira had been confirmed in numerous other towns. Anti-cholera vaccination had been practised upon all classes of society, but in many places the greater number of those operated upon belonged to the pauper class, and the results proved no less satisfactory. While of opinion that one inoculation is effective, Dr. Ferran recommends that it be repeated, in order to make assurance doubly sure. In reference to the official prohibition of vaccination for cholera (which has since been cancelled in deference to public opinion), Dr. Ferran intimates that the measure was taken in consequence of two persons belonging to an already cholera-visited family dying the day after vaccination. These casualties Dr. Ferran attributes to the use of impure lymph, and states that in 16,000 cases, for which he had personally inspected the lymph, no evil results had followed. It is not claimed that vaccination for cholera will give actual immunity, but that it will alleviate the attack whenever it may come. Anti-cholera vaccination, affirms Dr. Ferran, can never itself be the cause of an attack. If an attack comes within five days of vaccination it must have been previously contracted. Dr. Ferran attributes the discovery of anti-cholera vaccination to the theories of Prof. Pasteur.

DR. CORNISH, known for his investigations into the nature of cholera, has proposed (according to *Allen's Indian Mail*) that as between 300 and 400 persons are every year judicially sentenced to death in the Indian Empire and its dependencies, a number of these, say one-tenth, be made, with their own full knowledge and consent, subjects of experiments as to the spread of cholera, on condition that if they escape their lives be spared. An international commission of experts might, he suggests, be appointed to determine upon the experimental tests needed to ascertain if cholera is or is not a disease capable of being communicated from person to person. This would do more in the space of a few months to help forward the inquiry into the nature of cholera than has been accomplished by indirect observation during the last century. But if the principle underlying this proposal is admitted by the Indian Government, it might be extended to other most important experiments, such as the various causes and cure of cholera, the cure for snake-bites, hydrophobia, and the like.

THE following is an official statement of the number of visitors to the Whitechapel Fine Art Exhibition during the time it was open in March and April last:—Saturday, March 28, 1008; Sunday, March 29, 2494; Monday, March 30, 2622; Tuesday, March 31, 3332; Wednesday, April 1, 3292; Thursday, April 2, 1823; Good Friday, April 3, 3703; Saturday, April 4, 3269; Easter Sunday, April 5, 2717; Easter Monday, April 6, 4332; Easter Tuesday, April 7, 3720; Wednesday, April 8, 2944; Thursday, April 9, 2872; Friday, April 10, 1942; Saturday, April 11, 3348; Sunday, April 12, 3345; total for 16 days; 46,763. The Exhibition was opened in the afternoon of March 28, admission being by ticket only until 6 p m., 6 to 10 p.m. free; after that it was opened free from 10 to 10 daily (Sundays 2 to 10).

AT the meeting of the International Committee of Meteorology (instituted by the Congress held at Rome) in the beginning of September next, at Paris, the following topics will be considered:—Report of the Secretary on the work of the Committee since the Copenhagen meeting; report of MM. Brito Capello, Hildebrandson, and Ley on the observation of Cirrus; Should a third International Congress be convoked? the establishment of stations of the first order on the Congo; discussion of the meteorological *résumés* issued in different countries, and eventual preparation of a more uniform plan; the utility of American meteorological telegrams proposed by Gen. Hazen, and organisation of their distribution in Europe; best means of securing the timely reception of meteorological telegrams; ought barometric heights to be reduced to the pressure under 45° of latitude? Should meteorological hours be reckoned from 1 to 24 in conformity with the resolution of the Washington Conference? Designation of a completely covered sky as to the form of clouds; definition of days of rain and snow; should not a uniform height above the ground be recommended for pluviometers? recent progress in the more exact measurement of snow; international meteorological tables; modification of the rules for administration of the International Meteorological Committee. Communications should be addressed to Mr. R. H. Scott, F.R.S., Meteorological Office, 116, Victoria Street, London, S.W.

IN a communication to the Physical Society of Berlin, on April 24 Herr Kayser read a note concerning his experiments on the condensation of gases on surfaces, and Bunsen's criticisms thereon. In a paper published last year Bunsen had declared that the previous results under this head were erroneous, inasmuch as the observers had proceeded upon the false assumption that a maximum of condensation was attained in a few hours or days, Bunsen himself finding that the condensation might go on slowly for years. Herr Kayser, however, had, in reply, pointed out that Bunsen had not been sufficiently careful in cleaning the glass surfaces on which his experiments were made, and he now had the satisfaction to announce that Bunsen, after repeating his experiments with the necessary precautions, had arrived at the same conclusion as himself, namely, that there was no demonstrably slow condensation, but that the maximum of condensation was reached with extraordinary rapidity.

THE project to build a "Grassi-Museum" has now assumed a tangible shape at Leipzig, inasmuch as the site for the new museum has been chosen. The new museum is to contain the collections belonging to the Ethnographical Society, which are now crammed into premises entirely unsuitable for them.

DR. OTTO ZACHARIAS has recently made interesting researches concerning the freshwater fauna of the Silesian Riesengebirge and the county of Glatz. The Royal Prussian Academy of Sciences has just granted him a sum of money towards the continuance of his labours.

MR. HOWARD NEWTON, assistant municipal engineer, of Singapore, has published a series of notes and experiments on the different kinds of timber in ordinary use in the Straits Settlements. The pamphlet contains observations on the forests adjoining our colonies in the Malay Peninsula, and the need already of conservation. The trees are felled in large numbers for ordinary use, and the jungles are cleared and exhausted by the Chinese gambier and pepper planters. Twenty specimens of woods are then described in detail, and finally an account of the mode in which the experiments were conducted and elaborate tables of the results follow. The breaking weights of some of the timbers tested were as follow:—1850, 1836, 1656, 1374, 1286, and 1284 lbs. Notes on the toughness, fracture, deflection, &c., are also given. It is curious to notice that some of the finest trees near Singapore (in the Johore forests) have no botanical equivalents. Mr. Newton specially mentions a tree called by the Malays the *ballow*, which grows from 60 to 100 feet in height, with a diameter of 3 to 6 feet. It is a close-grained, tenacious, hard, heavy wood, very valuable for building. It is called popularly Johore teak, although it does not belong to the natural order *Verbenaceæ*.

THE Russian Geographical Society has awarded a gold medal to M. Klossowski for his work on thunderstorms in Russia. We take the following from M. Rykatcher's analysis of this remarkable work. The initiative of thunderstorm observations having been taken by the Geographical Society in 1871, no less than 1821 regular observations were made during the years 1873 to 1882 at 176 different stations. For 145 of them annual and monthly averages were calculated, and gave the following interesting results. The minimum of thunderstorms (5 to 7 per year) is found in the north; their number increases towards the Gulf of Finland (with a depression south of it) and on the middle Volga, where it reaches 12 to 15 per year, and remains nearly the same throughout middle and southern Russia, with a slight decrease in the Crimea. A rapid increase in the number of thunderstorms is found in Western Russia, especially in Bessarabia (33 at Kishineff), as also in the East, at Tamboff, Penza, and on the Lower Don. The maximum of thunderstorms, 41 per year, is found at Tiflis. As might be expected, the thunderstorms are more frequent where the summer rains and the relative humidity are the greatest. Their diurnal maximum is between

3 and 6 p.m., and the minimum between 3 and 6 a.m. Availing himself of the synoptical maps of Hofmeyer for 1874 to 1876, the author compares, day after day, the thunderstorms with the cyclones which reach Russia, and he arrives at the important conclusion that thunderstorms in Russia—without exception—accompany cyclones, their appearance being influenced at the same time by the local state of temperature and humidity. Marié-Davy, Mohn, and others subdivided thunderstorms into cyclonic and local ones, and the continental ones were reckoned to the second category; but M. Klossowski shows that even in so continental a climate as that of Russia, thunderstorms depend also directly on cyclones. They appear on the borders of the cyclones and mostly in their south-eastern quarters. By further researches, the author arrived at the conclusion that thunderstorms in Russia are secondary or tertiary cyclones appearing on the borders of a cyclone, and thus explains the oscillations of the barometer during thunderstorms, already noticed by Messrs. Scott, Mascart, and others. Hail is obviously closely connected with thunderstorms. It also accompanies cyclones and is always concentrated in its south-eastern quarter, in the zone of 750 to 760 millimetres' pressure. On the whole, the work of M. Klossowski is a valuable contribution to the study of electrical energy in the atmosphere.

IN a lecture delivered in the Institute of the Khedive at Cairo, Dr. G. Schweinfurth has given some account of the seats of manufacture of prehistoric stone implements in the desert of Eastern Egypt discovered by him in 1876 and 1877, and again visited and examined by him in his last journey. The two spots referred to are in the Wadī Sanur and Wadi Warag. The former lies due east of Beni Suef at a distance of thirty miles from that town; the latter is in the upper portion of the Wadi at the place where this water-course begins to be discernible as a longitudinal depression on the heights of the western part of northern Galala. Dr. Schweinfurth's belief that the two sites in question are really those of ancient manufactories of stone implements is grounded partly on the presence of accumulations of cores in the beds of the streams, partly on the fact that the raw material is found abundantly in the neighbourhood. The source of the raw material is a bed of flints belonging to the upper nummulitic limestone corresponding to that which exists behind Cairo. Implements and utensils indicating a stone period have now, Dr. Schweinfurth remarks, been found even in the very heart of Africa, and these show a surprising resemblance in form to those discovered in Europe. Those recently obtained by himself from Sanur and Warag, however, are of a special type, and Dr. Schweinfurth regards them as clearly distinguished from the forms already familiar by the fact that the facets are usually only upon one side and are very seldom seen surrounding the entire core.

IN connection with the trial of Pel for poisoning, which has just resulted in Paris in the condemnation of the accused, some interesting experiments were conducted at the Morgue with a view to testing whether it was possible, as alleged by the prosecution, that the murderer could have got rid of the body of one of his victims by burning it piece by piece in a common stove. The professional witnesses stated that they procured a body weighing sixty kilogrammes. They removed from it forty kilogrammes of organic matter, and lighted a fire of wooden logs. They thus ascertained that in an hour the complete reduction to ashes of one kilogramme of organic matter could be effected, and in forty hours the complete combustion of a body weighing sixty kilogrammes could be completed. The accompanying smell was not disagreeable. The bearing of this on the question of cremation is obvious. It is possible to consume the human body by fire at a comparatively small expense, as these experiments show. In Japan, where cremation has been practised for ages, the quantity of wood consumed in the cheapest cremation is so small that European doctors doubted the evidence of eye-witnesses. Cremation of the lowest class costs only two shillings, on account of the small quantity of wood used, and the operation generally lasts from six to nine hours. The smell for a considerable distance around the crematorium is, however, of a very offensive kind, and the accessories are, as a rule, far from agreeable. There is, however, no doubt that the body can be consumed at a far less expenditure of fuel than is generally considered possible.

THE following appears in the *Times*:—Last autumn, a bookseller named Meyer, of Ronneburg, tied a water-proof label under the wing of a swallow which had occupied a nest at his house, and had become comparatively familiar. On it he wrote a query in German to the effect that he wished to know where the swallow would pass the winter. The bird returned to its former nest bearing an exchange label similarly fastened, saying, in German also, "in Florence, at Castellari's house, and I bear many salutations."

THE Austrian Government has refused to authorise the establishment of private cremation societies, on the ground that they might encourage crime. The decree states that murders are often detected by the exhumation of bodies, and that, even if bodies were to be examined before cremation, there would be no time to apply in every case those delicate chemical tests which are used where poisoning is suspected.

A TELEGRAM from Tiflis states that a severe earthquake has occurred in the Eastern Caucasus. The town of Sikuch is said to have been completely swallowed up. The loss of property is estimated at several million roubles.

THE latest telegrams from India state that the Cashmere earthquakes continue to occur with increased severity. It is reported that 2280 persons have perished in the district of Muzufusabad.

INFORMATION has been received at the Hague from Java that the state of Krakatoa was causing some anxiety. Towards the end of April subterranean sounds were heard in the neighbourhood day after day, and flames arose from the crater. The rocks which emerged from the sea during the last eruption suddenly disappeared.

FROM a report of Mr. H. Walker, Commissioner of Lands of British North Borneo, it appears that gold exists in considerable quantities in that territory. Some natives had brought a little to Sandakan, and Mr. Walker set out to verify its existence in the Sagama district. He searched thirty or forty different places and found gold at almost every place, generally in small distinct specks, large enough to be gathered with the fingers, sometimes larger, and always in conjunction with a black metallic dust and iron or copper pyrites. The rocks met with were granite, gneiss, quartz, limestone, jasper, porphyries, red sandstone. Steps will probably be taken to have the whole region thoroughly examined by a competent geologist. The minerals already ascertained to exist in North Borneo are gold, silver, copper, chromium, tin, plumbago, lead, and coal. Antimony and cinnabar are reported. On the west coast chromium, copper, and arsenic have been found; in the neighbourhood of Kinabalu silver ore and pyrites; a sample of native copper has been sent to London; a rich sample of galena and silver, yielding on assay 115 ounces of silver to the ton, has been found. Hitherto the officials of the Company and the other Europeans on the coast have been dependent for local information respecting these and other minerals on the rough statements of natives. It appears certain, however, that, besides its great forest and agricultural wealth, British North Borneo is also rich in minerals—how rich cannot be said until a thorough examination by an expert has been made.

ACCORDING to the *San Francisco Courier* the great glacier of Alaska is moving at the rate of a quarter of a mile per annum. The front presents a wall of ice 500 feet in thickness; its breadth varies from three to ten miles, and its length is about 150 miles. Almost every quarter of an hour hundreds of tons of ice in large blocks fall into the sea, which they agitate in the most violent manner. The waves are said to be such that they toss about the largest vessels which approach the glacier as if they were small boats. The ice is extremely pure and dazzling to the eye; it has tints of the lightest blue as well as of the deepest indigo. The top is very rough and broken, forming small hills, and even chains of mountains in miniature. This immense mass of ice, said to be more than an average of a thousand feet thick, advances daily towards the sea.

IT is contemplated to use the electric light in Algiers for night work during harvest time, in order to escape the heat, which is almost murderous for Europeans, and is an obstacle to their carrying on agricultural work.

THE borings undertaken for scientific purposes in the shaft situated near the railway station of Koetzschau, about five miles from Lützen (Germany), have now reached the depth of 1500 metres. Observations of temperature are now being made in the shaft.

THE Norwegian Government has voted a sum of 50*l*. to Dr. O. J. Olsen for the prosecution of his studies of wild edible mushrooms.

THE education of girls in Russia does not appear to stand very high. According to the *Moskow Viedomoski* only 21 children out of 100 attending school were girls. The proportion varies with the religion. Thus, of Protestants the number was greatest, viz. 45·4 per cent.; of Jews, 34·1 per cent.; and of Roman Catholics, 14·4 per cent. The number is lowest amongst Greek Catholics, viz. 12·3 per cent.

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin Monkey (*Cebus albifrons* ♂) from South America, presented by Mr. E. Luxmore Marshall; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. A. R. Brown; a Martinique Gallinule (*Ionornis martinicus*), captured at sea, presented by Mr. G. S. Webb; two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Montevideo, presented by Miss Buist; a Red and Blue Macaw (*Ara macao*) from Brazil, presented by Mr. J. W. Beswick Purchas; a Yellow Conure (*Conurus solstitialis*) from Venezuela, presented by Mr. Albert H. Nicholson; a Barn Owl (*Strix flammea*), British, presented by Mr. W. Ostle; an Æsculapian Snake (*Coluber æsculapii*) from Central Europe, presented by Miss Lenox Conyngham; a Domestic Sheep (*Ovis aries*, var. ♂) from Somali Land, deposited; two Larger Tree-Ducks (*Dendrocygna major*) from India, two Gould's Monitors (*Varanus gouldi*), two Great Cyclodus (*Cyclodus gigas*), two Carpet Snakes (*Morelia variegata*), three Diamond Snakes (*Morelia spilotes*) from New South Wales, received in exchange; a Japanese Deer (*Cervus sika*), three Pigmy Hogs (*Porcula salvania*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMETARY ORBITS.—Prof. J. G. Galle has formed a most useful and very complete catalogue of orbits of comets which have been calculated since the publication of the third edition of Olbers's "Methode zur Berechnung der Cometenbahnen" in 1864. This catalogue appears in Nos. 2665–66 of the *Astronomische Nachrichten*. In one table are collected orbits of comets before 1860, which have been more definitively determined during the past twenty years, with a few orbits of ancient comets computed for the first time or founded upon better data, including those observed by Toscanelli; in a second table are contained the most reliable orbits of all comets discovered since the year 1860. The elements are given in an approximate form only, but in the notes accompanying each table reference is made to the place of original publication. Prof. Galle's *résumé* will be of much service to the student in this branch of a tronomy. It appears to have been drawn up on the suggestion of Prof. Krüger, seeing that there was no immediate intention of publishing a fourth edition of Olbers's celebrated treatise. Five newly-detected comets of short period figure in the second table.

BINARY STARS.—The following calculated angles and distances of several of the more rapidly revolving double-stars will serve to indicate how nearly measures made about the present time are represented by the best available orbits:—

Star	Epoch	Pos. °	Dist. "	Authority for orbit
ζ Cancri	1885·0	62·0	0·93	Seeliger
	1886·0	57·6	0·95	
η Coronæ Bor.	1885·5	173·9	0·61	Doberck
	1886·5	182·2	0·65	
ζ Herculis	1885·5	90·3	1·49	Doberck
	1886·5	85·3	1·50	
μ^2 Herculis	1885·5	285·6	0·80	Doberck
	1886·5	296·5	0·76	

Dubjago's orbit of β Delphini (Burnham 151) gives for 1885·6, Pos. 238°·1, Dist. 0"·28.

TYCHO'S NOVA OF 1572.—Some years since it was shown by Prof. Wolf that this object was observed by Lindauer at Winterthur on November 7, 1572, and it is equally certain that it was seen by Maurolycus at Messina at its meridian transit on the following evening, though there appears to be some confusion between altitude and declination in his published description. It was not seen by Tycho until November 11.

In 1808 the Abbé Scina, in a work printed at Palermo, entitled "Elogio di Francesco Maurolico," referred to his observations of this star, apparently given in the first instance in a special treatise written by Maurolycus (*Judicium de nova stella*), to which Lalande alludes in his Bibliography, and subsequently in 1613 in a life of the astronomer written by his nephew. According to Clavius, Maurolycus thus records his first observation of the star: "Hanc ego stellam in hoc Messanæ horizonte observans in meridiano extantem circa tertiam noctis horam, reperi altitudinem ejus esse 62. Unde conjecturam feci eam locari quasi, in summitate circuli arctici, ut distet hic a meo vertice per gradus 28, ac proinde ab æquatore per gradus 66½ fere, quoniam Messanæ latitudo habet gradus 38½, et eam sitam in puncto, in quo colurus æquinoctiorum secat arcticum circulum, aut ipsi puncto vicinissimum."

According to Argelander the place of the star for 1573·0 was in right ascension 0h. 1m. 52s., declination 61° 46'·4; the sidereal time at mean noon at Messina on November 8 was 15h. 49m. 50s., and consequently the star was on the meridian at 8h. 10m. 41s. mean time, or at 8h. 24m. 46s. apparent time, 3h. 24m. after sunset, and, the latitude of Messina being 38° 11', the meridian altitude was 66° 25', which was the distance from the equator given by Maurolycus. Nevertheless the Abbé Scina did not agree with Piazzi's suggestion that there was a typographical error in Clavius, and that 61½° should be substituted for 66½°. The only alternative, however, would point to an error of 4° or 5° in the observation (or estimation), and Scina writes of Maurolycus at this time that he was "très-avancé en âge (il avait alors 78 ans) dépourvu d'instrumens, accablá d'infirmités." . . . Zach sought unsuccessfully for the special work by Maurolycus, as well as for his "Life" by his nephew; Lalande gives no particulars of the former, and hence recourse has to be had to Clavius, who, as stated above, made some extracts from the *Judicium*.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, JUNE 21–27

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 21

Sun rises, 3h. 45m.; souths, 12h. 1m. 30·5s.; sets, 20h. 18m.; decl. on meridian, 23° 27′ N.: Sidereal Time at Sunset, 14h. 19m.

Moon (Full on June 27, 11h.) rises, 14h. 14m.; souths, 19h. 44m.; sets, 1h. 5m.*; decl. on meridian, 8° 24′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	3 12	11 29	19 46	23 33 N.
Venus	4 38	12 58	21 18	23 51 N.
Mars	2 4	10 0	17 56	20 26 N.
Jupiter	9 6	16 13	23 20	12 9 N.
Saturn	3 43	11 52	20 2	22 30 N.

* Indicates that the setting is that of the following day.

Phenomena of Jupiter's Satellites

June	h. m.		June	h. m.	
21	21 9	I. occ. disap.	25	22 30	III. ecl. reap.
22	20 47	I. tr. egr.	27	20 23	I. tr. ing.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich

June	h.	
21	—	Sun at greatest declination north; longest day in northern latitude.
24	8	Mercury at least distance from the Sun.
26	20	Venus at least distance from the Sun.
27	15	Mercury in superior conjunction with the Sun.

GEOGRAPHICAL NOTES

The last issue of the *Isvestia* of the Russian Geographical Society (xx., 6) contains an interesting paper, by M. Kosyakoff, topographer, who accompanied, in 1882, Dr. Regel during his journey through Karategin and Darvaz. The paper deals almost exclusively with the topography of the explored region, and thus gives a plain description of the explored routes, containing the necessary topographical data for forming an opinion on the much-debated questions as to the orography of that part of the Pamir region. A route-map, on the scale of ten miles to an inch, accompanies the paper. Starting from Penjkent, M. Kosyakoff soon reached the 9800 feet high lake, Kouli-kalam. Then he crossed the 12,000 feet high and snow-covered Badkhana Mountains which separate the Zarafshan from the upper Surkhab, tributary of the Fan, and continuing to make his way amidst deep and rocky mountain-gorges, he soon reached the lake, Iskander-kul, 7120 feet above the sea-level. Thence, crossing the Mura Pass, richly clothed with vegetation on its northern slope, the expedition descended to Karatag and Hissar, and, by a route quite suitable for carriages, they proceeded further to Kabadian. A good route along the Waksh River brought Dr. Regel and his travelling companions to Kurgantube; but, to reach Koulab, they had to cross the Tash-robat Pass, all covered from top to foot with pistach trees. From Kulab, which is more animated than Kabadian, the expedition went to the rich Mumin-abad Valley, peopled with Tadjiks agriculturists; thence to the twenty-five villages of the Dara district, and, continuing their journey north-east on the right bank of the Pendj, they soon reached Kala-i-khumb. The Pendj River being there but thirty-five miles distant from Tavil-dara on the Waksh, the expedition went there before proceeding further up the Pendj, and followed the upper Waksh in a north east direction for some fifty-five miles. From Kala-i-khumb, M. Kosyakoff made a further very interesting excursion up the Pendj and its tributary, the Vantch, up to its source, whence he was compelled by a fever to return to Kala-i-khumb and thence to Samarcand. The map published by the *Isvestia* contains, moreover, the very interesting route from Tavil-dara to Bal-juan, and thence to Hissar, and further west to Baisoun, Anar-bulak, and Yar-tube.

Among the works announced for this year by the Russian Geographical Society we see the last fascicule of the valuable "Geographical and Statistical Dictionary of Russia;" the atlas of maps to accompany Baron Kaulbars' work on the delta of the Amu-Daria; a geognostic map of the shores of Lake Baikal, by M. Chersky; the work of Dr. Sperck on the Amur region; and a work by M. de Vollan on the songs of Ugrian Russians. There is promised, also, the long-expected results of the great survey of Siberia, from the Ural Mountains to Lake Baikal, accomplished in 1874. The commander of the expedition having died since, the work had to be given for calculations to other persons; but now the name of M. Tillo, who has undertaken its publication, is a guarantee that this capital work will not be lost to science.

Dr. Fischer, of the University of Marburg, the author of a monograph on the climate of Mediterranean countries, read a paper before a recent meeting of the Verein für Erdkunde at Halle on the morphology of the coasts of the Mediterranean, which is reprinted in the *Hallische Zeitung*. "The Mediterranean," he said, "was specially important for some investigations into physical geography, for it has been the theatre of a long history, and we have therefore information about its coasts extending over many centuries. Although it washes the shores of three continents, this sea exhibits a striking similarity in its *fauna* and *flora* everywhere. It must, therefore, in its present form, belong to one of the most recent geological periods, even though particular basins may be much older. It owes its origin to great movements in the crust of the earth, and the form of its coasts is attributable to the same cause, modified by more recent influences. In the present coast formation in the north-western basin, two different types are perceptible, which may most conveniently be designated as the North Sicilian and the Languedoc types. If we follow the coast of Italy from Naples, then the Sicilian and North African coasts around to the Straits of Gibraltar, we meet with twenty-two smaller bays having the form of a semicircle. Their sizes do not vary greatly, the chord of the smallest being 15 km., that of the largest 65, and that of the great majority between 30 and 35 kms. Over this extent the coasts are almost everywhere precipitous, and a short distance from the shore the sea deepens rapidly. How has this formation arisen?" Quoting Suess's "Das Antlitz der Erde," Dr. Fischer said, "there appeared to be all along this coast a great fissure in the crust of the earth. The formation of the Appennines, the Atlas and the occurrence of volcanic phenomena along the whole line would point to this. But this would not account for the bays here mentioned; many of these are probably due to the sea washing away the softer from amongst the harder rocks. The projecting headlands are hard, old, crystalline rocks, while inside are the newer and softer kinds. These inlets, too, are not found everywhere along the coast, but only where the harder rocks are present. That the coasts here are greatly exposed to denudation by the action of the waves is shown by the numerous caves and cliffs, and the violent surge which beats against the vast harbour-works of the French on the coast of Algeria. The prevailing winds there are north and north-east, and thus assist the waves. Another factor is the current, which flows eastwards along the north coast of Africa from the Straits of Gibraltar. This meets the projecting capes and headlands, which deflect part of it into the bays, creating in the latter a counter-current which acts as a scour, keeping the bottom free from alluvium, and also exercising its influence on the semi-circular formation of the inlets. The Bay of Tunis is an exception. This is much deeper than the others, and the currents cannot therefore exercise the same influence over it. The alluvium is deposited, the River Medjerda brings down its contribution, and the result is a constant formation of land there. This bay belongs rather, on this account, to the second type, existing on the Mediterranean coasts of Northern Italy and Languedoc. The Tuscan coast was originally similar to that of Lower Italy, but it has now been altered beyond recognition. Here, to the west of the Appennines, there is a wide district with easily-denuded rocks. The rivers, especially since man has so disafforested the region, bring down vast quantities of alluvium. The current which flows into the Tyrrhenian Sea is deflected northward along the coast, and causes the deposit of the alluvium inshore, so that the ancient bays are gradually silting up. In ancient times the shores of this now harbourless sea had numerous bays, and Tyrrhenians were skilful navigators. At the mouth of the Arno the operation is best seen. Pisa, which was founded as the port on the sea at the mouth of the river, was no longer on the coast in Strabo's time, and is now some distance inland. The land-formation on the coasts of Languedoc is even more striking. In former times there were steep shores, protected by a row of islands, behind which lay a calm inland sea, on which the city of Narbonne was built. The sea silted up from inside and out—from inside by the rivers, from outside by the currents created by the frequent south-east winds which conveyed the alluvium of the eastern rivers, especially the Rhone, and deposited it there. The islands became joined to the land, and the inland sea disappeared. Thus arose on these coasts the flat plains, behind which are small lakes and marshes.

AT the meeting of the Paris Geographical Society of May 22 further information was read respecting the expedition of M. Teisserenc de Bort to explore the Sahara. Leaving Tuggurt, they marched south-south-west to Hassi Ouled Milond, the last point visited by the Flatters mission. Thence, passing through Bereçoff, they ultimately reached Gabes. Near Ghourd-Rouned M. de Bort found well-marked traces of an old lake of sweet water, about a kilometre long, and 700 or 800 m. wide. In the depression thus created there were evidences of a prehistoric station in numerous flint arrow-heads, and from this point to Gabes the presence of man at a very ancient epoch was attested by chipped flints.—M. de Quatrefages read a paper on the Red Indians, and on the half-breeds of the United States and Canada. The position which the writer maintains is that the Indians do not diminish so rapidly as is generally believed, as, for example, the Maoris. The half-castes are put in the census as whites; Indian women married to whites are similarly counted. "Placed in favourable conditions, the Redskins, far from diminishing in number, have increased, and are increasing. But they have not preserved their ethnic purity. Mixture with white blood has taken place even in the most remote tribes, and perhaps now the number of natives of pure blood is insignificant everywhere; but, on the other hand, the blood of the natives is mixing more and more with that of the whites, and the latter accept more easily day by day the half-breed as one of themselves." Although the Red Indians are disappearing as such, they will still live in the future true Anglo-American race. M. Henri Condreau gave a succinct account of six journeys which he made between 1881 and 1885 in Guiana. The writer is Professor at the Lycée at Cayenne, and performed two of these journeys during vacations; the others were undertaken at the request of the Governor of French Guiana. The most important one was from Manaos through the whole of Central Guiana, between the Rio Negro and Cayenne. He had already performed two-thirds of his task, and passed the sources of the Trombette, when he lost all his articles for barter amongst the Indians, and was deserted by his followers. During four months he was alone amongst savages, ultimately arriving at his destination by a forced march of thirty days through the virgin forest.

BEFORE the Society of Commercial Geography in Paris, M. Andreau described the prairies of Guiana which he traversed in his journey between the Rio Negro and Cayenne. Behind the enormous forests which extend inland from the coasts he found prairies wholly devoid of trees, where the air was dry and the climate mild. He strongly advocated the establishment of agricultural colonies there, describing the climate as in all respects the reverse of that found on the coast.

THE well-known African traveller, Major Serpa Pinto, is stated to have discovered large coal-fields south of the Rovuma River. The Rovuma is a coast river, and its estuary is situated about 11° S. lat. Along its banks runs the ancient caravan route from Cape Delgado to Lake Nyassa. The coal-fields were first claimed by the Sultan of Zanzibar, but have now been taken possession of by the Portuguese Government.

A SCIENTIFIC expedition under the charge of Lieut. Hovgaard, of the Danish Navy, is being prepared to investigate the eastern coasts of Greenland. M. Gamel, the owner of the vessel, has put it at M. Hovgaard's disposal, and the Danish Government will pay the cost of the expedition.

M. HANSEN-BLANGSTED has reported to the Geographical Society of Paris that the first steamer coming directly from the open sea arrived at Cologne on March 18. It is called the *Industry*, belongs to a company of Mannheim, and is of 513 tons burden. "This is an event important not only for Cologne, but also for every town on the Rhine."

PROF. KARL GOTTSCHE, of the University of Kiel, has just returned from his travels in Eastern Asia. After having lectured on Mineralogy and Geology for several years at Tokio, he undertook a scientific exploring expedition in Korea, at the request of the Korean Government, which lasted until December, 1884. His route extended over 3000 kilometres. Dr. Gottsche intends shortly to publish his geological, mineralogical, and ethnographical investigations of Korea. To our knowledge this is the first scientific investigation of the great East-Asiatic peninsula.

DR. H. Z. C. TEN KATE departed on May 18 from Southampton. He goes to the interior of Surinam, where he intends to devote himself to anthropological and ethnological studies. A grant has been given to him by Dr. Riebeck (Halle a/S) and Prince Roland Bonaparte.

A TELEGRAM dated "near Herat, June 9," states that, pending the settlement of the frontier question, the Frontier Commission is exploring and mapping out the country in all directions.

ON THE MESOZOIC FLORAS OF THE ROCKY MOUNTAIN REGION OF CANADA[1]

IN a previous memoir, published in the *Transactions* of the Royal Society of Canada, vol. i., the author had noticed a lower cretaceous flora consisting wholly of pines and cycads occurring in the Queen Charlotte Islands, and had described a dicotyledonous flora of Middle Cretaceous age from the country adjacent to the Peace River, and also the rich Upper Cretaceous flora of the coal formation of Vancouver's Island—comparing these with the flora of the Laramie series of the North-West Territory, which he believed to constitute a transition group connecting the Upper Cretaceous with the Eocene Tertiary.

The present paper referred more particularly to a remarkable Jurasso-Cretaceous flora recently discovered by Dr. G. M. Dawson in the Rocky Mountains, and to intermediate groups of plants between this and the Middle Cretaceous, serving to extend greatly our knowledge of the Lower Cretaceous flora and to render more complete the series of plants between this and the Laramie.

The oldest of these floras is found in beds which it is proposed to call the Kootanie group, from a tribe of Indians of that name who hunted over that part of the Rocky Mountains between the 49th and 52nd parallels. Plants of this age have been found on the branches of the Old Man River, on the Martin Creek, at Coal Creek, and at one locality far to the north-west on the Suskwa River. The containing rocks are sandstones, shales, and conglomerates, with seams of coal, in some places anthracitic. They may be traced for 140 miles in a north and south direction and form troughs included in the Palæozoic formations of the mountains. The plants found are conifers, cycads, and ferns, the cycads being especially abundant and belonging to the genera Dioonites, Zamites, Podozamites, and Anomozamites. Some of these cycadaceous plants, as well as of the conifers, are identical with species described by Heer from the Jurassic of Siberia, while others occur in the Lower Cretaceous of Greenland. The almost world-wide *Podozamites lanceolatus* is very characteristic, and there are leaves of *Salisburia sibirica*, a Siberian Mesozoic species, and branches of *Sequoia smittiana*, a species characteristic of the Lower Cretaceous of Greenland. No dicotyledonous leaves have been found in these beds, whose plants connect in a remarkable way the extinct floras of Asia and America and those of the Jurassic and Cretaceous periods.

Above these are beds which, with some of the previous species, contain a few dicotyledonous leaves, which may be provisionally referred to the genera *Stercula* and *Laurus;* and still higher the formation abounds in remains of dicotyledonous plants, of which additional collections have been made by Mr. T. C. Weston. The beds containing these, though probably divisible into two groups, may be named the Mill Creek series, and are approximately on the horizon of the Dakota group of the United States geologists, as illustrated by Lesquereux and others. The species are described in the paper, and differ for the most part from those of the Dunvegan group of the Peace River series, which is probably of the age of the Niobrara group, and, of course, still more from the overlying Laramie group. With regard to the latter, the author adduced some new facts confirmatory of his previously expressed view as to the position of the Laramie at the top of the Cretaceous and base of the Eocene, and also tending to show that some of the plants still held by certain palæo-botanists to be of Miocene age are really, in Canada at least, fossils of the Laramie group, and consequently considerably older than is currently supposed. The collections of plants studied by the author had for the most part been placed at his disposal by the Director of the Geological Survey.

HYDROMECHANICS

THE last of the series of lectures at the Institution of Civil Engineers during the session of 1884–85 on "The Theory and Practice of Hydromechanics," was delivered on Thursday

[1] Read before the Royal Society of Canada, May, 1885, by Sir William Dawson, C.M.G., LL.D., F.R.S.

evening, May 7, by Sir Edward Reed, K.C.B., M.P., on "The Forms of Ships." The President, Sir Frederick Bramwell, F.R.S., occupied the chair.

In the course of his address the Lecturer briefly explained the great development which the science of fluid resistance had undergone of late years, largely owing to the labours of Stokes, Rankine and others, but more largely still to those admirable investigations which had been carried out under the patronage of the Admiralty by the late Dr. William Froude, and subsequently by his son, Mr. R. E. Froude. He likewise explained the very great effect which those investigations had produced in the Royal Navy, owing to the judicious and prompt adoption of Froude's results by the Admiralty Constructors. Stress was laid throughout the lecture upon the importance of adjusting the form and proportions of ships not only to the loads which they have to carry, but likewise to the weight of the materials entering into their structure. It was a common error to judge of the merits of steamships by the relations which exist between their displacement, steam power, and speed, as expressed by formulæ of various kinds. Approximations to the theoretical form of least resistance were sought by some naval designers, and all considerable departures from that form were regarded as objectionable. The Lecturer, on the contrary, pointed out that no such theoretical form was any true or proper guide for a naval designer, since every change in the average weight of the hull necessitated a corresponding change in the form and proportions of the ship, and the great merit of a designer often was that he adopted forms differing widely from the abstract forms of the schools, and presenting a very inferior appearance when put into what are known as "Constants of Performance." This was illustrated by examples derived partly from actual ships and partly from calculations made for the purpose. Two actual warships were compared, one attaining the high figure of 213 marks when examined by the received formulæ, and the other gaining but 172 marks; yet in the Lecturer's view the latter was far and away the better ship, because she performed precisely the same service as the other, being inferior in no respect, and yet had cost less than the other by £114,000, and expended no more steam-power in attaining an equal speed. The Lecturer remarked that he should probably have regarded the abstract "form of least resistance" with more respect but for the circumstance that the designing of armoured vessels in which he was much engaged is "a branch of naval construction of much too concrete and ponderous a character to admit of any dalliance with abstract or fancy forms." He went on to express his regret that, owing largely to the restrictions which granite docks imposed upon naval constructors, and to the absence of iron floating docks capable of receiving ships of any form, and owing to other causes likewise, the construction of armoured ships—by which he meant ships which had a sufficient volume protected above the water to keep them afloat and upright while the armour remained intact—had been abandoned, and the first place upon the sea had been offered to any nation which had the courage and the will to assume it. In his opinion this was a purely voluntary abandonment, and was not the result of any scientific or economic necessity. He admitted that great changes in forms and proportions were very desirable in our great line-of-battle ships; for example, a great increase of breadth was necessary in order to economise the side armour, and to keep the ram and torpedo at ample distance from the boilers and magazines, which should be protected by an inner citadel, so to speak, well removed from the outer one. But so far was true science from presenting obstacles to these and other important changes, it actually invited these very changes, and increase of beam in particular had been shown by Froude to facilitate the attainment of practical invulnerability combined with very high speed. Size and cost were among the bugbears of our naval administration; by the true engineer they were always regarded as secondary to great and noble objects, among which objects he included the naval pre-eminence of our country. At any rate, there was no engineering obstacle whatever to England constructing and sending to sea, not merely those great and swift but delicate and fragile Atlantic hotels in which the British Navy is now to embark and fight, for the want of something better, but also war-ships—real war-ships—almost as invulnerable as these islands themselves, and capable of bearing the once-proud flag of England boldly into the waters of any enemy whatever.

On the motion of the President, a cordial vote of thanks was passed to Sir Edward Reed for his interesting and instructive lecture.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the second part of the Natural Science Tripos the examiners have placed the following in the first class in alphabetical order:—Men: Acton (Botany), St. John's; Eve, B.A. (Physics), Pembroke; Fitzpatrick (Physics), Christ's; Gordon (Physiology), Trinity; Shore (Physiology), St. John's; F. M. Young, B.A. (Physics), Trinity.

The Senior Wrangler, Mr. Berry, of King's College, was a student at University College School and College; the Second Wrangler, Mr. Love, of St. John's, was educated at Wolverhampton Grammar School. The Wranglers, thirty-four in number, are alone eligible to compete in the third part of the Mathematical Tripos a year hence.

In the Natural Sciences Tripos, Part I, the following were placed in the first class, in alphabetical order:—Men: Bury, Trinity; Couldridge, Emmanuel; Edgeworth, Caius; Evans, F. P., St. John's; Oliver, F. W., Trinity; Rolleston, St. John's; Seward, St. John's; Walters, H. G., Trinity. Women: Freund, J., Girton; Willoughby, C. A. J., Newnham.

The University Lectureship in Mathematics, lately held by Prof. J. J. Thomson, will be filled up by the General Board of Studies and the Special Board for Mathematics early in the Michaelmas Term.

It is proposed, in dealing with the increased income of the Craven Fund, to establish a new Studentship of 200*l.* a year for research in the Languages and History of Ancient Greece and Rome and the Comparative Philology of the Indo-European Languages; the Studentship to be tenable for one year, but a student might be re-elected on not more than two occasions.

It is proposed still further to systematise and improve the courses of local lectures in populous centres, and to give students University certificates and exemptions in all cases where satisfactory work has been done, instead of confining these special privileges to affiliated Colleges. The majority of the courses given in the past winter have been scientific, and the work continues to extend, under the energetic administration of Dr. R.D. Roberts. Much difficulty exists in some of the most promising centres, where the students (miners and artisans) are poor, in providing funds. There ought to be no difficulty in persuading colliery proprietors and manufacturers to find the money needed.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, 5me Fascicule, 1884.—On ancient superstitions still surviving among the Bretons, by M. Bonnemère. An interesting paper, showing among many other proofs of superstition that the peasantry believe in the possession by certain individuals, whom they characterise as "Ribotteurs," of the power of injuring others by causing their milch cows to lose their milk. The so-called "Ribotteurs" are believed to acquire this power by roaming naked through the fields on the night of April 30 to gather, at early dawn, the May dew, in which dwells the malevolent property of drying up the milk of cows.—On the uni-discoidal placenta of a mandril, by M. Chudzinski.—On the degree of atrophy of the olfactory nerves compatible with the persistence of the sense of smell, by M. Mathias Duval. The writer draws attention to the number of cases in which a post-mortem examination has proved the atrophy, or even total absence, of olfactory nerves, although there had been no apparent defect in the sense of smell during life. M. Dally is of opinion that in such cases an excess of the gray matter of the brain at any one point may serve to supplement a deficiency in some other cerebral region. —M. Topinard presented to the Society a copy of his great chart of the relative heights, registered among the conscripts and in the public schools of different parts of France.—Report of proceedings at the first meeting of the "Conférence Transformiste," organised last year in memory of Darwin. In accordance with the scheme of the Conference an address was to be annually delivered by a member of the Anthropological Society of Paris, who was to indicate the influence which Darwinian ("Transformist") views had had on the special branch of scientific inquiry which the lecturer prosecuted.—This year's address in the Physical Section of the Conference was delivered by M. Duval, who chose for his theme the evolution of the eye from the early development of the visual organs among the lower animals. His treatise is profusely illustrated by admirable diagrammatic woodcuts.—In the Psychical Section of the Conference M. Letourneau treated of the evolution of morality, tracing the rise and progress and various fluctuations of the moral sense among different races.—M. Pozzi, in announcing the decision of the Committee for awarding the Broca prize, explained that he and his colleagues had selected the works of three among the numerous competitors, viz. MM. Collignon, Chudzinski, and Testut, as of pre-eminent merit. The prize was, however, unanimously awarded to the last-named, M. Testut's great work, "Muscular Anomalies in Man explained by Comparative Anatomy," having secured him this distinction both on account of its able and exhaustive character and its great literary merits. The selected essays of MM. Collignon and Chudzinski, treated respectively of the "anthropometric differences of the leading races of France," and of the "Anatomy of the Negro." In his address M. Pozzi gave a summary of M. Testut's work, of which he spoke in terms of unqualified praise, both as regards the methods with which his observations had been conducted, and the manner in which the results were compared and tested.—Report of the eulogy on Paul Broca, delivered by M. Dally on the day the Broca prize was awarded for the first time. As an old friend and colleague, M. Dally, in his historical and literary notice of the life and works of Broca, was able to give many hitherto unknown particulars, which add largely to the interest of his address.

Bulletins de la Société d'Anthropologie de Paris, 1er Fascicule, 1885, containing *résumé* of the rules, organisation, and actual condition of the Society, with lists of members, affiliated societies, and recent obituary, &c., &c., &c. Among the works presented to the Society at its inaugural meeting, 1885, special notice is due to the "Elements of General Anthropology," by M. Topinard, who here gives a *résumé* of his lectures at the School of Anthropologie since 1876; the "Gitaños of Spain and Portugal," by M. Bataillard; "Ethnic Mutilations," by M. Magitot; and "Cannibalism among the Red-Skins," by M. Letourneau. In regard to each of these, the authors treated at great length of the objects aimed at in their respective works, the character and scope of which they fully explained.—M. Chudzinski presented the Society with the cast of the deltoid muscle of a negro, showing an anomalous separation of the bundles, which had a Simian character.—M. Delisle drew attention to an ox's head belonging to *Bos indicus* of Senegal, in which a perfectly developed horn protruded from between the nasal bones.—A paper by Dr. Hoffman, of Washington, on a curious relic found in South California, supposed to have been a case for keeping the colouring-matters and instruments employed in tattooing.—On the Quaternary deposits of Rosny (Nogent-sur-Marne), by M. Eck. Among these finds are fine teeth of *Elephas primigenius*, *Rhinoceros tichorhinus*, *Equus*, &c.—Report by M. Gouïn, of Cagliari, on the skulls and objects found by M. Issel in the recently-opened cave at Orreri, in the Island of Sardinia. M. Issel believes, from his study of the prehistoric remains of Western France, Spain, and the basin of the Mediterranean generally, that these and the finds at Orreri all point equally to the diffusion of a primitive race, which was extant in the Canary Isles within historic times.—On Laos, by M. P. Neis, who explored the Laotian territory bordering on Cambodia in 1882-84. The author, as a French official, enjoyed exceptional advantages for travelling in Cochin China and the neighbouring districts, and his careful study of the character and habits of the people has enabled him to collect much interesting information regarding the distinctive anthropological and social characteristics of the different races of Indo-China. M. Neis sees no ground for the opinion that these races exhibit traces of a Negrito element, but he draws attention to the fact that everywhere the Mongol is displacing the Thay and other ancient nationalities, although this is most evident in the territories between Mam-on and Tonkin, and he believes that, unless the King of Siam takes prompt measures to stop this invasion, Siamese supremacy and French authority will be alike endangered.—Ceylon and its inhabitants in ancient and modern times, by M. Beauregard. The author derives his materials from English sources.—On the caves of Saumoussay, by M. Bonnemère, who believes that these grottoes served in prehistoric ages as a tannery.—On the measurements of the long-bones as a basis for the reconstruction of the entire skeleton, by M. Topinard, with plates of the osteometric instrument used by Broca.—On will, considered from a physiological point of view, by M. Fauvelle.

SOCIETIES AND ACADEMIES

London

Royal Society, May 7, with a note added May 12.—"On the Electric Resistance of a New Alloy named Platinoid." By J. T. Bottomley, M.A., F.R.S.E.

In the course of a series of experiments on the electric resistance of various metals and alloys and in particular on the variation of the electric resistance of these metals and alloys with temperature, the author has examined a new alloy (called by the inventor "platinoid"), which has turned out to have important properties.

This alloy is the invention of Mr. F. W. Martino, of Sheffield, who kindly supplied specimens of the metal, and wires specially drawn down to the finer gauges for experiments.

Platinoid is practically German silver with the addition of a small percentage (1 or 2 per cent.) of metallic tungsten. The tungsten is added in the form of phosphide of tungsten, a considerable percentage of which is in the first place fused with a portion of the copper. The nickel is then added; and then the zinc and the remainder of the copper. The mixture requires to be re-fused more than once, and during the process the phosphorus and a considerable portion of the tungsten originally added is removed as scoriæ. In the end there is obtained a beautiful white alloy, which is platinoid. When polished the alloy is scarcely distinguishable in appearance from silver. To test the quality claimed for it as to being untarnishable, the author has been keeping ornamental specimens lying exposed to the ordinary town atmosphere; and has satisfied himself that the alloy has a very remarkable power of resisting the tarnishing influence of the air of a large town.

It is, however, the electric resistance of platinoid that has chiefly interested the author. German silver wire has proved of great use in the construction of galvanometer coils and resistance coils, on account of two important properties, viz., its very high resistance and the smallness of the variation of its resistance with change of temperature. Both those properties are possessed in a still higher degree by platinoid alloy.

The resistance of German silver differs considerably in different specimens. It is commonly stated to be $21{\cdot}17 \times 10^{-6}$ B.A. ohms between opposite faces of a centimetre cube at 0° C.;[1] or, reducing to legal ohms, $20{\cdot}935 \times 10^{-6}$ legal ohms between the opposite faces of a centimetre cube. The following table shows the resistance of a number of specimens of platinoid wire:

Specifying number	Diameter in decimals of a centimetre	Cross Section	Resistance legal ohms per metre	Resistance between opposite faces of a centimetre cube legal ohms.
16	·1610	·0204300	·181	$36{\cdot}98 \times 10^{-6}$
17	·1430	·0160200	·202	32·36
18	·1230	·0119400	·288	34·38
19	·1110	·0096770	·353	34·16
20	·0865	·0058760	·555	32·61
A	·0595	·0027180	1·250	$34{\cdot}76 \times 10^{-6}$
B	·0495	·0019240	1·707	32·85
28	·0402	·0012690	2·605	33·06
29	·0340	·0009070	3·412	30·94
32	·0290	·0006605	4·371	28·87
36	·0220	·0003801	8·219	31·24

It appears from these results that the specific resistance of platinoid is about *one and a half* times that of German silver.

The experiments on the variation of resistance of platinoid with temperature were carried on in the following way. The specimen of platinoid to be tested was wound on a wooden bobbin, on the surface of which a screw had been cut, and the spires of the helix were kept separate by lying between the threads of the screw. This coil was immersed in a bath of oil, and was connected in series with a known wire of German silver, the temperature of which was kept constant, and with a single Daniell's cell. The differences of potential between the two ends of the platinoid wire and the two ends of the German silver wire were determined by applying the electrodes of a a high-resistance galvanometer. The ratio of the differences of potential is the same as the ratio of the resistances of the two wires.

[1] Given by Prof. Fleeming Jenkin, F.R.S., as expressing the results of Matthiessen's experiments.

In the following table is shown the ratio of the resistances of a specimen of platinoid wire at different temperatures to its resistance at zero. The wire used was the same as that specified as No. 20 in the table of resistances. The length of the wire experimented on was about four-fifths of a metre. The only trouble in the experiment was the keeping the oil-bath, which was filled with linseed oil, thoroughly stirred, and of uniform temperature throughout.

Temperature.	Resistance. The Res. at 0° C. being = 1.
0°	1·0
10	1·0024
20	1·0044
30	1·0075
40	1·0066
50	1·0097
60	1·0126
70	1·0134
80	1·0166
90	1·0188
100	1·0209

This gives for the average percentage variation of resistance per 1° C., between the temperatures 0° C. and 100° C., the number 0·02087. A second wire tested very carefully in a similar way gave for this average percentage variation between 0° and 100°, 0·022 per degree, with a steadily increasing rate of variation from the beginning.

To compare this increase in resistance due to increase of temperature with that observed in other metals and alloys, we find that the percentage increase of resistance for 1° C. at 20° C. for copper is 0·388, platinum-silver alloy 0·031, gold silver alloy 0·065, and for German silver 0·044. These numbers were obtained by Matthiessen in the course of his experiments for finding a suitable metal or alloy for the purpose of constructing the British Association standards of electric resistance. It appears that the variation of resistance of platinoid with temperature is very much smaller than the smallest observed for any of the metals and alloys then examined.

The modulus of rigidity, the Young's modulus (or modulus for elastic longitudinal extension), and the breaking weight for platinoid wire were also determined. The wire used was a portion of that marked *A* in the foregoing table. This wire is a little larger than No. 24 of the Board of Trade standard wire gauge, and has a diameter of 0·0595 cm.

The rigidity modulus was found to be $4751·8 \times 10^6$ grammes weight per square centimetre. The Young's modulus is $1222·4 \times 10^6$ grammes weight per square centimetre.

The breaking weight is about $6·029 \times 10^6$ grammes weight per square centimetre.

The specific gravity of platinoid wire has also been found by the author to be 8·78 compared with water at 20° C. Platinoid when drawn hard is softened, like copper, by heating and sudden cooling.

Physical Society, May 23.—Prof. Guthrie, President, in the chair.—Dr. A. H. Fison was elected a Member of the Society.—The following communications were read:—Experiments showing the variations caused by magnetisation in the length of iron, steel, and nickel rods, by Mr. Shelford Bidwell. The subject of the extension and retraction of bars of iron and nickel under the action of magnetic force has been investigated by Drs. Joule and A. M. Mayer, and by Mr. Barrett. In the present experiments the magnetising force has been increased, with the result of bringing out some striking and novel characteristics. The apparatus employed consisted of a vertical magnetising helix considerably longer than the experimental rod, the latter forming the central portion of a compound rod, the two ends being of brass. The lower end of this rod is plane, and stands on a firm support; the upper end is a knife-edge, which bears against a brass lever 18 cm. in length, about 1 cm. from the fulcrum; the portion of the rod to be examined is in the central portion of the helix. The above lever is furnished with another knife-edge at the end, which acts in a similar manner on a second lever, at the extremity of which is a small mirror. A lamp and vertical scale being placed at a distance of 470 cm., the slightest motion of the mirror could be read with great accuracy, an elongation of the bar, amounting to 1-100,000th mm., being easily detected. A few of the more important results are as follow:—In the case of soft iron the bar continually increased in length till nearly saturated, up to which point Mr. Joule had traced it, but then it reached a maximum, decreased, and continued decreasing to the limit of the experiments, at which point the retraction was about double of what the extension had been. The effect depended upon the thickness of the bar, an increase of diameter diminishing the maximum extension, and increasing the critical magnetising force, or that force which produced the maximum extension; the results seemed to show that this extension varied inversely as the square root of the diameter of the bar. The general behaviour of steel was the same as that of soft iron, but the critical point varied with the hardness and temper of the metal, appearing to be a minimum for steel of yellow temper. The results of experiments upon nickel coincided with those obtained by Prof. Barrett, the effect of magnetisation being to cause a continuous retraction greater than that obtained with soft iron. In answer to Prof. Hughes, who believed that the effect of the coil was always to produce *retraction* of the bar, the *extension* at first being due to the molecular arrangement of the particles during magnetisation, Mr. Bidwell further described an experiment showing that the action of the coil was to produce the *extension* of a magnet. Two thin strips of soft iron fastened together at the ends, their central portions being about 2 cm. apart, were placed in the coil. On making the current the ends were drawn out, the sides coming together. Prof. Forbes suggested that the effect of thickness was really owing to the irregularity of magnetisation produced by the ends, and that in future experiments the middle of the bar only should be examined.—On the spectral image produced by a slowly rotating vacuum-tube, by Mr. Shelford Bidwell.—Note on the action of light in diminishing the resistance of selenium, by Mr. Shelford Bidwell. As the result of the investigation upon the behaviour of selenium, Messrs. Adams and Day arrived at the conclusion that it conducted electrolytically. Since this would necessitate the assumption that selenium is not an element according to accepted theories, caution must be exercised in accepting this. It seemed possible, however, that since the selenium in the cells had always undergone a prolonged cooking in contact with the metal terminals, selenides of these metals might exist in the selenium, forming a kind of network, and thus affording conduction through the mass, which, without the cooking, is non-conducting. It had not been possible to test this directly, but a somewhat analogous case had been tried. Some precipitated silver had been heated for some hours with sulphur, and the clear liquid poured off. A cell was then made by coiling two silver wires side by side upon a strip of mica, the spaces between the wires being filled with the prepared sulphur, which would contain a small quantity of sulphide of silver. It was found necessary to reduce the resistance of the cell by placing a small strip of silver leaf over the sulphur and cooking again. The cell thus prepared was very sensitive to light: by burning a piece of magnesium near, the resistance was reduced to one-third. Mr. Clark said that Mr. Bidwell's cells probably contained sulphides of copper or silver, substances which the researches of Faraday had shown conducted electrolytically in the solid condition. On the other hand, Cu_2Se and Ag_2Se conducted like metals and were probably often present in the ordinary selenium light cells. Mr. Clark thought that Mr. Bidwell's paper raised this question: What influence had light upon the electrolytic conduction of Cu_2S and Ag_2S and upon the metallic conduction of Cu_2Se and Ag_2Se?—On certain cases of electrolytic decomposition, by Mr. J. W. Clark.—The first part of this paper consisted of a critical examination of the behaviour of those substances which have been described as exceptions to Faraday's laws, with the object of generalising as to the condition of internal or molecular structure corresponding to their electrical properties. The second part described an experimental investigation into the nature of the conduction of fused mercuric iodide and mercuric chloride, both of which were stated to undergo electrolytic conduction. Decomposition and re-combination of the products of electrolytic action may, however, follow so closely as to simulate metallic conduction. The first product of electrolytic decomposition of mercuric iodide was stated to be iodine and mercuroso-mercuric-iodide (Hg_4I_6), which latter, under the continued action of the current, yields free mercury. Similarly it was found that fused mercuric chloride, when electrolysed between graphite terminals, split up into chlorine and mercurous chloride. Metallic conduction, *i.e.* conduction without decomposition, in fused compound solids, therefore appears to be unknown.—Note on electrical symbols, by Mr. J. Munro.

Mathematical Society, June 11.—J. W. L. Glaisher, F.R.S., President, in the chair.—Prof. J. Larmor was admitted into the Society.—Mr. Basset read a paper on the potential of an electrified spherical bowl, and on the motion of an infinite liquid about such a bowl, upon which Prof. Larmor made some remarks.—Mr. Elliott communicated a short paper by M. Z. J. Rogers, entitled, notes on the polism of the inscribed and circumscribing polygon.—Mr. Kempe, F.R.S., made a brief communication on pairs of collinear points; and a paper by Prof. Mannheim, liaison géométrique entre les sphères osculatrices de deux courbes qui ont les mêmes normales principales, was taken as read.

Chemical Society, June 4.—Dr. Hugo Müller, F.R.S., President, in the chair.—Mr. Harold Follows was admitted as a Fellow of the Society.—The following paper was read:—On the constitution of the haloid derivatives of naphthalene, by Prof. Meldola.

Anthropological Institute, June 9.—Francis Galton, F.R.S., President, in the chair.—Prince Roland Bonaparte exhibited a large collection of photographs of Lapps.—Mr. P. A. Holst exhibited three water-coloured photographs out of a collection of 240, representing all the tribes of the Russian empire.—Dr. J. G. Garson read a paper on the physical characteristics of the Lapps; and by the permission of the authorities of the Alexandra Palace, the family of Lapps now being exhibited there were present in the room with their sleigh, reindeer skins, and dog. The group consists of three men, two women, and two young children. The average height of the men is 5 feet 1½ inches, that of the women 4 feet 11½ inches. The chief characteristics of the Lapps may be said to be their low stature, round heads, and large cranial capacity.—Prof. Keane read a paper on the Lapps: after glancing at their origin, ethnical relations and nomenclature, explaining the perplexing terms Lapp, Finn, Same, &c., the Professor proceeded to describe their present habitat, their national and political divisions, and population; not more than about 30,000 Lapps remain, and their number appears to be diminishing. Their social usages were then described, and allusion made to their reindeer, dogs, sledges, snow-shoes, and tents, and the paper concluded with an account of their religion, education, present condition, and future prospects.—A paper by Dr. H. Rink on Eskimo dialects was taken as read.

EDINBURGH

Mathematical Society, June 12.—Dr. Thomas Muir in the chair.—Prof. Tait gave an address on the detection of amphicheiral knots, with special reference to the mathematical processes involved.

PARIS

Academy of Sciences, June 8.—M. Bouley, President, in the chair.—Action of chloroxicarbonic ether on the cyanate of potassium, by MM. Wurtz and Henninger. In an accompanying note it is stated that this important posthumous monograph was mostly prepared in 1875, but that its publication was delayed by the authors in order to complete their researches on various points. After the death of M. Wurtz the work was continued by M. Henniger, who was about to publish the results when he also fell a victim to his arduous labours. In its present form the paper has been prepared and edited by M. Edouard Grimaux.—Memoir on the temperature of the atmosphere and ground at the Paris Natural History Museum during the years 1883 and 1884, by MM. Edmond Becquerel and Henri Becquerel. This memoir forms a continuation of the researches begun twenty-two years ago at the Museum by M. A. C. Becquerel, by means of the thermo-electric apparatus invented by him.—On the geographical distribution of animal and vegetable species as affected by the climatic conditions, the character of the soil, the disposition of land and water, the progress of culture, and other outward influences of the environment, by M. Emile Blanchard.—Propagation of the earthquake shock felt in Andalusia on December 25, 1884, a rectification, by M. F. Fouqué.—On a new order of metallic spectra, by M. Lecoq de Boisbaudran.—Note on a new vegetable type from the lower coralline formations of Auxes, in the neighbourhood of Baune, Côte d'Or, by M. G. de Saporta. This type, by the author named Changarniera, from its first observer, appears to be of lacustrine origin, and to bear a certain relation to the Rhizocaulon from the freshwater chalk-formations of the South of France, still surviving in Provence. It may, perhaps, represent one of those proangiosperm types, the existence of which has only begun to be suspected by botanists.—Note on some recently-discovered documents connected with the infancy of Jean Le Rond d'Alembert, by M. L. Lallemand. These inedited records show that, contrary to Condorcet's statement, d'Alembert was sent to the Maison de la Couche, and placed with a nurse for six weeks in a Picardy village, after which he was consigned to the charge of Jacques Molin (Dumoulin), one of the most distinguished physicians of the time.—On a method of rapidly analysing all the nitrogen contained in substances in the organic, ammoniacal, and nitric state, by M. A. Houzeau.—On a method of employing the sextant in such a way as to obtain by a single observation the simultaneous altitudes or angles of two stars, of a star and the moon, or of a star and the sun, by M. Gruey.—On the convergence of a continuous algebraic fraction, by M. Halphen.—Remarks on the radiations emitted by incandescent carbons, such as those prepared for use in lighthouses for the production of voltaic arcs, by M. Félix Lucas.—Remarks on the apparatus usually employed for the measurement of continuous and other electric currents, by M. Mascart.—A thermo-chemical study of electric accumulators, by M. Tscheltzow.—Note on the action of silver, copper, iron, and some other metals on a mixture of acetylene and air, by M. F. Bellamy. The author's experiments show that in the burner these metals, and especially copper, act on acetylene in the same way that platinum does on hydrogen.—Note on the sulphurets of cerium and lanthane, by M. Debray.—On a new reaction for digitaline, by M. Ph. Lafon. This reaction, which is extremely sensitive, will enable the chemist to distinguish more sharply than has hitherto been possible between the numerous products employed in therapeutics under the general name of digitaline.—Note on aseptol (orthoxiphenyl-sulphurous acid), by M. E. Serrant. For this substance (so named by the author from the Greek negative particle ἀ and σηπτόν, corruption) it is claimed that it will be found three times superior to phenic acid as a practical antiseptic.—On electric alcoholic fermentation, by M. Em. Bourguelot.—Remarks on the tail of the human embryo, by M. H. Fol. From his researches the author is satisfied that during the fifth and sixth weeks of its development the human embryo is furnished with a tail in the strict anatomical sense of the term. Being destitute of all physiological use, this organ must be classed with all other rudimentary members.—On the natural evolution of the cantharides, by M. H. Beauregard. The results are here embodied of three years' research, during which the author has succeeded in clearing up many obscure points connected with the physiological life and functions of these insects.—Note on the extraction and composition of the gases contained in the leaves of plants, by MM. N. Gréhaut and Peyrou.

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THURSDAY, JUNE 25, 1885

THE CHITTAGONG HILL TRIBES

The Chittagong Hill Tribes. Results of a Journey in the Year 1882. By Dr. Emil Riebeck. Translated by Prof. A. H. Keane. (Asher, 1885.)

THE visit paid by Dr. Riebeck to the frontier tribes between Chittagong and Independent Burmah in the spring of the year 1882 formed a mere episode in the great expedition to the Far East, from which he has recently returned, laden with ethnological treasures of all sorts. But this episode, carried out at the suggestion of Dr. Bastian, "prince of ethnologists," proved from a variety of causes so unexpectedly fruitful in results, that he has been well advised to publish a separate account of it, pending the appearance of a comprehensive work on his general travels in Somaliland, India, China, Japan, and other Eastern regions. In its arrangement, profusion of coloured and other illustrations, and especially in the treatment of the subject matter, this first instalment almost reaches the standard of ideal perfection—of such perfection as can be achieved only by patient and intelligent observation, and by the cooperation of specialists in their several faculties combined with a generous use of unlimited means. Certainly the principle of division of labour in literary and scientific work has never been more happily illustrated than in the present instance. Wisely limiting his own functions to those of a laborious collector and narrator of his personal experiences, Dr. Riebeck has placed all his rich materials at the disposal of the foremost naturalists in Germany, by whom the data thus supplied have been made a convenient text for so many separate monographs of great value on the various scientific aspects of the subject.

The work thus comprises, besides the journey itself graphically described by the traveller, four independent treatises—by Dr. A. Grünwedel, on the ethnology; by Dr. Rudolf Virchow, on the anthropology; by Prof. Julius Kühn, on the zoology; and by Herr von Danckelmann, on the meteorology of the hilly region traversed during the expedition.

The trip included altogether two separate excursions, the first from Chittagong up the Karnaphuli river to Pakhoma and Forts Sirtay No. 1 and 2, close to the Burmese frontier; the second, again from Chittagong southwards to the Sangu, up that river nearly to its source, thence across the border to Dalakmey on the Koladan in Arakan, and from that point down the Koladan to its mouth at Akyab. None of these river basins can be described as unknown regions, seeing that they all lie well within British territory, and have been frequently traversed in various directions by Lewin, Hunter, and other explorers, by Government surveyors, and even occasionally by military expeditions. Nevertheless, such is the intricate character of the land, consisting of nearly parallel mountain ranges running close together, mainly north and south, separated by deep intervening river gorges, often densely wooded, and inhabited by a multiplicity of semi-independent hill tribes in almost every stage of social culture, that the broad physical features both of the country and its inhabitants had hitherto been but imperfectly understood, while few of the details had been fully worked out. Hence a rich harvest still awaited our traveller, and the abundant materials collected by him and carefully sifted by his scientific fellow-workers could not fail to prove useful and help to solve some obscure problems in the natural history of the country.

Thus a comparative study of the two Gayal skulls from Chittagong and Arakan enables Dr. Kühn to clear up several questions touching the mutual relations of the gayal (*Bos gavæus*, Colebrooke), the arni or true wild buffalo (*Bubalus indicus*), the gaur (*Bos cavifrons*, Hodgson), and other members of the ox tribe in India and Indo-China. It now appears evident that the gayal or wild ox of Bengal, Assam and Further India does not differ specifically from the gaur of India proper, as George Vasey and others wrongly supposed. "While the wild gayals' skulls show all the features of the gaur, the forms of the tame gayal from the same locality correspond altogether to the normal gayal type as described by its best observer, Hodgson. Room is thus afforded for the surmise that both types characterise, not two distinct species, but forms only of the same species; that consequently gaur and gayal are specifically one, and that the deviations of the latter in its tame form have merely the value of a variation due to domestication."

Of more general interest are the admirable ethnological and anthropological papers of Dr. Grünwedel and Dr. Virchow, whose learned analysis of the data, and especially of the numerous measurements supplied by Dr. Riebeck, throws a flood of light on the many perplexing questions connected with this obscure ethnical domain. Accepting the already-established broad distinction between the Khyoung-thâ or River Tribes, and Toungh-thâ, or Hill Tribes (Lowlanders and Highlanders), a distinction which has more than a mere geographical significance, these anthropologists find that, on the whole, the hill tribes are of purer descent, that is, represent the aboriginal element more closely, than the riverain populations. The latter (Maghs, Chakmas, Toungjinyas, &c.), have become more intermingled with the Bengalese and other intruders from India, and are characterised by a yellower complexion suggestive of Mongol, or perhaps Malay, affinities. The former (Pankhos, Banjogis, Mros, Kumis, Kukis or Lushais, Shos, Shindus, &c.) are of a darker hue, and seem to approach nearer to the Kolarian aborigines of India. At the same time Dr. Virchow is careful to point out that none of these Hill Tribes lend any support to the theory of an aboriginal Negrito element formerly spread over the whole of India and Indo-China, advocated especially by De Quatrefages and other French ethnologists. "According to unanimous testimony they have all black, long, and smooth, but by no means straight, hair, and, although not athletic, their stature still at once separates them from the dwarfish Andamanese and Negritoes. On the other hand, in further inquiry the question cannot be waived whether the Hill Tribes of Chittagong, perhaps also of Nepal, may not, after all, be somewhat nearly related to the primitive 'black skins' of India. The name Dasyu, or

Dasa, recalls in a remarkable manner the word Dzo, applied both to the Lushais and their speech."

On the whole the Lowlanders appear to be closely related to the Arakanese, and consequently to the Burmese, and are characterised by distinctly Mongolic features. They may, in fact, be regarded as a Mongoloid people, intermediate between the true Mongols of Northern and Central Asia and the Malays of Malacca and the Eastern Archipelago.

This section of the subject is illustrated by very complete tables of measurements, and by as many as twenty-six photographs of Lushais, Pankhos, Maghs, Chakmas, Tipperahs, and other highland and lowland tribes.

Dr. Riebeck's account of his experiences amongst these children of nature is extremely graphic, and all the more entertaining that the arrangement with his collaborateurs enables him to eliminate all dry technicalities and strictly scientific matter. At the time of his visit a famine prevailed amongst the border tribes in the upper Karnaphuli basin, causing an irruption of Lushais and others into British territory. Thanks to this circumstance he was enabled to procure many valuable articles from the half-famished people in exchange for a little rice and spirits. The circumstances connected with these transactions are related with a frankness which almost savours of excessive candour. "The brandy I concocted myself," he tells us, "by diluting spirits of wine with water, and colouring it with burnt sugar, thereby producing a still more alluring drink for their uneducated palate. In return, they not only parted with a large quantity of their implements, but also allowed me to take bodily measurements and submitted to be photographed by my fellow-traveller Rosset. If for brandy I had substituted money, this would have soon found its way into the pockets of the Bengali dealers, who cozened and plundered the natives to the utmost. I may therefore be pardoned if I preferred to tickle the palate of the Lushais with fire-water rather than play into the hands of the blood-sucking usurers."

A tropical thunderstorm, by which he was overtaken in the Ruma district, is described in exceedingly vivid language. "The spectacle which now presented itself was one of the most stupendous imaginable. In a few seconds the firmament became completely overcast; then the welkin towered up, looking in the gleam of the electric flashes like mighty sheaves of flame. The weird effect was heightened by the neighbouring woodlands, which were now all ablaze. For the natives had fired the surrounding bamboo-clad hills in order to clear the land for paddy-fields, and sow their rice in the ashes. Thus was mingled the crackling of the burning and crashing bamboo canes with the roaring thunder aloft, the whole producing a din like that of a neighbouring battle-field."

These passages may also serve as specimens of Prof. Keane's very admirable, faithful, and idiomatic translation. It may be mentioned that the German and English editions, both in folio size and splendidly printed, were issued simultaneously by Messrs. Asher, of Berlin and London. The work forms a sumptuous volume which should find a place in every well-appointed library.

THE METEOROLOGY OF BOMBAY

Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1883, *under the Superintendence of Charles Chambers, F.R.S., Rev. Fr. Drechman, S.J., Ninayek Narayen Nene, and Frederick Chambers.* (Bombay, 1884.)

OF the series of volumes entitled "Bombay Magnetical and Meteorological Observations," the present one of forty pages folio is the twenty-fourth. The observations were begun in 1841, and whether we consider the high class character of the observations themselves, the fulness with which they were made from hour to hour, or the long period over which they extend. hey must be regarded as among the very best meteorological records we possess. In the discussion of many of the larger questions of Indian meteorology, such as are from time to time dealt with by the meteorologists of India with so much ability and success, the Bombay observations are simply invaluable; and they are at least of equal importance in the wider questions of the science, and particularly in those cosmical inquiries which have largely engaged the attention of physicists in recent years.

In this report a very satisfactory account is given by Mr. Chambers of the observatory, its position, and surroundings, the instruments in use, and the duties of the various members of the observing staff, all showing that a trustworthiness and an accuracy is secured for the observations which leaves nothing to be desired. Five eye-observations are made every day without exception, at 6 and 10 a.m., and 2, 4, and 10 p.m. In addition to these, continuous registrations are obtained by means of automatic recording instruments, consisting of the magnetographs, the barograph, thermograph, pluviograph, and anemograph, the first four registering photographically and the last mechanically.

From these observations and registrations hourly readings of the various instruments are obtained, and from them the daily means are deduced. These daily means, together with the monthly means, are published in a series of tables appended to the Report. The daily results of the wind observations are given with more than usual fulness,—these consisting of the mean velocity in miles per hour without regard to the direction from which it blew; the aggregate and mean velocities and relative frequency of different winds; and the mean daily velocities of the north or south and east or west components of the winds which blew each day, in miles per hour. At Bombay the greatest mean daily velocity in miles per hour was 31·8 on June 11, and the least 5·2 on October 4; whilst the mean hourly velocity from June to August was 16·2 miles, and from September to May it was only 10·9 miles.

Underground observations are made at depths of 1, 9, 20, 60, and 132 inches below the surface, the first two depths being observed five times daily and the last three once a day, inasmuch as at these depths no diurnal variation is shown. At depths of 1 and 9 inches the monthly maximum and minimum temperatures occurred in December and May, but at the depth of 132 inches these annual phases were delayed till March and July. The mean annual temperature of the air during 1883 was 78°·8, and of the ground, at a depth of 1 inch, 80°·9; 9 inches, 80°·7; 20 inches, 82°·6; 60 inches, 83°·8; and 132 inches, 83°·2. It is desirable that the errors of these underground thermometers were ascertained.

Down to the close of 1864 the hourly observations made at Bombay were published *in extenso*, and these twenty-four years' hourly observations furnish data for the prosecution of many inquiries, the value of which it would be difficult to over-estimate. From 1865 to 1872 the individual observations ceased to be published, but the hourly means for the different elements continued to be published. From these the hourly means of pressure, temperature, humidity, cloud, thunderstorms, &c., can be obtained for a period of more than thirty years. From the beginning of 1873, however, no hourly observations, or even hourly means, appear in the reports, want of funds presumably being the cause of the omission. Irrespective altogether of the length of time over which the observations have been made and the immense value this single consideration gives to the Bombay observations, the position of this observatory with respect to the monsoons and other vital elements of the meteorology of India render the maintenance of a first-class meteorological observatory in this part of the empire indispensable. It is in truth simply necessary in the interests of Indian meteorology and its satisfactory development that the Bombay Observatory be kept in a state of high efficiency, and that the individual observations made there be published and distributed among men of science at least as liberally as they were previous to 1865.

OUR BOOK SHELF

Supplement to "Euclid and His Modern Rivals," containing a Notice of Henrici's Geometry, together with Selections from the Reviews. (London: Macmillan and Co., 1885.)

We noticed the original work at such length in these columns (NATURE, vol. xx. p. 240), that it is not worth while on the present occasion to do more than draw attention to the issue of this "Supplement."

Prof. Henrici's "Congruent Figures" was published nearly contemporaneously with Mr. Dodgson's book, and so he was unable to discuss the methods employed by the Professor, who, in the words of the present preface, "fills the *rôle* of that popular functionary, dear to Parisian diners, *le quatorzième*."

The discussion forms scene vi. of Act ii., and is headed "Treatment of Parallels by Revolving Lines," and an extract, as usual, leads the way from Henrici's Art of Dining (so our humourist puts it), viz. "in order that an aggregate of elements may be called a spread, it is necessary that they follow continuously."

It will thus readily appear to the readers of the "Euclid and his Modern Rivals," or of our account referred to above—which by the way is honoured by a partial reproduction amongst the review-selections—that Mr. Dodgson is still himself, and that his hand has lost none of its former cunning. We should have liked him to have given his opinions on other parts of the Professor's book, but it has not seemed good to the author so to act, and he has confined himself mainly, if not entirely, to the Lobatschewky treatment of parallels. With two such combatants now fairly in the arena, we shall be content to act as a mere onlooker whilst the strife wages fiercely between them, eagerly noting the parry and the thrust, and ready, if need be, to use the sponge as this or that combatant is struck.

It might be a mighty pretty encounter—Modern Treatment versus the Euclidian.

Mr. Dodgson inserts remarks here and there in the text of the reprinted criticisms: he does not notice that a complaint he makes against us was in great part apologised for on p. 404 (vol. xx., see above).

Leitfaden bei zoologisch-zootomischen Präparirübungen. Von A. Mojsisovics Edlen von Mojsvár. 2nd ed. (Leipzig, 1885.)

We are glad to welcome a second edition of this work, which is a very useful manual for museum curators and for demonstrators in the rapidly increasing number of zootomical laboratories. Although it appears to be designed for use in high schools we cannot think that it is likely to displace the manuals already in use in this country: it wants the didactic character of Huxley and Martin's "Elementary Biology," the simplicity and directness of Prof. Milnes Marshall's admirable little book on the "Frog" (which is, we are glad to learn, to be soon followed by others), or the detailed directions of Prof. T. J. Parker's "Zootomy." We may note by the way that these works appear to be unknown to our author, whose knowledge, indeed, of English works on anatomy, or, as Messrs. Wilder and Gage call it, anatomical technology, is very incomplete.

So far as German authorities on "Museologie" are concerned, the second edition appears to have been brought up to date; some additions, not always, however, improvements, have been made in the illustrations; some of the English authors whose works are neglected would have provided the author with a better figure of *Astropecten* than the shocking "representation" which is copied from Bronn. When the third edition is called for we hope we shall find the grave, but perhaps the only important, defect which we have noted corrected and accounted for.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

On Watering the Coal-Dust in Mines

Referring to an explosion that happened at Lievin Colliery in the Pas de Calais on January 14 last, my friend M. Ed. Sauvage, Ingénieur des Mines, writes as follows:—"Some experiments have been lately made at Lievin Colliery (Pas de Calais), where a disastrous accident happened a few months ago. I do not think any report of these experiments has been published; but they found the coal-dust inflammable, and the watering of the ways in the mine has been resorted to as a precaution against future accidents."

Twenty-nine persons were killed by this accident, that is to say, all who were in the mine with the exception of one. The survivor, a miner named Cornet, and one of his comrades, had prepared a blasting-shot for dynamite, and called upon the shot-firer to ignite it. The latter examined the place, pronounced it to be free from fire-damp, and lighted the fuse.

At the inquest Cornet stated that he saw the shot go off, and had just time, by a quick movement, to throw himself under a heap of straw lying near when the explosion took place. He remembered nothing more, and attributed his escape to the partial protection afforded by the straw.

After investigating the case and hearing Cornet's evidence, the Government engineer and those of the Company who owned the mine came to the conclusion that the explosion was caused by the ignition of the coal-dust that had been lying upon the timbers which formed the supports of the gallery. In corroboration of this opinion they pointed out the fact that the current of air which swept through the gallery in which the explosion originated was too swift to admit of firedamp lodging there.

For some years past a system of more or less careful watering has been practised in some of the largest and driest of the steam coal collieries in South Wales as a precaution against explosions —and the recent occurrences at Usworth, Lievin, Camphausen, and Pendlebury seem to show that similar measures are greatly wanted elsewhere.

Should watering the dust (locally in the neighbourhood of blasting-shots, or generally in the workings) ultimately prove to be the panacea for great colliery explosions, then it is obvious that the responsibility for the holocausts that are now occurring lies almost as heavily upon those who, having the power, fail to hasten its adoption, as upon those who continue to offer it a selfish or factious opposition. W. GALLOWAY

The Colours of Arctic and Alpine Animals

I MUCH regret that I have been too busy to reply to my friend, Mr. A. R. Wallace (NATURE, April 16, p. 552), till the present moment, but this delay, unavoidable on my part, is the less to be regretted, since it has given an opportunity for the interesting facts recently adduced by Sig. Lorenzo Camerano (NATURE, May 28, p. 77) to be taken into consideration. As Mr. Wallace, with that keen penetration so familiar to all who know him and his writings, goes to the root of the matter under discussion and raises a distinct issue, I will now beg permission to offer a few words in reply to both these gentlemen.

First, with respect to the physical side of the question, Mr. Wallace is perfectly correct in supposing that colour *per se* has no influence upon the radiating or absorbing powers of bodies as far as regards obscure radiation. But I would point out that in the present case we are not concerned with colour alone; we have not merely to consider whether black or white is the best radiator, but we have for comparison two surfaces, hair or feathers, as the case may be, having, as far as we know at present, the same structure, and differing only in colour. The question before us is whether this colour-difference *in the same substance* is associated with any difference in radiating or absorbing power, and the final answer can only be given by carefully conducted experiments. I may add that I have long been waiting for an opportunity of conducting the necessary investigation, and with aid that has been kindly offered from several quarters I hope before long to be in a position to arrive at some satisfactory conclusion. The form of experiment suggested by Mr. Wallace, although decidedly worth the trial, does not appear to me to be very safe, inasmuch as the natural structure and arrangement of the fur would be lost in the process of weaving into cloth. Mr. Wallace's strictures as to the use of artificial dyes are, however, quite sound, and in these I fully concur. I may further state that when this question was raised some years ago, I searched literature (although by no means exhaustively) to see whether any experiments had been recorded, and although many hundreds of observations upon the radiative and absorptive powers of different bodies have been made by various physicists from the time of Franklin downwards, I have not been able to find any experiment bearing directly upon the question under consideration.

The point to be decided is, not only whether dark hair or feathers are better radiators than white hair or feathers, but whether the radiative power of these white coverings is less for that particular kind of radiation which is most greedily absorbed by the substance (snow) among which the animals have to pass their winter existence. Till this problem is solved physically we have, as it seems to me, only the purely biological considerations to fall back upon.

Before passing on to the more strictly zoological side of the subject I should like to disclaim the notion to which Sig. Camerano's letter may give rise, that the radiative (as distinguished from the protective) theory of Arctic colouring is original as far as concerns myself. With respect to the white covering of the warm-blooded animals, this theory was, as far as I knew at the time, original when first broached in 1880; but Lord Walsingham afterwards showed that the same conclusion had been arrived at in 1846 by Craven, with whose name it should be more fairly associated. The application of this theory (in a reversed sense) to explain the melanism of Arctic insects is entirely due to Lord Walsingham, and as my friend Mr. Wallace is disposed to give the weight of his authority to this extension of the theory, there is no occasion to discuss this point further on the present occasion.

It now remains to point out some of the considerations which have led me to the belief that the protective theory of white colouring is not wholly sufficient. Thus, among birds there seems to be a tendency among the falcons (*F. candicans*, *F. islandus*, &c.) to become white in high latitudes—a mode of coloration which does not appear to me to be of much use in such species. These birds, as far as I know, swoop down on their prey from above, under which circumstances the lighter colouring would be of no advantage in enabling them to approach their prey undetected; on the other hand, it can hardly be maintained that these birds are subject to any persecution which would cause their lighter plumage to be of protective value. When on the wing the back only would be seen by another bird hovering over the falcon, and it is noteworthy that this part of the falcons in question is *darker* than the under side. The same considerations apply to the snowy owl (*Nyctea scandiaca*). In many other birds, again, such as the plovers (*Charadrius pluvialis*, *Squatarola cinerea*, &c.) and various species of *Scolopacidæ* (*Tringa variabilis*, *T. subarquata*, &c.), the under side only changes to white in winter—a change which it is impossible to associate either with protection from foes or with predatory advantage. On the other hand, it seems not unreasonable to suppose (on the radiation theory) that the under side of the bird, being nearest to the snow-covered surface of the ground, would require the most protection. It is of interest also to bear in mind from the present point of view that many mammals are known to become white on the under side during winter. Thus, Surgeon-Major Leith Adams, F.R.S., states in his observations on the natural history of Eastern Canada[1] that "there is, moreover, a seemingly strong disposition for the lower parts of animals to become white in winter —*i.e.* the parts in closest contact with the snow; thus the under surfaces of the deer tribe are always whitest. And, as if from its habit of constantly digging among the snow with its snout in quest of food, we find the cariboo with a white patch on its lips and around the hoof, &c." Such facts as these cannot, as it appears to me, be explained on the protection theory; but if any connection exists between the mode of colouring of an animal and its external conditions of life, the theory of preventive radiation or even the direct action of low temperature on the formation of the pigment seems to be more applicable.

The objections raised by Signor Camerano, although supported by some interesting observations, are, I venture to think, somewhat wide of the mark. The writer, indeed, endeavours to bring within the scope of the radiation theory classes of facts which I for one should certainly never dream of attributing to this cause, even if it had been demonstrated on a sound experimental basis. There can be no question as to the truth of his concluding statement that the causes tending to modify the colours are of an extremely complex character. It is this very complexity, indeed, which renders it so highly important to thoroughly investigate any explanation which bears the stamp of truth, though perhaps applicable to but a very limited group of facts. In view of these difficulties, and bearing in mind the inexhaustible resources of nature in adapting organisms to their environment by apparently opposite means, it is not at all surprising that cases should exist which stand apparently opposed to the particular class of cases here dealt with. There are many conceivable ways of enabling an animal to struggle against a severe climate besides that of lightening the colour of its fur, and natural selection would take advantage of any and every means presented for securing this end. To say, therefore, that some animals become darker in winter (*Cervus mandarinus*), or that others do not change colour at all (*Rupicapra europea*, *Capra ibex*), is no real objection to the radiation theory, but simply an illustration of the principle that there are many ways of securing the same result. Thus, in the case of the two last-named species, Sig. Camerano himself states that there is a great difference in the thickness of the winter covering. Then, again, the statement that a more or less distinct seasonal change of colour is observable in many animals appears to me to have no precise bearing on the question—all that can be said from the point of view either of adaptation or climatic protection is that in such slight mutations we have given to us a hint as to the method by which the more striking seasonal changes have been brought about. We must regard such changes either as the incipient stages of a seasonal variation which could, if necessary, be worked up into a more perfect adaptation (*protective* or *climatic*), or as the vanishing remnants of a seasonal variation formerly important, but now useless. The facts that some animals which are not polar or alpine are *permanently* white, that the

[1] "Field and Forest Rambles," 1873, p. 124.

colours of some Alpine Coleoptera are brighter than those of the warmer plains, and that the species of small islands often show a tendency to melanism, are at present simply inexplicable, but, as far as I can see, do not tell for or against either theory. It would certainly be a strong case against the present view if any animal could be named which became white in winter and was not an inhabitant of a country subject to cold winters. As far as my knowledge extends no such species exists. The light colour of desert mammals is most probably due to predatory advantage—the melanism of desert insects mentioned by Sig. Camerano is, I must confess, a new fact to me, and not at all in accordance with my own limited experience. The strongest objection raised by Sig. Camerano is, perhaps, contained in the statement that in the birds of the Antarctic region black is much more prevalent than in those of the Arctic regions. It is unfortunate, however, that the writer adduces in illustration such countries as Australia and New Zealand, which certainly cannot be considered within the Antarctic region.

In conclusion I should like to emphasize that the theory of climatic protection is not, as Mr. Wallace appears to believe, *opposed* to the theory of adaptation. If my first letter gave rise to this impression, I will take the present opportunity of pointing out that the animal kingdom abounds with cases of what our German colleagues happily call "functional change" (*Functionswechsel*)—that is, the conversion of a character (or function) originally acquired for one purpose to a totally new use. It is thus not at all improbable that a mode of coloration originally acquired as a climatic protection, may afterwards be found to be of adaptive value, so that climatic and natural selection would in such cases work together. I fully concede that many of the Arctic and Alpine species now derive such advantages from their white covering; the question is whether this colouring was originally acquired solely for this purpose, or whether climatic adaptation may not have had an equal or even a greater influence in its production. R. MELDOLA

Clifford and Professor Tait

MAY a "(so-called) Metaphysician"—who has modestly waited to see if some one for whom Prof. Tait could have more respect would anticipate him—venture to remark upon a passage in the review of Clifford's "Exact Sciences" that appeared in NATURE of June 11?

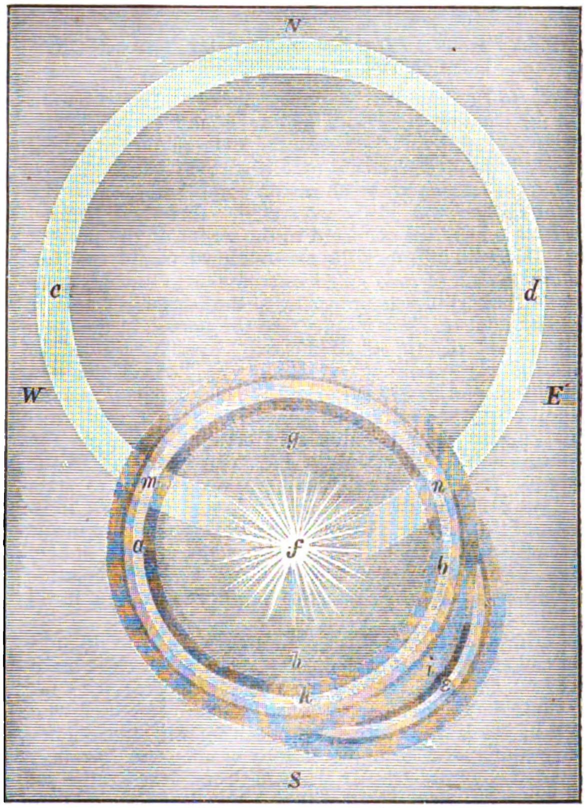
Prof. Tait first calls "awkward" and "unnecessarily puzzling' Clifford's statement that 'if we can fill a box with cubes whose height, length and breadth are all equal to one another, the shape of the box will be itself a cube'; and then, declaring with greater emphasis that it "at first sight seems to be nonsense," he adds:—"Read it, however, thus: 'If we can fill with cubes a box whose height, &c. . . . the shape of the box itself will be a cube,' and the absurdity, suggested by the collocation, disappears."

Now Clifford's statement is not sufficiently guarded, being, as it stands, not true of the cube only; but it surely conveys a real meaning, in a "collocation" of words as plain as possible. It is something (whether much or little) to be told that a cube can be made up of a number of equal cubes; especially in view of the context (p. 16). But does Prof. Tait, with *his* sentence, tell us anything at all, except that a cube is—a cube; or say even that plainly? R.

June 22

Unusual Atmospheric Phenomenon

THE accompanying drawing—a copy of a sketch taken at the time—represents an unusual atmospheric phenomenon witnessed by several friends and myself during a recent visit to Ireland. It occurred on the 6th inst., a bright warm day, with a light breeze blowing from the east. The sky was free from clouds, excepting a few cirrus and cirro-stratus collections on the northern horizon. Engaged at the time in fishing from a boat on one of the Irish loughs, I was conscious of a change in the character of the light reflected from the water and distant objects and looking towards the sun (*f*), noticed that it was surrounded by an exceedingly brilliant halo (*a b*) of about 48° diameter, the contained space (*g h*) being filled with vapour of a dull leaden blue colour, which, by obscuring some of the solar rays, apparently produced the peculiar light effects that first attracted my attention. The time was 1.30 in the afternoon. Calling the attention of my friend, Dr. Simpson, to the phenomenon, I recorded the accompanying details. The primary liula (*a b*) consisted of a brilliant, well-defined band of about 8 width, composed of the spectral colours in the usual sequence, the red ring being nearest the sun. The whole band was most vivid, but the northern half the brightest. At about two o'clock I noticed a bulging (*i*) of the leaden-coloured vapour of the primary halo (*a b*) to the extent of 6° or 7°, and in its south-eastern quadrant, and this protrusion, at first only faintly fringed with colour, soon was bounded by a spectral bow (*e*) at least as vivid as the brightest portion of the primary halo. The adjacent portion of *a b*, whether by comparison with *e* or whether because partially obscured by the protrusion of the vapour around which *e* was formed, I cannot be sure, seemed much paler than the rest of *a b*. Simultaneously with the formation of this secondary bow a large white ring, represented in the drawing by *c d*, slowly formed around a centre to the north of the sun, and rapidly assumed a well-defined contour. Its diameter was 72°. Had it been complete it would in its southern portion have passed through the sun, but after cutting the primary halo (*a b*) at the points (*m* and *n*),



which it rendered more faint, it gradually disappeared before reaching the sun. This latter ring (*c d*) began to disappear about a quarter of an hour after I first noticed it, its north-western portion fading first. I noticed no mock-suns at the points of contact of either of the excentric rings, and was, unfortunately, unprovided with my small pocket polariscope, and therefore unable to ascertain how much of the phenomenon was due to double refraction. The portion (*e*) may have been thus produced, but it certainly appeared, as drawn, to be a portion of a ring of *smaller* radius than (*a b*). The Rev. T. G. Beaumont, who also observed this spectacle, states that he saw the primary halo (*a b*) gradually start from a much smaller ring around the sun. The accompanying drawing, though rough, is as accurate as compatible with the absence of measuring instruments. ALEX. HODGKINSON

26, King Street, Manchester, June 16

Sky-Glows

Your correspondent of Clairvaux-sur-Aube says (NATURE, vol. xxxii. p. 147) the sky-glows are again visible in France. I can corroborate the fact as regards the valley of Lake Leman, in Switzerland. At Geneva, a newspaper has described the abnormal crepuscular glows of June 2, 3, 4, and 13. At Morges (46° 30′ N. lat.), Prof. C. H. Dufour and myself have observed them on the 12th and 13th.

On the 12th the sun disappeared beyond the Jura range about 7h. 30m. p.m.; at 8h. 10m. my attention was called by the brilliant illumination of a strange pale yellow, the same which in December, 1883, and January, 1884, always foretold the great crepuscular glows; at 9h. the western sky was coloured by brilliant purple red tints, which spread as high as the zenith; the red colour only vanished from the horizon at 9h. 30m.—*i.e.* two full hours after sunset. The successive phases of the phenomenon were the same as in the winter 1883-1884; the brilliancy of the colours was, however, fainter, but they were, perhaps, of greater duration.

On the 13th the same glows were observed, with decreasing intensity; on the following days nothing extraordinary has been noticed.

F. A. FOREL

Morges, Switzerland, June 21

THE INTERNATIONAL EXHIBITION—MUSIC LOAN COLLECTION[1]

THE story runs that a countryman, visiting London for the first time, and feeling bound to see Westminster Abbey, by a slight mistake overlooked the Royal Fane, and attended service in St. Margaret's Church hard by. He told his friends in the shires on coming home that the ancient edifice was sadly overrated. Exactly a parallel case to this has just occurred to the writer of the present lines. He was informed by an unknown friend that the small collection of unlabelled instruments in the basement of the Albert Hall was unworthy of the occasion; and he only made out on close inquiry that the person in question was speaking of one out of the two "overflow rooms" in which the superabundant stores of the Loan Collection are housed, and had never seen the Loan Collection itself at all. This was the more remarkable as the said individual carried the proof-sheets of his guide-book to the Inventories which he was in the act of sending to the printers. It is therefore clearly not superfluous to state that this, probably the grandest and most complete illustration of the history, progress, and development of music ever furnished, occupies the whole of the circular gallery which forms the top storey of Capt. Fowke's gigantic building, and runs over into two large rooms at a lower level.

It is impossible in a short preliminary notice to do more than call early attention to the vast mass of priceless materials here collected, and soon to be again dispersed; nor can sufficient credit be accorded to Mr. Alfred Maskell, who, aided by his learned father, has been mainly instrumental in arranging and bringing it into order. He has been seconded signally by Mr. Hipkins, representing the old and honoured firm of Broadwood and Sons, so that the collection of ancient spinetts, virginals, clavichords, harpsichords, and the like is the most remarkable ever brought together. There is at least one such instrument lent by its noble owner from his family seat in Ireland which is all but unknown even to connoisseurs.

The Belgian Government have most liberally lent the whole of the grand museum of the Brussels Conservatoire of Music, originally presented to that institution by M. Victor Mahillon. This in itself is a "*Syntagma Musicum*," like the scarce work of Prætorius, but presenting the very things themselves, not merely their graven images.

The realism of the exhibit is carried to the highest degree by three beautiful model rooms, designed with the taste and accuracy for which Mr. Davidson, himself an exhibitor of some grand fiddles, is so justly noted, each room showing furniture, decoration, and instruments of a great epoch in musical history. The visitor can, if he choose, yield to the pleasant illusion and revel in the madrigals of Orlando di Lasso, "*Il più dolce cigno d'Italia*," the motetts of the Elizabethan age, the Lulli-inspired melodies of Purcell; or sit at the clavichord with Handel and grand old John Sebastian Bach. Of its kind the thing is as nearly perfect as can be, and the undersigned takes the first possible opportunity of praying his brother and sister amateurs not to let slip the unique privilege of seeing it.

W. H. STONE

[1] We hope to supplement this preliminary note by a more detailed notice of the collection when it is complete and the Catalogue ready.—ED.

THE MEASURE OF FIDGET

LATTERLY—no matter where—I was present at a crowded and expectant meeting. The communication proved tedious, and I could not hear much of it, so from my position at the back of the platform I studied the expressions and gestures of the bored audience.

The feature that an instantaneous photograph, taken at any moment, would have most prominently displayed was the unequal horizontal interspace between head and head. When the audience is intent each person forgets his muscular weariness and skin discomfort, and he holds himself rigidly in the best position for seeing and hearing. As this is practically identical for persons who sit side by side, their bodies are parallel, and again, as they sit at much the same distances apart, their heads are correspondingly equidistant. But when the audience is bored the several individuals cease to forget themselves and they begin to pay much attention to the discomforts attendant on sitting long in the same position. They sway from side to side, each in his own way, and the intervals between their faces, which lie at the free end of the radius formed by their bodies, with their seat as the centre of rotation varies greatly. I endeavoured to give numerical expression for this variability of distance, but for the present have failed. I was, however, perfectly successful in respect to another sign of mutiny against constraint, inasmuch as I found myself able to estimate the frequency of fidget with much precision. It happened that the hall was semicircularly disposed and that small columns under the gallery were convenient as points of reference. From where I sat, 50 persons were included in each sector of which my eye formed the apex and any adjacent pair of columns the boundaries. I watched most of these sections in turn, some of them repeatedly, and counted the number of distinct movements among the persons they severally contained. It was curiously uniform, and about 45 per minute. As the sectors were rather too long for the eye to surely cover at a glance, I undoubtedly missed some movements on every occasion. Partly on this account and partly for the convenience of using round numbers I will accept 50 movements per minute among 50 persons, or an average of 1 movement per minute in each person, as nearly representing the true state of the case. The audience was mostly elderly; the young would have been more mobile. Circumstances now and then occurred that roused the audience to temporary attention, and the effect was twofold. First, the frequency of fidget diminished rather more than half; second, the amplitude and period of each movement were notably reduced. The swayings of head, trunk, and arms had before been wide and sluggish, and when rolling from side to side the individuals seemed to "yaw"; that is to say, they lingered in extreme positions. Whenever they became intent this peculiarity disappeared, and they performed their fidgets smartly. Let me suggest to observant philosophers when the meetings they attend may prove dull, to occupy themselves in estimating the frequency, amplitude, and duration of the fidgets of their fellow-sufferers. They must do so during periods both of intentness and of indifference, so as to eliminate what may be styled "natural fidget," and then I think they may acquire the new art of giving numerical expression to the amount of boredom expressed by the audience generally during the reading of any particular memoir. F. G.

RECENT EARTHQUAKES

THE shocks of earthquake in Cashmere continue with unabated violence and even appear to increase in frequency and force. Three severe shocks occurred during the night of the 13th and a smart convulsion on the morning of the 14th. It is now ascertained that 2281 lives were lost in the Muzzafferabad district, where at first it was thought there had been no casualties. The earthquake was also felt in Gilghit. Another very severe shock at Baramulla on the 17th demolished all the buildings which escaped former shocks. At Skardo on the 14th and at Srinugur on the 17th, 18th, and 19th, shocks were felt. In the Kamraj district the loss of life exceeds 2700. The Jheelum Valley, from Srinugur to Dopatta, appears to have suffered most. It is stated that both sides of the river from Sopur to Baramula have been seared with cracks, as also the low alluvial hills in the vicinity. The available data fix the centre of the disturbance in the vicinity of Gurais. It thus appears that in extent and amount of destruction the Cashmere earthquake must rank amongst the great seismic catastrophes of the century.

On Thursday morning last (June 18) a portion of Yorkshire was visited by an earthquake shock. The reports from outlying districts show that the shock extended from the east coast through the Wolds and westwards as far as Headingley, near Leeds. Signalmen on the North-Eastern Railway speak positively as to the vibration and noise. Crockery and glass rattled on the shelves of houses, and at Knottingley and Ferrybridge persons ran from their houses from fear. At Easingwold desks and tables were seen to move, and there was a rumbling noise as of thunder. In some cases there was a severe shaking of houses, and doors were moved. The various reports concur as to the time being 10.50, and it is said there were two shocks. It is a curious coincidence that about an hour previous to this on the same day and in the same region the frightful explosion at the Clifton Hall Colliery took place. Unhappily our knowledge will not permit us to connect seismic disturbances with disasters or mishaps in mines, but we have here a violent and unusual disturbance in the crust of the earth in Yorkshire and an almost simultaneous mining catastrophe in Lancashire.

We have received the following communications with reference to the Yorkshire earthquakes:—

A SLIGHT shock of earthquake was felt here yesterday morning in the favourable stillness of the "Friends'" meeting for worship. The time was observed to be about 10.47 a.m. I was seated with my back to the north, when a rumbling sound appeared to be swelling onwards for about two seconds from the south or south-west. I then noticed that the hanging leaf of a small table in front of me (its plane lying east and west) was rattling very distinctly, and immediately I became aware that the back of my seat was shaking me perceptibly. Others heard some of the windows rattling on both the east and west sides of the house, and were shaken by their seats moving slightly; these seats were some of them at right angles to mine. Some of these persons thought the rumbling came from the east; others from the west. One gentleman, sitting in a corner, thought that his right shoulder, against a north partition, was shaken more than his left, against the east wall. He also thought that the rumbling came from the south end of the house. The place of worship is about two-thirds of a mile to the north-east of our observatory, which is in lat. 53° 38′ 40″·8, and long. 1° 20′ 32″·75 W. Nothing was noticed at the time by a man and a boy working in our garden. It is reported in to-day's *Leeds Mercury* to have been felt at York, Leeds, and Driffield. WILLIAM SCARNELL LEAN

Flounders College, Ackworth, near Pontefract, June 19

CAPT. STAVELEY, at whose house the recent earthquake of June 18 was felt in a marked degree, gives me the following information respecting it. His house at North Dalton (seven miles south-west of Driffield) stands on a slight elevation surrounded with undulating hills common to the Cretaceous formation of the Wolds. The shock occurred between 10.30 and 10.45 a.m. (the exact time was not noted), and lasted about three seconds, travelling from west-south-west to east-north-east. Mrs. Staveley, who was in her bedroom at the time, felt a slight shock, then a rumbling sound as of thunder, and after that another stronger shock. The servants downstairs felt a distinct rocking, and the bricklayer's boy, on a ladder level with the roof, saw the whole roof heave up and down three times. In the dairy some dishes firmly placed on a high shelf were thrown down and broken, and at the inn on the other side of the road the walls trembled perceptibly, and the bottles and glasses were shaken and knocked against each other. The inhabitants of this and neighbouring villages felt the vibrations more or less distinctly, but the shock seems to have been greatest at, and in the direction of, Capt. Staveley's house. The colliery explosion near Manchester happened about an hour earlier; is it possible for there to be any connection between the two? J. LOVELL

Driffield

The following extracts are from the *Hull Express* of June 20:—

Information which reached us yesterday shows that the earthquake-shocks experienced on Thursday in York and Market Weighton were also felt in more or less degree in other parts of the great shire.

Mr. W. Botterill, of Parliament Street, Hull, writes:—"On returning home (Newland Park) from business last evening, my wife informed me that during the morning she had for some seconds very sensibly felt a vibratory motion in the house, which she fully believed to be caused by a slight shock of earthquake, and added that she should confidently expect to find in this morning's papers notices in confirmation thereof. It was, therefore, no surprise to learn from your current issue, and other papers of to-day, that similar effects had been experienced at York, Market Weighton, and elsewhere, about the same hour of the day."

A North Cave correspondent says that at about eleven o'clock in the morning nearly every house was subjected to a slight shaking.

A Driffield correspondent says that at the village of Hutton several residents felt a severe shaking of their houses, and at the same time the inner doors were suddenly moved, crockery upset, and other signs of disturbance were observed. People were so terrified that they cannot very accurately describe the shock, but state they felt a "reeling" sensation.

Another correspondent writing from Driffield says:—"Yesterday morning a somewhat severe shock of earthquake was felt at North Dalton, a village about eight miles from Driffield. The shock appears to have been the most distinctly felt at the residence of Capt. Staveley, which stands in an isolated and elevated position, and the house vibrated from basement to roof for several seconds. A bricklayer's apprentice who was repairing the roof had a narrow escape of being thrown down, and the greatest alarm was felt by the villagers, who 'ran out of their houses in fear for their lives.'"

The shock was also distinctly felt in Leeds. In Delph Lane, Wood-house Ridge, the occupants of three houses which adjoin each other noticed it. It resembled the effect which would be produced by the violent shutting of doors, the windows rattling, and there being a perceptible vibration of the buildings. The same tremulous motion was also felt in Victoria Road, Headingley, and no doubt in other parts of the town.

At Snaith and neighbourhood similar effects were produced. Mr. Barrett, the postmaster of that town, says the shock was so severe as to cause quite a noise with the goods on the shelves in his shop window vibrating, and he felt the floor under him shake distinctly. At 10·48 a.m. on Thursday morning an earthquake was distinctly felt at Thorne, Hatfield, Epworth, and Eastoft. At various parts of Thorne crockery and glass rattled upon the shelves in the houses, furniture was shifted, and many of the inhabitants were greatly alarmed by the floors slightly descending. At Hatfield Levels also some consternation was caused by the earthquake, which was felt very perceptibly. We have not heard of any damage being done by the shock.

About one o'clock on the morning of the 18th, north-western Argyleshire was visited by an earthquake. The shock was distinctly felt at Ballachulish, and in many of the houses in the slate quarry district of Glencoe. The shock was felt with distinctness in Clachaig Inn, at the top of Glencoe. It travelled in a south-eastern direction.

Dr. Forel, of Morges, writes that a pretty strong shock was felt on the morning of June 20, at 5.16, in the cantons of Neuchâtel, Vaud, Berne, Fribourg, and Geneva, the seismic centre being probably the neighbourhood of the Lake of Neuchâtel. The intensity was No. IV. of the scale of seismic intensity.

THE SCOTTISH MARINE STATION

THE equipment of the Research Station at Granton, Edinburgh, has now been increased by the construction of a system of large tanks provided with a constant circulation of sea-water. These tanks are arranged very nearly according to the plan described in the account of the station and its work which was published in April last. The aquarium itself occupies the ground-floor of the building, whose upper story forms the biological laboratory, and it consists of seven large tanks, five of which are shallow, and two deep, the latter being provided with glass fronts. The pump, which is driven by a steam-engine, the high-level reservoir, and the low-level reservoirs are situated at other parts of the premises. One of the deep tanks is being used for the study of the still mysterious life-history of *Myxine glutinosa*. Last week nearly 150 specimens of that animal were brought alive to the station from the neighbourhood of St. Abb's Head, where it is very abundant. These were successfully domiciled in the aquarium. As out of three specimens brought alive to the "Ark" (the floating laboratory belonging to the station) on May 1, and kept in a small glass aquarium about 15 inches long and 9 inches broad, two are still alive and healthy, there is good reason to hope that there will be no difficulty in keeping a large number alive for any length of time in a tank about 7 feet by 5 feet by 4 feet, which are the dimensions of the one now used for the purpose. It was found in the former experiment that the Myxine when left to themselves, burrowed into the layer of mud which had been placed at the bottom of the small aquarium, and lay for hours motionless, their bodies, with the exception of the extreme tip of the snout, being entirely buried. The snout is protruded for the purpose of respiration, a current of water passing constantly through the nostril into the œsophagus, and escaping at the two respiratory apertures. The normal condition of the animal when not actively engaged in the search for food is evidently to lie thus buried in mud. It is well known to fishermen, at least to those who are employed in line-fishing, that eellets, as Myxine are called by them, are met with almost exclusively on muddy ground. At the place where the creatures are more abundant than anywhere else in the neighbourhood of the Firth of Forth, namely, off St. Abb's Head, the sea-bottom throughout an extensive area consists of soft black mud. A quantity of this mud was brought to the station with the living specimens, and a layer of it 6 or 8 inches in depth placed at the bottom of the tank in which the Myxine were to be kept. The animals are now thickly scattered through the layer of mud, like earthworms in garden soil.

Some of the shallow tanks are being used for the study of the reproduction of the oyster. Supplies of oysters are being obtained from various sources, and before long a series of experiments as to the conditions necessary to the life of the oyster larvæ will be carried out. It is hoped, as the least result from this work, that new interest will be aroused in this country in the question of the scientific artificial cultivation of oysters.

The opportunities afforded for research by the laboratory and new aquarium cannot be fully utilised by those now working at the Station, and biologists who would come and carry out original work at the Station would be gladly welcomed.

A temporary branch of the station is now being organised at Millport, on the Firth of Clyde. It will be open during the months of July and August. The floating laboratory known as the "Ark" will be moored next week in still water off one of the small islands in the Bay of Millport, and the yacht *Medusa* will be stationed there for the purpose of dredging and providing material for study. Several naturalists have mad e arrangements to carry on work at Millport during part or whole of the time that the "Ark" will be there: amongst others the Rev. A. M. Norman, Prof. W. A. Herdman, of University College, Liverpool, Mr. David Robertson, of Glasgow; Mr. J. Harvey Gibson, Mr. J. R. Henderson. Mr. John Murray, convener of the Committee, entrusted with the management of the Scottish Marine Station, will be at Millport during the greater part of the time. It is hoped that one result of the work will be the preparation of an account of the fauna of the Firth of Clyde which will include, besides the results of the investigations to be carried on, the results of the previous work in the same field. As several of the experienced naturalists mentioned above are already familiar with the fauna of the Firth, a publication on the subject produced by their cooperation will be complete and authoritative. Any naturalists who may wish to carry on research at the Millport temporary station are invited to communicate with Mr. John Murray.

J. T. CUNNINGHAM

COMPOSITE PORTRAITS OF MEMBERS OF THE NATIONAL ACADEMY OF SCIENCES[1]

THOSE of the members who were present at the Washington meeting of the Academy last spring will remember that, at the request of Prof. Brewer and myself, they sat for their separate photographed portraits for the purpose of obtaining an experimental composite picture. Prof. Baird kindly offered the facilities of the photographic department; and the pictures taken by Mr. Smilie, the photographer in charge, bear the same stamp of excellence that characterises so generally the work of that department of the National Museum.

As only one or two previous attempts, I believe, have been made to produce composites in this country, I will state briefly what they are, and how they are made.

The idea in its broadest sense was conceived and applied by Francis Galton for the purpose of obtaining an average or type portrait—*i.e.* a picture that should show the features that are common to a group of individuals, and exclude those that are purely individual. It is clear that, in proportion as this result is attainable, the method will be of value in obtaining a clear conception of the external characteristics of any given type or class.

[1] From *Science*, to the editor of which we are also indebted for the use of the photographic plate accompanying the article.

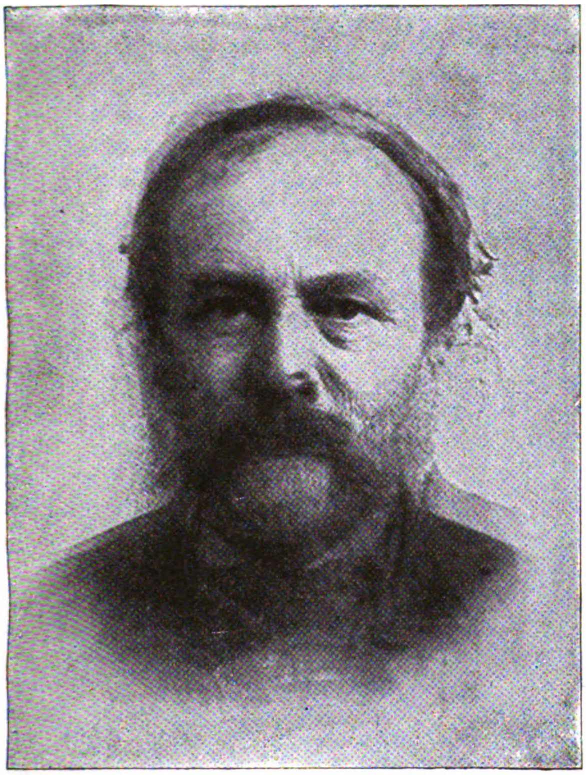


FIG. 1.—TWELVE MATHEMATICIANS.

FIG. 2.—SIXTEEN NATURALISTS.

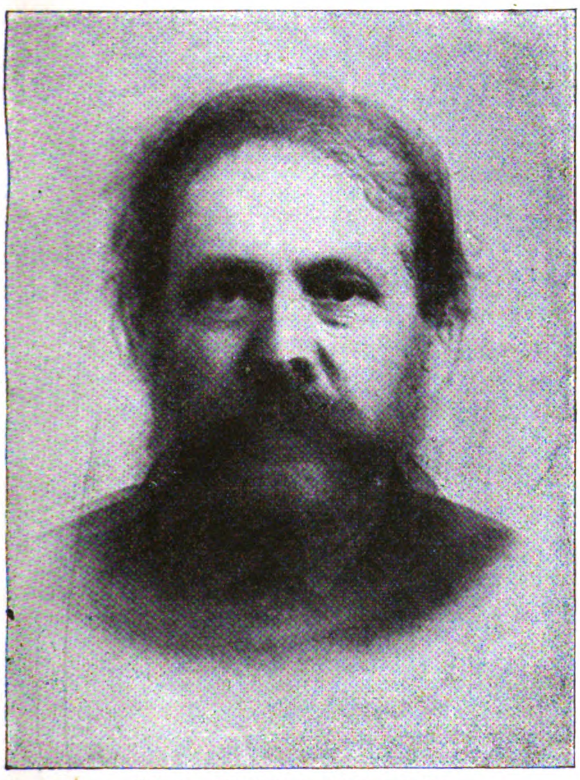


FIG. 3.—THIRTY-ONE ACADEMICIANS.

FIG. 4.—TWENTY-SIX FIELD-GEOLOGISTS, TOPOGRAPHERS, ETC.

COMPOSITE PORTRAITS OF AMERICAN SCIENTIFIC MEN.

Galton reminds us that, during the first days of a traveller's meeting with a very different race, he finds it impossible to distinguish one from another, without making a special effort to do so: to him the whole race looks alike, excepting distinctions of age and sex. The reason of this is that, by short contacts with many individuals, he receives upon his retina, and has recorded upon his memory, a composite picture emphasizing only what is common to the race, and omitting the individualities. This also explains the common fact that resemblances among members of a family are more patent to strangers than to the relatives.

The individuals entering into these composites were all photographed in the same position. Two points were marked on the ground glass of the camera; and the instrument was moved at each sitting to make the eyes of the sitter exactly coincident with these points. The composites were made by my assistant, Mr. B. T. Putnam, who introduced the negatives successively into an apparatus carefully constructed by himself, and essentially like that designed by Mr. Galton, where they were photographed by transmitted light. The arrangements of the conditions of light, &c., were such that an aggregate exposure of sixty-two seconds would be sufficient to take a good picture. What was wanted, however, was not an impression of one portrait on the plate, but of all the thirty-one; and to do this required that the aggregate exposure of all the thirty-one should be sixty-two seconds, or only two seconds for each. Now, an exposure of two seconds is, under the adopted conditions, too short to produce a perceptible effect. It results from this, that only those features or lines that are common to all are perfectly given, and that what is common to a small number is only faintly given, while individualities are imperceptible. The greater the physical resemblances among the individuals, the better will be the composites. A composite of a family or of near relatives, where there is an underlying sameness of features, gives a very sharp and individual-looking picture.

It would be difficult to find thirty-one intelligent men more diverse among themselves as regards facial likeness than the academicians entering into this composite. They are a group selected as a type of the higher American intelligence in the field of abstract science, all but one or two being of American birth, and nearly all being of American ancestry for several generations. The faces give to me an idea of perfect equilibrium, of marked intelligence, and, what must be inseparable from the latter in a scientific investigator, of imaginativeness. The expression of absolute repose is doubtless due to the complete neutrality of the portraits.

Fig. 3 contains eighteen naturalists and thirteen mathematicians, whose average age is about 52 years. Fig. 1 contains twelve mathematicians, including both astronomers and physicists, whose average age is about 51⅝ years. Fig. 2 is a composite of sixteen naturalists, including seven biologists, three chemists, and six geologists, with an average age of about 52½ years.

I may mention, as perhaps only a remarkable coincidence, that the positives of the mathematicians, and also of the thirty-one academicians, suggested to me at once forcibly the face of a member of the Academy who belongs to a family of mathematicians, but who happened not to be among the sitters for the composite. In the prints this resemblance is less strong, but in these it was observed quite independently by many members of the Academy. So, also, in the positive of the naturalists, the face suggested, also quite independently to myself and many others, was that of a very eminent naturalist, deceased several years before the sitting for this composite.

There is given also a composite (Fig. 4) of a differently selected group. It is of twenty-six members of the Corps of the Northern Transcontinental Survey—an organisation of which I had charge, and the object of which was an economic survey of the North-Western Territories. It was a corps of men carefully selected as thoroughly trained in their respective departments of applied geology, topography, and chemistry, and having the physique and energy, as well as intelligence, needed to execute such a task in face of many obstacles. The average age of this group was 30 years.

RAPHAEL PUMPELLY

HOW THE NORTH-NORWAY FJORDS WERE MADE

IN NATURE (vol. xxx. p. 202) there was published an article by me "On Northern Norway under the Glacial Age," in which, among other subjects, I referred to the course of the travelled granite blocks in the neighbourhood of Tromsö. The researches I had then made in this direction were, however, confined to a limited area, whilst last summer I was able to extend the same to the point whence the blocks started. Although one of my assumptions in the former article has not been confirmed by my last researches, the conclusions I then arrived at have in the main been corroborated. And as I believe that this subject is one of considerable importance to science, I venture to give an account of my last researches.

In order to understand the subject, it is necessary to explain the orographical conditions along the course of the travelled blocks from the Swedish frontier to the Arctic Ocean.

From the eastern end of the Alt Lake, near the Swedish frontier, and northwards to the Store Rosta Lake, the country on the Norwegian side assumes the form of an extensive alpine plateau, with broad depressions, the average height of which is about 2000 feet, running between low rounded ridges. In the south-eastern part of these plateaux, not far from the eastern end of the Alt Lake, the Divi River rises. Having for some 10 graphical English miles followed the plateau, this river flows gradually towards the Divi Valley, which it enters and follows throughout its whole course in a north-easterly direction, flowing eventually into the Maals River at a height of 260 feet (82 m.) above sea-level. Its length, from where it leaves the plateau, to the spot where it joins the Maals River, is about 30 geographical miles. In its upper course, where the Maals River receives the Divi River, the former flows through a wide plain or low plateau, the so-called Överbygd, which gradually slopes down to a distinct valley, the Maals Valley proper, which runs in a westerly direction along the southern slope of the high, island-shaped mountain ridge called Mauken. The latter begins about 5 miles west of the spot where the Divi River enters the Maals River, whence it runs in a direction east-west for a length of about 15 geographical miles, the highest tops being upwards of 4000 feet (1255 m.). On the north-western side, however, the Överbygd gradually rises towards the broad mountain depression filled by the Tag Lake, 7 miles in length, which runs in a direction east-west along the northern slope of Mauken, viz. between the latter and the more northerly-lying ridge Omasvarre, which, with tops upwards of 1900 feet (596 m.) in height, also runs in a direction east-west. The bottom of this depression is filled with the imposing Tag Lake, which lies on a height of about 600 to 700 feet (188 to 220 m.) above sea-level, and thus about 400 feet (120 m.) *higher* than the Divi River at the spot where it enters the Maals River. At the western end of the Tag Lake this depression takes the form of a broad mountain basin, the so-called Tag Valley, which in a north-easterly direction descends to Balsfjord. The distance between the Tag Lake and the Balsfjord is about 10 geographical miles. The Tag Valley is, on the western side, bordered by the lofty Maartin peaks, and further to the north-east by the Slet

Mountain, which, like an arm of the Maartin peaks, gradually slopes down to the Balsfjord.

The line of depression from the spot by the frontier where the Divi River rises, to the bottom of the Balsfjord which we have thus followed, is about 50 geographical miles in length. The course of the Balsfjord is north-westerly, but very crooked, between mountains upwards of 4000 feet (1255 m.) in height. The latter are, however, not continuous, but separated into island-like parts by deep depressions, which, in a recent geological period, when the level of the sea was 300 to 400 feet (91 to 126 m.) higher than at present, must have been submerged, thus making each part an island. In spite, therefore, of the typical fjord character of the Balsfjord, it was originally only a number of sounds, by which it was once connected with the Malangen Fjord on the western, and the Sörfjord, Ulfsfjord, and Lygenfjord on the eastern side. This is a circumstance of great orographical importance, and which deserves every attention, particularly because it does not apply to the Balsfjord alone, but is a characteristic of the formation of every fjord in the north of Norway from Salten (Bodö) in the south to Lyngen in the north—*i.e.* from 67° to 70° N. lat.

From the bottom to the mouth, in a sound between the mainland and the south-eastern side of the great island, Kvalö, the length of the Balsfjord is about 30 miles. At the Troms Island, which lies about five miles to the north of the mouth of the Balsfjord, this sound is divided into two narrow sounds, about five miles long, on each side of the Troms Island. From the northern point of this island these sounds reunite, and the sound becomes the broad Gröt Sound on one side, which, running in a northerly direction, joins the Ulfsfjord at its mouth by the Fugle Sound—a broad arm of the sea cutting into the land. On the other side, the sound is also connected with the open sea by the Kval Sound, 10 to 15 miles long, which runs in a westerly direction, between the two great islands Kvalö and Ringvadsö. The length from the mouth of the Balsfjord to the end of the Kval Sound by the ocean is about 30 miles, or about the same as the length to the end of the Gröt Sound. Thus, from the bottom of the Balsfjord to the sea the distance described is about 60 miles.

As regards the depth of the Balsfjord and the adjacent sounds, it may be mentioned that that of the former varies from 80 to 100 fathoms (480 to 600 feet = 151 to 188 metres), but from the mouth of the fjord towards the Troms Island the depth steadily decreases, being, in the sounds on both sides of it, not more than 20 to 30 fathoms (120 to 180 feet = 38 to 56 m.). To the north of this island, in the Gröt Sound, on the other hand, the depth increases to 100 or 120 fathoms. In the eastern half of the Kval Sound the depth is from 20 to 30 fathoms, while in the western half it reaches, at the mouth, 120 fathoms. It will therefore be seen that the depth of this channel in the main increases seawards, if we except the two places by the Troms Island and in the Kval Sound, the shallowness of which may be caused by narrowness of the sounds, and the consequent opportunity for the deposit of marine *débris*.

Thus, the entire length of the line of depression we have examined from the sources of the Divi River to the ocean is 96 geographical miles, while the bottom of the same falls from 2000 feet above the level of the sea to 720 feet below it—*i.e.* a total fall of 2720 feet.

The geological structure of the mountains here is very remarkable. A large mass of granite which appears at each end extends inland far into Sweden, and, on the Norwegian side, reaches the upper Divi Valley. The rock is composed of orthoclase, microlin, plagioclase, a great deal of quartz, but very little mica. The colour is reddish, the structure granulated. At the other end of the line we have followed, on the Kvalö and Ringvadsö Islands, there are several masses of a grayish, streaky gneiss-granite, rich in mica, closely allied to the gneiss-masses found here. Petrographically, the Divi Valley and the coast granites are so different, that it seems at first sight very easy to distinguish them, but this is not so easy with the variations of the two kinds.

The mountains which project into these granite-masses are built of layers of crystalline slate, and travelled blocks of this material may be found everywhere; but as it would be a matter of great difficulty to refer these to their original birthplace, I shall not take them into account here. We will, therefore, only follow the course of the granite blocks travelling from the Swedish frontier to the coast.

There are two roads by which they might have moved, viz., one from the southern part of the granite-mass along the Alt Lake to Bardö, and so on; the other more northerly, along the Divi Valley. It is the latter which I intend to discuss here.

The above-mentioned alpine plateaux are strewn with travelled granite blocks, and that the same have travelled westwards from the granite masses by the frontier cannot be doubted. The same applies to all the blocks strewn along the Divi Valley. At the spot where the Divi River joins the Maals River the travelled blocks have followed two courses—viz. one through the Maals Valley, along the mountain Mauken—which we shall not follow—and the other in a north-westerly direction across the Överbygd to the Tag Lake, the lower parts of the Överbygd being thickly strewn with granite blocks which, judging by their petrographical composition, I am sure belong to the Divi Valley granite. Hence the course of the blocks can be traced along the depression in the mountain by the Tag Lake, not only at the bottom, but high up on the mountain sides. Thus, the northern slope of the Mauken is everywhere, up to a height of 2500 feet (784 m.), strewn with travelled granite blocks; indeed the brink of every terrace looks—seen from below—as if it were faced with travelled blocks, which everywhere seem to belong to the Divi Valley granite. Travelled granite blocks were found, too, strewn up the slopes of the Omasvarre Mountain to a height of 1200 feet (376 m.)—viz. as far as I was able to carry my researches. I believe they would be found right up to the top.

From the western end of the Tag Lake the blocks have moved along the Sag Valley, and then to the bottom of the Balsfjord. The flat stretch of shore, 210 feet broad, high, and covered with loose *débris*, is strewn with blocks which without doubt belong to the Divi Valley granite.

From what I have thus explained we may safely assume that an enormous mass of inland ice has once moved from the frontier through the above-described channels, down to the Balsfjord, and that it must, along the Mauken, a distance of 10 miles from the fjord, still have maintained a height of at least 2500 feet (784 m.) above the then sea-level.

Before we follow the course of the blocks further, I will refer to certain circumstances connected with it thus far. About five miles to the westward of the mountain plateau near the frontier rises the isolated mountain Store Jerta to a height of 4500 feet (471 m.)—viz. about 1000 feet (314 m.) higher than any of the surrounding mountains. The Store Jerta is throughout built of hard crystalline slate. On the very summit of this peak I found a large block of granite which I feel confident is a travelled block from the granite mass to the east of it. Its birthplace must in that case have been at least 1000 feet (314 m.) *lower*, and, as the Store Jerta has been situated right in the track of the ice-stream from the east, I am of the opinion that the ice has been screwed up here to a very great height; but I confess it seems hardly possible to understand that it could be to such an enormous height.

I have stated above that the Tag Lake lies 42 feet *higher* than the spot where the Divi River enters the

Maals River, and supposing that this was also the case during the Glacial age the ice-stream must have moved up an incline before it could reach the depression leading down to the Balsfjord. This cannot, however, have been the case. As long as the ice-stream had perfect liberty to travel *down* an incline—here present in the shape of the broad Maals River, along the southern slope of the Mauken—it would hardly ever move in the opposite direction *up* an incline, leaving, however, local accumulations out of consideration. It might therefore be reasonable to suppose that the configuration of the land along the Divi Valley, and especially the Överbygd, was very different during the Glacial age. A continuous, though slightly inclining, surface must under these circumstances at that period have extended from the alpine plateaux above the Divi Valley to the depression along the Tag Lake, and the present configuration be caused by subsequent erosion. It should be stated that the outlet of this lake does not now follow the course of the ice-stream towards the Balsfjord—which might have been reasonably assumed—but is at the opposite, eastern, end towards the Maals River. This seems to indicate that the present declivity of the Överbygd in an easterly direction in any case cannot be older than the close of the Glacial age.

As stated, travelled granite blocks from the Divi Valley are found in great numbers along the northern slope of the Mauken, towards the Tag Lake, upwards of 2500 feet (784 m.); but that these should have been raised from lower levels to their present height seems improbable. The northern slope of this mountain does not lie transversely to the course of the ice-stream, but longitudinally to it. Of course the screwing-up of the ice may also take place in the latter case, but I should say only in isolated spots; this cannot have been the case along the Mauken. Neither is it possible that the bottom of the lake lay at that level in the Glacial age. It must then have lain lower than the alpine plateaux by the frontier, and even if we allow for enormous glacial erosions, it would be impossible to believe that the bottom then lay at such a height. As the blocks on the Mauken cannot thus have been deposited along the bottom of the ice-stream, nor brought thither through screwing-up of the ice, we must assume that they have been deposited from the surface of the ice-stream. The latter being strewn with blocks, which at the frontier was above 3000 feet (941 m.) high, has therefore, at 40 or 50 miles therefrom, had a height of 2500 feet. The surface can, therefore, under this long journey, only have had a very small declivity outwards.

From the western end of the Tag Lake the great ice-stream has moved forward to the Sag Valley, which, being then as it is at present, has been able to receive it and turn it in a north-westerly direction downwards to the Balsfjord. That the Sag Valley cannot be of glacial origin, produced by erosion, is clear from the very nearly acute angle it forms with the Tag Lake depression. It might also be assumed that the ice-stream here might have moved forward across the Slet Mountain and the long, narrow peninsula between the Malangen and Balsfjord, but that this was not the case is proved clearly by the circumstance that travelled granite blocks are found on this peninsula, or only at low levels, which I shall presently explain.

It may be probable that the ice-stream from the Tag Lake has met another descending from the Maartinder in the Sag Valley, but there is no middle *moraine* proving this. On the other hand, travelled granite blocks are but sparsely strewn along the north-western side of the Sag Valley, at the foot of the Slet Mountain. Should the Sag Valley, therefore, be of glacial origin, it might more naturally be attributed to the ice-stream from the Maartinder, but even then eroded before the great inland ce-stream entered it. If, however, this was the case, the former ice-stream must have been in motion long before the latter, of which there is no probability.

We therefore come to the conclusion *that the basin of the Balsfjord, viz., the Tag Lake depression and the Sag Valley, cannot be the result of the erosive action of the inland ice, but that it existed prior to the Glacial age, and that, in fact, the depression in question was the cause of the ice-stream taking this course.*

We will now follow the depression through the fjord and adjacent sounds.

As soon as we leave the true bottom of the fjord the travelled blocks are differently situated to those inland. There are plenty of granite blocks to be found, but *they are everywhere confined to lower levels, viz., from the shore-line up to 120 feet (38 m.). Above, there is none, and the line of disappearance is very marked.* My researches have extended, on the eastern side of the fjord, from the bottom to the sea; on the western side, though they do not extend so far, they go to show that the conditions there are identical with those on the eastern side. It is particularly significant that neither here are the blocks found above a height of 120 feet along the low, transverse ridge which runs from the Balsfjord on one side westwards to the Malangenfjord, and on the other, eastwards to the Lyngen and Ulfs fjords. Thus, the outer Malang isthmus, which, rising slowly to a height of 400 feet (125 m.), leads from the Bals to the Malang fjords, is along the former strewn with blocks, but only at lower levels. Above 120 feet they disappear. From this also it is clear that the inland ice cannot have moved forward across the Slet Mountain and the isthmus between the Bals and Malangen fjords, previously referred to. From the bottom of the Nordkjos, a short bye fjord of the Balsfjord, running eastwards, the Balsfjord isthmus, two miles long, with a height of 250 feet (78 m.), leads to the bottom of the Storfjord in Lyngen. Here, too, the blocks are confined solely to lower levels towards the Nord and Balfs fjords. The blocks have not reached as far as across the isthmus to the Storfjord.

The blocks may in the same manner be followed along the Ramfjord, which as a bye fjord runs from the mouth of the Balsfjord eastward to the Bredvik Isthmus. From the southern side of the mouth of the Ramfjord the Anders Valley runs in a southerly direction between lofty mountains and with a steady incline. Here, too, travelled granite blocks are found to a height of 120 feet, *but not a single one above.* The case is the same along the sounds around the town of Tromsö. Further, I have followed the blocks northwards, on the mainland to Tunnes, about five miles from the town, but whether they have travelled further along the Gröt Sound I have not yet been able to ascertain. The same applies to the Kval Sound. But researches made on the islands *outside* this sound prove beyond a doubt that the granite blocks from the Balsfjord cannot have reached these islands by way of the Kval Sound.

The greatest number of travelled blocks along the Balsfjord belong, judged petrographically, to the Divi Valley granite, blocks which might with certainty be referred to the coast granite not having been found. Along the sounds, too, the greatest number of blocks, if not all, may be referred to the Divi Valley granite; but blocks belonging to the gray, streaky gneiss-granite of the Kval Island are also met with here, some of which may even be referred to exact localities in the island. Among the rocks along the Troms Island and adjacent sounds blocks of a coarse-grained syenite are also often found. In the Divi Valley no varieties of syenite appear, but they are often encountered combined with gneiss and gneiss-granite on the coast. Although I have not yet succeeded in finding syenite in place which with certainty can be said to be petrographically identical with that of these travelled blocks, I have every reason to believe that they hail from the west.

We have now followed the course of the blocks along a continuous distance of 84 geographical miles—viz. 48 on the mainland and 36 on the shores of fjords and sounds.

From what I have advanced here as regards the blocks during their journey through the Balsfjord, it seems clear that their transport here cannot be ascribed to a moving stream of inland ice. The sharp line of demarcation, above which no blocks are found, seems in itself to demonstrate this. The line extending for miles along a long fjord and extensive sounds, and being so sharply defined, bespeaks that the transporting agency at work here must have been far more regular during a length of time than a stream of inland ice possibly could be. We have therefore every reason to conclude *that these blocks have been carried along the level of the sea on drift-ice*, i.e. *shore-ice*. As the block-transport appears from the first simultaneously along the long stretch of shore from the Balsfjord, and past the Troms Island, a strong in- and outflowing current during the diurnal tides has in all probability been at work at a period when the level of the sea was 120 feet higher than at present. And the strong drift of the ice outwards *must have been stronger than the one inwards up the fjord*. Travelled blocks of the Kval Island granite are, therefore, *not found in the interior of the fjord*, but the case is different along the broad sounds about the mouth of the fjord; here the in- and outflowing currents have had alternate sway, *and here are also found blocks of the Divi Valley, as well as of the coast granite*.

There is another important circumstance which beyond a doubt proves that the inland ice during the Glacial age cannot have moved along this fjord, scouring the bottom. Thus, if we consider the present depth, about 600 feet, and remember that the level of the sea during the Glacial age was about 600 feet higher than at present, and further that great quantities of *débris* must have been deposited at the bottom of the ice, it is evident that an ice-stream moving through the fjord, and a sixth part of whose volume rose above the then sea-level, must have reached several hundred feet above the former—that is, the outgliding stream must have reached several hundred feet above 120 feet, the line of demarcation for the blocks, as it then lay at least 200 feet below the sea. If, however, this had been the case, granite blocks should now be found at a far greater height than 120 feet. Neither can the Balsfjord during the Glacial age have formed a valley along which the inland ice might move, as, in this case, travelled blocks would have been found along the sides at even far greater heights.

I have, therefore, after the most careful researches here, yard by yard, and extending over many years, come to the conclusion *that the Balsfjord is not of glacial origin, but formed an incision or depression in the mountains of older origin than the Glacial age*. And this conclusion I believe *may, in the main, apply to the question of the formation of all fjords in the north of Norway*. But whether it is applicable to all fjords *in the whole of Norway* I shall not attempt to answer.

There may, however, be reason to assume that the explanation of the fjord-formation in parts which have lain under an earlier Glacial age as being of glacial origin, is rather based on speculation than such careful and minute researches as those I have referred to here, and which may, perhaps, contribute to prove the correct theory.

KARL PETTERSEN

Tromsö Museum

VARIABLE STARS[1]

THIS catalogue may be regarded as complemental to the "Catalogue of Known Variable Stars," by the same author, which was read before the Royal Irish Academy, January 28, 1884. It contains a list, including lettered numbers, of 745 stars in which some change of magnitude is suspected. The stars are tabulated in order of Right Ascension for the epoch 1880·0, and in separate columns are to be found particulars of the supposed change of magnitude and the authority on which the supposed change rests. In the "Notes and Observations" by which the Catalogue is followed are given particulars of the history of each star, together with observations by the author of such stars as have received attention from him. The work is accompanied by a map showing the distribution of known and suspected variable stars.

A catalogue of this character forms a valuable working catalogue for the observer's use. By further observation suspected variation will in some cases be proved to be real, and the stars claim a place in a catalogue of known variables. A claim of this kind might indeed already be made in the case of Nos. 234, 455, and 635 of Mr. Gore's list. It may just be mentioned in passing that the place of No. 234, U Canis Minoris, is incompletely given in the Catalogue. Its more exact place for 1880 is R.A. 7h. 34m. 49s., Decl. + 8° 39'·5. There are other cases in which, though the period is as yet indeterminate, the fact of variation and its amount may be stated with some confidence. On the other hand further observation may tend to throw a doubt on the suspicion of change in the case of other stars, and (as our author observes) "these must of course be removed from future catalogues." In the notes to No. 287 of his Catalogue α Hydræ, Mr. Gore quotes remarks by Sir John Herschel, Dr. Schmidt, and Dr. Gould to the effect that the supposed variability of this star may possibly be due to the influence of its ruddy colour on the estimates of its brightness. Is it not possible that the effect of colour on estimates of magnitude as respects different observers, or the same observer at different times, has hardly received so much attention as it deserves?

Large as is the number of stars included in Mr. Gore's Catalogue, further additions might be made to it. Comparing it, for instance, with the Table of Suspected Variables extracted from Mr. Chandler's unpublished Catalogue by Prof. Pickering, and printed in his "Recent Observations of Variable Stars" in the *Proceedings* of the American Academy, we find some 30 stars which are not included in Mr. Gore's list, and it is probable that others might be found in other quarters also. Indeed the experience of most variable star observers would probably suggest the view that cases of slight but distinctly recognisable light variation are relatively numerous.

A word in regard to No. 445 in the Catalogue may possibly help to avert the chance of a little confusion in the future. This star was entered as U Bootis in Prof. Schönfeld's first Catalogue of Variable Stars, but was rejected by him in his "Zweiter Catalog." There is another star called U Bootis by Mr. Baxendell in a paper in the Manchester Lit. and Phil. Soc. *Proceedings*, vol. xxi. No. 11, the place of which, brought up to 1880, is R.A. 14h. 48m. 47s., Decl. + 18° 10'·9. This star has a period of 175·5 days, with a range of magnitude from about 13·5 at minimum to about 9·2 at maximum.

In conclusion we commend to the attention of all who are interested in the subject of variable stars a work the preparation of which must have entailed on the author a considerable amount of labour both as compiler and observer.

[1] A Catalogue of Suspected Variable Stars, with Notes and Observations, by J. E. Gore, M.R.I.A., F.R.A.S. A paper read before the Royal Irish Academy, May 12, 1884.

NOTES

A BERLIN telegram announces the sudden death of Dr. Emil Riebeck, at Feldkirch, where he was preparing for another five years' journey. Our first review in this week's NATURE refers to some of the last results of Dr. Riebeck's journeys. Either directly or indirectly he has done good work for science in various parts of the world. He was a liberal patron of explorers; the recent researches of Dr. Schweinfurth, in Socotra, for example, were carried out at Dr. Riebeck's expense. His death is a serious loss to science.

THE death is also announced, at the age of sixty-seven years, of Mr. W. S. W. Vaux, F.R.S., the well-known numismatist and Oriental scholar, and Secretary to the Royal Asiatic Society.

WE have still another death to record this week—that of M. Henri Tresca, an eminent French physicist and mechanical engineer. He was born at Dunkirk in 1814. He studied at the Polytechnic School, and on leaving it entered the corps of the Ponts et Chaussées, but soon afterwards quitted the service in order to devote himself to scientific study. In 1850 he was appointed principal inspector of the French Section of the Exhibition at London, and afterwards became sub-director of the Conservatoire des Arts et Métiers, and he there filled with great distinction the Chair of Industrial Mechanics. In 1872 he was elected a Member of the French Academy. Of his numerous works may be mentioned his "Cours de Mécanique Appliquée" and his "Écoulement des Liquides." The Academy of Sciences, on hearing of his death from the President, M. Boulay, closed the sitting as a mark of grief.

WE are informed that Dr. Barius, Surgeon-General to the French army in Tonquin, died on the 10th in Haiphong after a short illness caused by overwork and anxiety in that unhealthy climate. Dr. Barius is well known to the scientific world from his meteorological writings, especially his able and exhaustive "Recherches sur le Climat du Sénégal." While in Haiphong Dr. Barius took the trouble to make observations every day at 10 a.m. and 4 p.m., which he reduced and forwarded to Hong Kong, and his loss is severely felt; but some time before his death he mentioned in a letter that the meteorological observatory, of which he had urged the necessity, would be started in a few months.

AT the Oxford Commemoration, last week, the honorary degree of D.C.L. was conferred upon Prof. Huxley.

THE organising committee of Section A of the British Association have arranged for the following discussions at the Aberdeen meeting:—(1) On Kinetic Theories of Gases; (2) On Standards of White Light. It would be convenient if those wishing to take part in the discussion would send in their names before the meeting to the Recorder of Section A.

THE Council of the Society of Arts have awarded the Society's silver medals to the following readers of papers during the session 1884-85:—To Anton Jurgens, for his paper on "The Preparation of Butterine." To P. L. Simmonds, for his paper on "Present and Prospective Sources of the Timber Supplies of Great Britain" To A. J. Ellis, B.A., F.R.S., for his paper on "The Musical Scales of Various Nations." To Thomas Wardle, for his paper on "Researches on Silk Fibre." To H. H. Johnston, for his paper on "British Interests in East Africa, especially in the Kilimanjaro District." To E. C. Buck, for his paper on "The Agricultural Resources of India." To Mancherjee M. Bhownaggree, for his paper on "The Present Condition and Future Prospects of Female Education in India." To Dr. Frederick Siemens, for his paper on "Tempered Glass." To Frederick J. Lloyd, for his paper on "The Chemistry of Ensilage."

IF the few details that have reached us in the form of newspaper accounts are to be relied upon, Clifton Hall Colliery, near Manchester, in which the great explosion occurred on Thursday last, killing 140 men and boys, appears to have been dry and dusty and at the same time very free from firedamp. It remains to be seen whether those who investigate the causes of this accident will give due weight to the now undeniable influence of coal-dust, instead of contenting themselves with putting forward the usual set of traditional guesses and assumptions, which, it is to be feared, have too often supplied the place of those careful and exhaustive methods of inquiry and deductive reasoning that are alone capable of dealing with the apparent mystery in obscure cases of this kind. It is noteworthy also that this explosion has occurred in the inspection district in which shot-firing is supposed to be altogether prohibited except when the workmen are out of the mine; and it will be a curious commentary upon the late high-handed attempt of the Home Office to force a rule of the same kind upon the other mining districts of the country, should it turn out that the accident in question was not originated by a shot but was due to some other cause, such as the ignition of a local accumulation of fire damp. We await the result of the inquiry with very great interest.

MR. J. R. HENDERSON, M.B. (Edin.), F.L.S., zoologist of the Scottish Marine Station, Edinburgh, has been appointed Professor of Biology in the Christian College, Madras. This is, we understand, the first Professorship of Biology which has been founded in India. Mr. Henderson had a very distinguished career in the University, being awarded, among other honours in natural science, the Dobbie Smith Gold Medal. He is at present engaged in describing the Anomura collected during the *Challenger* Expedition.

PROF. T. C. MENDENHALL, of the University at Columbus, has received an appointment in connection with the United States Signal Service. This is an important accession to the scientific staff of the Meteorological Service of the United States, and is another instance of the enlightened policy carried out by General Hazen, the Chief Signal Officer. The high-class contributions to meteorology we receive from time to time from the office of the Signal Service are the outcome of these appointments.

To the *American Meteorological Journal* for June Mr. H. Allen Hazen sends a short but interesting communication on thunderstorms and air-pressure. Thunderstorms may be divided into (1) common storms with light winds, more or less rain, and generally not very heavy thunder; (2) those preceded or attended by a high and sudden wind; and (3) those that may be termed electric storms, mostly experienced in the west of the States, and of which little has been written or is known up to the present time. As to this third class, it is alleged that storms occur in the west with heavy electric discharges, and more or less wind *but no rain*. These storms the Signal Service proposes to investigate most carefully, particularly since, if it be conclusively shown that thunderstorms occur unaccompanied by any rain, a contribution of no ordinary importance will be made to the theory of the thunderstorm. It gives us the greatest pleasure to learn that the American observers are urged to take readings of their aneroid barometers every five minutes during thunderstorms, together with non-instrumental observations of rain and other accompaniments of the storm. In this department of meteorology, accurately observed facts continue still to be the great desideratum.

DETAILS of the recent violent volcanic eruptions in Java, of which brief telegraphic intelligence has already been published, have now reached Holland. The volcano of Smeru has been active for many years, casting out fire and smoke, but on April 17 and 18 an eruption of extraordinary violence occurred. The mountain is regarded as the highest volcano in Java, and takes the form of a handsome, regular cone. On the present occasion the side of the mountain for one-third of the way down from the summit is described as having been burst open, a tremendous cleft being formed, from which a torrent of lava and mud was ejected. A whole estate called Kalibening was overwhelmed, the manager and a large number of Javanese labourers being carried away by the torrent. From the reports it appears that the eruption of Smeru was accompanied by volcanic disturbance all over the western part of Java. A mud spring, or rather lake, bubbled up into the Preanger, in West Java; a volcano, Slamat, lying west of the Merapi (itself a quiescent volcano), has manifested signs of renewed activity, as has Klut, farther to the east. Lamongan, lying still farther eastward, throws out showers of ashes, and in Rotti, an island near Timor, mud has issued from the side of a mountain, and has overflowed a district described by the natives as twenty minutes' journey in breadth.

M. GASTON TISSANDIER made, on Friday, June 20, an ascent with a photographic apparatus to take instantaneous views. Not less than twenty-four were obtained on the trip, which began at 2 o'clock and lasted up to 6. The departure took place at Point du-Jour (Paris), and the descent in the vicinity of Rheims.

MR. R. ANDERSON, F.C.S., has in the press a new and enlarged edition of his work on "Lightning Conductors, their History, Nature, and Mode of Application." Messrs. Spon are the publishers.

MR. MORRIS, the Government botanist of Jamaica, delivered an address before the Jamaica Institute on the 7th ultimo on the scientific work done, and still to be done, by that establishment, more especially in the local museum. The latter is still in course of formation, but during the past four years there have been brought together collections of the fish, birds, insects, shells, and an illustrative collection of other island productions. The geological collection is described as being of a most complete and useful character. It shows not only the nature, age, and character of the rocks, their chemical constituents, fossil contents, and mineral wealth, but also deals with such topics as the nature and origin of soils, the character and quality of building stone, &c. The collection of Jamaica birds contains about 100 specimens, leaving 89 still to be added before it can be regarded as complete. The insects of Jamaica, Mr. Morris says, are comparatively little known to science, and this field is especially recommended to local collectors. Up to a few years ago the fish of Jamaica could best be studied in Boston and Washington Museums, but the local museum has lately commenced a collection of food fishes, and about 60 species are already carefully arranged and classified. Little, however, has been done of a practical and tangible character to develop the fisheries of the island. 630 species of land and freshwater shells have been found in Jamaica; these are being carefully arranged, and indicate that the island forms a rich province in the class Mollusca, and that "the classes of phenomena within her narrow limits afford room for the highest order of scientific studies." Jamaica is particularly rich in ferns; it contains about 500 species, which is one-sixth of the ferns of the whole world. The orchids and grasses are also being prepared for the museum, and it is hoped as opportunity offers to add a good collection of the medicinal and industrial plants. Here, as in his annual reports, which we have noticed on their appearance, Mr. Morris dwells on the immense economical value of a properly ordered and complete museum to an agricultural colony like Jamaica. There is no lack of materials; the difficulty has been to collect, preserve, and systematically arrange collections and place them in such a state and under such conditions as to conduce to their due and proper utilisation.

IN the first days of August next an International Botanical and Horticultural Congress will be held in Antwerp. Amongst the questions which will be suggested for special consideration is the flora of the new Congo Free State, the methods of culture already existing there, and the possibility of acclimatising new plants. The commission appointed to carry out the preliminary arrangements for the Congress has drawn up a series of questions, which, with the help of the Association Internationale Africaine, has been sent out to the Congo for replies. A special sitting will be devoted to this subject, and a herbarium of the principal flowers and plants of various neighbourhoods in the State and a collection of fruits and seeds will be accessible to members. The queries sent to the Congo refer to the nature of the soil; the maximum and minimum temperatures; the climatic conditions; the conditions favourable to cultivation, and those which are unfavourable; the food, medicinal, poisonous and industrial plants; the help which Central Africa offers to botanists for the study of tropical flora and physiology; the cultivation of vegetables on the Congo; the principal enemies of cultivation in the vegetable and animal kingdoms; and the best mode in which botanists and gardeners can utilise the labours of the Congo explorers. Like other recent Congresses the International Botanical and Horticultural Congress this year will apparently be mainly occupied with questions relating to Mr. Stanley's new State.

WE have received from Mr. F. W. Putnam, the Curator of the Peabody Museum of American Archæology and Ethnology, two papers by him: one, a first notice of the pine grove or forest river shell-heap, near Salem; the other, remarks on chipped stone implements, which we noticed on its appearance in the *Bulletin* of the Essex Institute.

MR. J. MACDONALD CAMERON has printed a report on the bituminous deposits of the Camamū basin of the province of Bahia in Brazil. In addition to the purely commercial portion of the report, there is much interesting information with regard to the various descriptions of these oleaginous deposits. Mr. Cameron has some interesting remarks on the influence of the mangrove on the muddy swamps on the coast. The dirty greyish black mud in which the mangrove vegetation is very luxuriant, resembles that noticeable in England in rivers and streams on the banks of which oil or soap works are situated. He inclines to the opinion that this mud is principally formed by the continuous decomposition of the roots and branches of the mangrove trees. The tidal currents ebb and flow slowly, and hence do not sweep away the mud. Thus abundant food for the tree is ensured, "as well as a store of oleaginous material for the use of distant generations of human beings."

WE have received the report of the Hackney Microscopical and Natural History Society for the past year. Mr. Greenhill's paper on Hackney Brook is of much interest, although the title is suggestive of the investigation in the Hampstead ponds undertaken by the immortal Pickwick Society. Mr. Greenhill has hitherto classified the stone implements which he has found in north and north-east London into (1) Hackney brook, (2) Lea valley, (3) Thames valley; and the purport of his paper is to arrive at a sound theory as to the comparative age of these three valleys and their implements. The principal conclusion of the paper is that the brook and its valley were not formed till long after the Stone age. Dr. Cooke's presidential address is a novelty; it is a Christmas vagary, describing the characteristics, the whims and oddities of the individual "chips" who attend one of the society's excursions.

THE Annual Report of the Bedfordshire Natural History Society refers to the work of preparing a new flora of the county. It is hoped that the first part of the work will shortly be ready for print. The *Transactions* of the past two years have contained a complete list of the phanerogams, mosses, and Characeæ of South Bedfordshire, by Mr. Saunders, and attempts are being made to form similar lists for other parts of the county. The papers read were few in number, but these do not represent the work of the Society. A scheme of village lectures on scientific subjects has been carried out with success.

In a paper read at the last meeting of the Librarians' Association, Mr. J. R. Boosé describes the progress of Colonial public libraries. Commencing with those in the Dominion of Canada, he stated that as far back as 1779 there was a public circulating library at Quebec. He then traced the progress of the public library system up to the present, giving a detailed account of the Parliamentary Library at Ottawa, and also referring to the recent establishment of free public libraries. He then traced the progress made in the Australasian colonies, dealing separately with the libraries of Victoria, and stated that the establishment of public libraries in those colonies only dated from the second decade of the present century. Their growth, however, had been of extraordinary rapidity; the statistics for Victoria showed that there were 143,073 volumes in the public library of Melbourne, 317,295 in the libraries of the colony, and that these institutions were visited in 1883 by 3,100,000 persons. Mr. Boosé, after describing the libraries of the other Australian colonies, referred to those of the Cape Colony, Natal, Singapore, Jamaica, British Guiana, Trinidad, the Bahamas, &c., and, in conclusion, observed that it was scarcely possible to overrate the advantages of these institutions, inasmuch as, in addition to their existing collections of books, every effort was made to enrich them by such valuable works of reference as were too costly to be purchased privately, and were only presented to libraries having a recognised status. He thought therefore that the Colonial Governments should provide means annually for their proper maintenance, and not throw the cost of them on the municipal authorities.

The additions to the Zoological Society's Gardens during the past week include two Barbary Apes (*Macacus inuus*) from North Africa, presented respectively by Mrs. Allison and Mrs. D. Fox Tarratt; two Common Marmosets (*Hapale jacchus*) from Brazil, presented by Col. Howell Davis; two Brown Bears (*Ursus arctos*) from Russia, presented by Mr. Walter Holdsworth; two Bandicoot Rats (*Mus bandicota*) from India, presented by Col. C. S. Sturt, C.M.Z.S.; an American Robin (*Turdus migratorius*) from North America, presented by Mr. H. Keilich; two Partridges (*Perdix cinerea*), British, presented by Mr. H. J. Snelgrove; an Azara's Fox (*Canis azaræ*) from South America, a Pleasant Antelope (*Tragelaphus gratus* ♀) from West Africa, six Common Chameleons (*Chamæleon vulgaris*) from North Africa, purchased; a Japanese Deer (*Cervus sika* ♂), three Canadian Beavers (*Castor canadensis*), a Chiloe Wigeon (*Mareca chiloensis*), seven Australian Wild Ducks (*Anas superciliosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

The Periodical Comets of De Vico and Barnard.—As was first pointed out by Prof. Weiss, there is a certain degree of resemblance between the elements of the comet discovered by Barnard in July, 1884, and those of the comet of short period detected by De Vico in August, 1844, which Leverrier considered was probably identical with the comet observed by Lahire at Paris in 1678, though not known to have been seen in the long intervening period. It appears from Brünnow's minute investigation of the orbit of De Vico's comet that the mean motion at perihelion passage in 1844 is not determinable from the observations within very narrow limits, as might rather have been expected, considering the degree of precision with which that comet was observed from the beginning of September to the end of December, Mr. Otto Struve's observations in particular being of remarkable excellence. According to Brünnow's later calculations, the results of which were published in his "Ann Arbor Notices," the mean motion was close upon 650″ daily, but he considered that it might be as small as 640″ or as large as 660″, or, in other words, that the period of revolution at perihelion passage in September, 1844, might be as long as 2025 days, or it might not exceed 1964 days. Dr. Berberich finds the period of Barnard's comet 1959 days, and Mr. Egbert, of Albany, U.S., 1970 days, so that the periods of the two comets are pretty accordant; but the interval 1844–1884 does not correspond thereto, and the differences that exist in the other elements, notwithstanding the general similarity remarked by Weiss, point to considerable perturbation in this interval, supposing the identity of the comets. De Vico's comet in the orbit of 1844 could not have approached near to the planet Jupiter, to which body we are accustomed to look, as the great disturber of cometary orbits, but there is the possibility of a very close approach to the planet Mars, and this is also the case in a striking degree with Barnard's comet, which, in Dr. Berberich's last ellipse, is less than 0·008 of the earth's mean distance from the orbit of Mars in about 350° 50′ heliocentric longitude; as already pointed out in this column, there may have been a close approach of the two bodies at the end of 1873 or beginning of the following year. The nearest approximation of the orbits of 1844 and 1884 is 0·043 in heliocentric longitude 310°, and there is another approximation, 0·065, in 143°. At present, however, the identity of the comets of De Vico and Barnard is to be regarded as at least doubtful.

The Double-Star 19 (Hev.) Camelopardi.—The annual proper motion of the principal component of this double-star, which is Σ 634, resulting from a comparison of Groombridge's Catalogue (mean year of observation 1808·4) with the Greenwich Catalogue of 1872, appears to be $-0''·297$ in right ascension, and $+0''·164$ in declination, the accurate trigonometrical formula being employed. For the relative motion of the smaller component with respect to the principal one, we may compare Struve's epoch for 1834 with a mean of the measures of Dembowski, Flammarion, and Asaph Hall between the years 1875 and 1879, viz.—

1834·15 ...	Pos. 348°·57 ...	Dist. 34″·042
1877·29 ...	,, 1·11 ...	,, 20·303

Whence we find for the annual relative motion in right ascension $+0''·858$ and in declination $-0''·302$, and we have thus a confirmation of the opinion expressed by M. Flammarion in his "Catalogue des Étoiles Doubles et Multiples en Mouvement relatif certain," that the smaller component has a real motion, more rapid than that of the principal star, of contrary sign, and not far from parallel to it.

A Daylight Occultation of Aldebaran.—On July 9, civil reckoning, Aldebaran will be visibly occulted in this country about noon. If the distribution formulæ of Littröw and Woolhouse are applied, the following expressions result for finding the Greenwich mean times of disappearance and reappearance, and the angles from north point—

Disappearance ... July 8, 23h. 26·7m. $-$ [0·2369] L + [9·5144] M
Reappearance ... July 9, 0h. 15·3m. + [9·1126] L + [9·4189] M
Angle at Disappearance 49°·3 + [0·542] L $-$ [8·004] M
,, Reappearance 321°·6 $-$ [0·528] L $-$ [8·701] M

Here the latitude of the place is put $= 50° + L$, and M is the longitude in minutes of time, *positive* towards the *east*. If we apply the formulæ to Oxford, we have $L = +1°·76$, and $M = -5·043$ m., and hence

Disappearance, July 8, 23h. 22·0m. at 55°.
Reappearance July 9, 0h. 14·2m. at 316°.

It should be added that the above quantities within square brackets are logarithms.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JUNE* 28 *TO JULY* 4

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 28

Sun rises, 3h. 48m.; souths, 12h. 2m. 58·7s.; sets, 20h. 18m.; decl. on meridian, 23° 16′ N.: Sidereal Time at Sunset, 14h. 46m.

Moon (one day after Full) rises, 19h. 58m.*; souths, 0h. 27m.; sets, 4h. 58m.; decl. on meridian, 18° 1 S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	3 43 ...	12 8 ...	20 33 ...	24 33 N.
Venus ...	4 56 ...	13 8 ...	21 20 ...	22 55 N.
Mars ...	1 50 ...	9 53 ...	17 56 ...	21 25 N.
Jupiter ...	8 45 ...	15 50 ...	22 55 ...	11 45 N.
Saturn ...	3 19 ...	11 29 ...	19 39 ...	22 31 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

June	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
30	13 Capricorni	6	0 0	1 7	119 239
30	14 Capricorni	5	1 36	2 22	158 233
July					
2	B.A.C. 7774	6	2 37	3 59	99 302

Phenomena of Jupiter's Satellites

June	h. m.	
29	20 26	I. tr. ing.
	22 46	I. tr. egr.
30	20 56	I. ecl. reap.

July	h. m.	
2	22 35	III. occ. reap.
3	20 28	IV. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

July 3, 23h.—Sun at greatest distance from the Earth, the distance being one-sixtieth part greater than the mean distance.

GEOGRAPHICAL NOTES

THE Royal Geographical Society have decided to send out another African expedition. This time the region to be explored is one of more than usual interest, and the method of procedure will be considerably different from that which has been hitherto usually followed. We have had many lines run through Africa in all directions, and what is now needed is the leisurely study of the continent in detail. This is what will be done by the expedition which will leave England in August next, under Mr. J. T. Last, who, as a lay agent of the Church Missionary Society, has done admirable work in the Zanzibar interior. Mr. Last, after making up his caravan at Zanzibar, will proceed south to Lindi, to the north of the mouth of the Rovuma River. Thence he will proceed to the confluence of the Rovuma and Lutende Rivers, and fix the longitude of the junction—an important geographical point not yet settled. He will then go on in a generally south-westerly direction, and, before reaching the north end of Lake Shirwa, turn southwards and make for the Namulli Hills, which, with other new features in this region, were discovered by Consul O'Neill in the end of 1883. Here Mr. Last will establish himself and make a detailed study of the whole region in all its aspects. He will make a complete survey of the surrounding country, its topography, its people, its botany, economic products, climate, and languages. When this is completed Mr. Last will enter the valley of the Likugu River, which rises in the neighbourhood of these hills, and follow it down to the coast of Quizungu, whence he will travel south to Quilimane or north to Angoche, and thence to Mozambique. Mr. Last will make a special point of collecting all possible information concerning the country he passes through, its changes; its people, their customs, languages, &c.; the climate, its sanitary conditions, and its suitability for the introduction of European and other economic plants.

THE last number of Petermann's *Mittheilungen* contains the conclusion of Herr Schunke's account of Kaffraria and the eastern borderlands of Cape Colony; the Panama Canal, with a map, by the Editor; the German possessions on the Slave coast, also with a map, by Herr Langhans; the latest explorations in Costa Rica, by Dr. Polakowsky. This last is specially interesting. It is a continuation of a paper, published two years ago, and describes ten additional journeys to various parts of Costa Rica by Dr. Thiel the bishop. It is unfortunate for science that this ecclesiastic, whose energy in educating his flock and whose thirst for scientific investigation are alike remarkable, should have been expelled by the Costa Rican Government, and that in such haste that he was compelled to leave behind him all his journals, collections, scientific observations, &c. He travelled and lived much amongst the various tribes of Indians, and studied their dialects, the antiquities, and ethnology of the country. He is at present visiting the eastern coasts of Nicaragua and Honduras in order to collect Indian antiquities and the remnants of Indian languages. The same paper also contains a report of a journey in Costa Rica by Padre Fernandez.

A CORRESPONDENT writes to *Ausland* from Santiago to correct a mistake as to a reported discovery of a glacier in Chile. The glacier in question is called the Ada glacier, and occupies the upper end of the Cajon de los Cipreses, a branch of the valley of Cachapual. In a note which appeared in the fourth number of *Ausland* this year and was copied from the *Proceedings* of the Royal Geographical Society, the discovery of this glacier was attributed to Dr. Güssfeldt. Some years previously the same discovery had been ascribed to Mr. Charles Wiener. The fact is, the correspondent states, the glacier has been known to the visitors to the baths of Cauquenes for the last twenty years at least. MM. Wiener and Güssfeldt, like other visitors to the baths, had had their attention called to it, and each in turn was consequently credited with its discovery.

THE French Minister of Public Instruction has published a report which he has received from M. Chaffanjon, a professor in Guadeloupe, giving an account of his mission on the Orinoco. In order to investigate fully the hydrography of the river he has often found it necessary to travel far away from the banks on both sides, and he has thus been able to survey the former beds. He has also obtained the materials for a geological map of the region and for a description of the phenomena attending the formation of this part of the earth's crust. Hitherto we have had only vague ideas respecting the Indian races, because they were without history or ancient remains. Prof. Chaffanjon has discovered in five different places inscriptions and pictures in granite, which he has carefully copied. He has collected a crowd of ethnological objects amongst the Caribs, the Panaies, and the Mapoyes. He hopes also to be able to fill certain gaps in the zoological and botanical collections in the Paris Museum. The report is accompanied by a sketch on a scale of 1 to 660,000 of the course of the Orinoco between Caicara and Ciudad Bolivar, which gives a considerable number of names new to geography.

THE Berlin Geographical Society has decided to erect a monument at the burial place of the late Dr. Nachtigal, at Cape Palmas, and all Germans are invited to send contributions to the fund for this purpose.

ELECTRICAL DEFINITIONS, NOMENCLATURE, AND NOTATION[1]

WITH the rapid progress that has lately been made in electrical science and its applications, there has sprung up a new and fast-increasing class of practical electricians. These, partly from necessity and partly from well-meant respect, have adopted and applied the old terms and expressions which appeared suitable to their predecessors, as well as coined not a few new ones, until now their vocabulary is in considerable confusion, and, as all must admit, requires sifting and reform.

Nothing is more tantalising and perplexing than the different modes of expression and symbols used by different authors, and sometimes by the same author, to explain and interpret one and the same thing or result. All this might be avoided if an international system of definitions, nomenclature, and notation was agreed upon and legalised. The rapidity with which the new definitions of the ohm, ampere, and volt (issued and legalised last spring at Paris by the International Congress of Electricians) were universally adopted, shows this. These definitions should be still further extended to other electrical units. They should embrace a suitable system of notation, whereby electrician could represent in symbols and letters, terms, expressions, and formulæ of common occurrence, in a similar manner to that adopted by chemists in connection with chemical elements and their combinations. Last session the author promised a communication to the Society on this subject, and, being again reminded by the Secretary of his unfulfilled promise, he now submits a few of the more apparent instances where ambiguity or want of uniformity exists, with suggestions, in the hope that a discussion may follow, and that a Committee of this Society may be formed to consider and draw up a series of definitions, nomenclature, and notation that would be generally acceptable. The proposed Committee might then confer with the French Committee, also with a similar Committee appointed by the British Association, and, finally, this important question should be referred to the International Congress of Electricians, in order that they may legalise and issue their decisions in a similar manner to that adopted by them in the case of the ohm, the ampere, and the volt. Undoubtedly, if such a course were adopted, most beneficial results would accrue to all concerned.

[1] Paper read before the Society of Telegraph Engineers and Electricians on May 14, 1885, by Prof. Andrew Jamieson, C.E., F.R.S.E., Member. Principal, College of Science and Arts, Glasgow.

Only last November M. Hospitalier brought this subject prominently before the International Society of Electricians at Paris, and strongly advocated an investigation, so that you shall no doubt have their support and concurrence.[1]

Examples.—(1) At the very outset students are perplexed by such different terms as "Ordinary[2] or Static or Frictional or High-tension Electricity." One author will tell his readers or students: "For a long time the name Frictional Electricity was given to a group of phenomena produced by electrical charges. This is an improper expression, because friction is only one means for producing electrical charges."[3] Another says: "Static Electricity is, however, a misnomer: it has no existence: all the phenomena are due to static strains, but there is always a gradual loss called leakage, which is, however, the current due to the actual conductivity of all circuits, and every motion set up by so-called static electricity implies a transfer of energy and action occurring in a field of force set up in the form of strains in the particular inductive circuit in which the motions occur."[4] A third objects to the word "tension" in respect to electricity, and points out that "all the phenomena observable in connection with so-called High-tension Electricity may be produced by electricity drawn from batteries or dynamos if the electromotive force or difference of potential is sufficiently increased." Would not the term "Electro-statics" be more suitable and comprehensive?[5]

(2) The old nomenclature "vitreous" and "resinous," as applied to substances which, when rubbed by certain other substances, produce opposite electrical properties, and the scholastic one and two fluid theories based upon these effects, should be discarded for the more comprehensive modern theory of electric polarity of molecules or continuous particles, expressed by "positive" and "negative," or by the algebraical signs (+) and (−).

(3) "Electrics," "dielectrics," "non-conductors," "insulators," and "isolators" are terms used by different writers to express a condition or behaviour of certain materials with respect to electricity, in contradistinction to the terms "non-electrics" or "conductors" as applied to other materials. The words "electrics," "non-conductors," and "non-electrics" are, strictly speaking, meaningless, because all materials may be termed electrics and all conductors, only differing in degree. The words "isolators" and "isolation" (from the French verb *isoler*, to isolate or separate) should give way to "insulators" and "insulation" as applied to substances which offer a comparatively greater resistance to electricity than semi or good conductors used in connection with the apparatus being referred to at the time.

The term "dielectric"[6] was first used by Faraday on finding that conduction was effected by induction (of polarity from molecule to molecule), and is generally employed by practical electricians when speaking of the inductive capacity of the insulating material surrounding the conductor of leading wires or submarine cables, or that placed between the plates of a condenser. In this sense, viz., of a body transmitting electric induction, or capable of undergoing electric stress, and retaining the stressed condition, it is a very appropriate term to use.

[1] Communication faite à la Société Internationale des Électriciens, le 5 Novembre, 1884, par M. E. Hospitalier sur L'Unité de Définitions, Conventions, Notations, et Symboles Électriques (*vide L'Electricien*, 15 Décembre, 1884).

"Sur la proposition du Président, l'assemblée décide qu'une Commission spéciale sera nommée à l'effet de rechercher les meilleures méthodes à adopter pour les notations électriques et de codifier ces notations.

"M. le Président propose, au nom du Bureau, d'appeler à faire partie de la Commission des notations électriquez—

"MM. Ed. Becquerel	MM. H. Becquerel
E. E. Blavier	G. Cabanellas
Marié-Davy	J. Capentier
Tresca	Gauthier-Villars
Maurice Lévy	E. Hospitalier
G. Lippmann	D. Monnier
Félix Lucas	D. Napoli
Mercadier	Pollard
De Meritens	J. Raynaud

M. V. Williot.

"L'assemblée adopte cette liste à l'unanimité."

[2] The term used by Faraday. (See "Experimental Researches," by Michael Faraday, p. 82, Art. 264.

[3] "Electrician's Pocket-Book," by E. Hospitalier, p. 5.

[4] "Electricity," second edition, by Sprague, p. 6, Art. 20.

[5] "Electricity and Magnetism," by Clerk Maxwell, vol. i., part 1.

[6] Faraday's "Experimental Researches." p. 364. "I use the word *dielectric* to express that substance through or across which the electric forces are acting." (See also pp. 537, 538.)

(4) The term "accumulator" is the name given in several text-books to apparatus, such as the Leyden jar or condenser, for receiving and retaining quantities of electricity, but has been lately inappropriately applied to secondary batteries, which do not accumulate electricity.

(5) "Cascade," as applied to Leyden jars, should give way to "series."

(6) "Tension"[1] "potential," and "electro-motive force," are terms which, when variously and indiscriminately applied, have given rise to considerable confusion, and a great deal of writing in trying to define them. If we consider "tension" as simply the stress put upon the current by the electro-motive force, and not in the sense that it used to be employed (for example: "Join up a battery or set of condensers for tension"), it might do very well if kept in its place; but it can easily be dispensed with. "Potential" is a word that has also given great trouble.

We find in Sprague's "Electricity"[2] no less than three pages devoted to an explanation of the different ways in which the words "tension" and "potential" are employed. Clerk Maxwell said: "The theory of electro-statics is greatly simplified by the introduction of this new conception of potential." "As soon as we pass from electro-statics to other departments of electrical science, we find that the conception of potential is no longer available, except when used in a restricted sense and under carefully-defined conditions." "In other parts of electrical science we have to deal with electro-motive force in cases where 'potential' and consequential 'potential difference' are words without meaning." Prof. Fleeming Jenkin, in his well-known text-book on electricity and magnetism, devotes twenty-six pages to "potential," and defines "unit difference of potential or electro-motive force in electro-static measure to exist between two points when the unit quantity of electricity in passing from one to the other will do the unit amount of work." "The property of producing a difference of potential may be said to be due to a peculiar force, to which force the name *electro-motive force* is given." "The words *electro-motive force* and *difference of potential* are used frequently one for the other, but they are not, strictly speaking, identical." "Electro-motive force is the more general term of the two, and includes difference of potential as one of its forms." "Potential" might well be reserved for electro-statics, and "electro-motive force" for electro-kinematics, or current electricity, and thus prevent confusion. The word "electric-pressure" has come into vogue lately, and strongly appeals to those of a mechanical turn of mind, seeing that the hydraulic simile of "head" or "pressure" is often brought forward to assist in explaining the terms "potential" and "electro-motive force."

(7) In magnetism we find the same want of uniformity exists. Take the case of a freely-suspended magnetised needle. The pole which turns towards the geographical north is variously called the "austral pole," "north pole," "north-seeking pole," marked pole," and is painted red by Sir Wm. Thomson, while Sir Wm. George Airy, Prof. Guthrie, and others paint it blue. It is sometimes indicated by French makers by the letter *A*, and by British by the letter *N*. The pole which turns towards the geographical south is correspondingly called the "boreal pole," "south pole," "south-seeking pole," "non-marked;" painted blue by Thomson, and red by Airy, Guthrie, and others, and indicated by the letter *B*. or *S*. Such is the general doubt and diversity in regard to the nomenclature on this subject, that each author on magnetism considers it necessary to state at the outset which term and symbol he intends to apply. If once for all the pole which turns towards the north was termed the "*north* pole," painted blue, and indicated by the letter *N*, and the opposite pole was termed the "*south* pole," painted red, and indicated by the letter *S*, much vexation would be saved. The French terms "austral" and "boreal," with letters *A* and *B*, should be obliterated. In this way the earth would have a uniformly recognised polarity, which would of course be opposite to that of the magnetised needle—in other words, the true north pole of the earth would be that situated near the geographical south pole.[3]

(8) Sailors and some writers on the mariner's compass call the angle which the magnetic meridian makes with the geographical meridian the "variation" of the compass, while electricians

[1] For a good definition of these terms, see "Electricity and Magnetism," by Clerk Maxwell, vol. i. p. 49. [2] 1884 edition, pp. 58-62.

[3] Sir Wm. Thomson calls the magnetic pole of the earth, situated near the geographical north, the "north pole," and the end of the magnetised needle which points towards it the "*true south pole*" of the needle, and paints it red

call it the "declination." Variation is, properly speaking, the hourly, diurnal, annual or secular changes which occur in the value of the elements of terrestrial magnetism. This leads to great confusion and argument between the electricians and the officers of a telegraph steamer. The declination for each place is marked on the Admiralty charts. Sailors also speak of the "deviation" of a compass, meaning by that the local error due to the resultant of the quadrantal, semicircular, and heeling errors, &c. It would be far better if they simply spoke of the "compass error," or angle which the meridian of their compass-needle makes with the true north and south magnetic bearings. This deviation or compass error arises from local magnetic influences. Sir William Thomson's well-known compass, when properly adjusted on board a ship, has no compass error, and therefore the only thing to guard against and correct for in the steering of a ship is the declination of the place where the ship may be at the time of observation. Of course, if the magnetism of the ship changes in the slightest, due to a change of cargo or position thereof (if of iron or steel), or due to buffeting the waves for some time on one course, a slight error will creep in, but the compass can be soon adjusted to the new condition of affairs, and the officers have therefore seldom to think of or even speak of "deviation" or "compass error."

(9) When we come to electricity generated by batteries, we find the expressions "galvanism," "voltaic electricity," "dynamic electricity," "electro-kinetics," "current electricity,"[1] &c., according to the fancy of the writer or speaker. Surely one name might suffice; and certainly the older term "galvanism," and "voltaic electricity" might well be left to the past. The simple term "current electricity" seems to commend itself, as most of the effects in connection with this branch of the subject have reference to electricity as if it was in motion or distributing itself over a conductor.

(10) "Density of current" and "intensity of current" often cause great confusion. "Density of current" should only be used in the case of electrolysis or electro-deposition of metals. Here it means the amperes per unit of surface of the cathoder. In electro-statics "surface density" or "electric density" means the quantity per unit area of surface. "Intensity" was used at one time in the same sense as "electro-motive force" is now, and therefore not so much out of place there; but several writers, notably Prof. Silvanus Thompson, have thought fit to borrow the French term "*intensité de courant*" wholesale, instead of a translation thereof, and to symbolise it by the letter *I*. The literal translation of the French word *intensité* being strength or amount, therefore the expression "current strength," or simply "current," symbolised by *C*, is far preferable, for it conveys the correct meaning of the quantity in a given time. With a little pressure, French electricians would no doubt agree to the symbol *C* instead of *I*, to promote uniformity. Then *I* might be reserved for intensity of magnetism, where it suits very well.

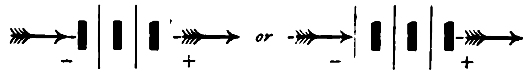
11. "Positive electrode," "(+) terminal," "zincode," "anode," "positive pole," and "negative plate," severally used by different writers to designate that end of a cell, battery, or pile where the current leaves, and "negative electrode," "(–) terminal," "platinode," "kathode" or "cathode," "negative pole," "chlorous pole," "positive plate," where the current returns to or enters the same, requires revising and simplifying, more especially when we consider that the end plates of a battery are of opposite sign to their electrodes or terminals, and that the nomenclature is still further complicated when we come to consider secondary batteries or electrolysis by the terms "anion," "kation" or "cation," and "ions." Take, for example, the definition given by Sprague[2] of "anode": "The positive electrode or pole of a battery; the wire or plate connected to the copper or other negative element of the battery; the plate which leads the + current into a solution to be decomposed, and at which are set free the oxygen, acid radicals and all —ions (anions).[3] In electro-metallurgy it is usually formed of the metal to be deposited, in which case it is called the soluble anode or pole"!!

[1] See Ferguson's "Electricity," second edition, by Prof. Blyth, p. 164. The term "electro-kinematics" has been used by Clerk Maxwell to cover a large part of this subject, such as "electric current," "conduction," "resistance," "electro-motive force," "electrolysis," &c. (See "Electricity and Magnetism," by Clerk Maxwell, vol. i. part 2.)

[2] Sprague's "Electricity," 1884 edition, p. 624.

[3] See Faraday's "Experimental Researches," articles 661 to 667, on *Definitions of New Terms*, where he very clearly points out the meaning he attaches to the words "electrode," "anode," "cathode," "ions," "anion," "cation," &c.

12. Again, we have the two different ways of graphically representing a battery



according to the whim or fancy of the writer. Practical submarine electricians were the first to use this very neat and handy way of representing a battery and its poles, and always adopted the former method, with the long thin vertical line for the plate where the current leaves, and the thick short line for the plate where the current returns to the battery. Why should this have been departed from? It is a mere arbitrary arrangement, but, being a most convenient symbol, it should be used in a uniform manner. Mr. John Munro proposes that the symbol for a secondary battery should be a modification of this, viz.,

the current outside the cell proceeding from the long line to the short one.

13. "Parallel circuit," "multiple arc," "loop circuit," "in loop," "derived circuit," "shunt circuit," are all expressions to signify pretty much the same thing, where one expression, "shunt circuit," would do.

14. "Polarisation" is a term used in many different senses—for example, the polarisation of battery plates, molecular polarisation due to electrification or magnetisation, polarisation of light due to magnetism, &c., as in Dr. Kerr's experiments. Some reform is required here.

15. Coming to telegraphy, telephony, and electric lighting, we find, as M. Hospitalier points out, "the words 'generator,' 'receiver,' 'transmitter,' and 'motor' are mixed up by different inventors, sometimes through ignorance, sometimes willingly." "A 'generator' is an apparatus which, receiving energy of a certain nature, produces an energy of another nature, and it borrows its name from the nature of the energy which it generates. A 'receiver' is an apparatus analogous to the generator, but it borrows its name from the energy which it receives." "A given apparatus is at once a generator and receiver—for example, an electric motor is a generator of mechanical energy and a receiver of electrical energy." "The name 'transmitter' ought to be reserved for an apparatus which, receiving an energy of a certain kind, produces or brings into play an energy of the same kind or of the same form." For example, a relay on a telegraph system, or induction coils as used on a trunk telephone line with several subscribers' lines at each end, or in electric lighting on the Gaulard and Gibbs' system, lately tried in London. Professor Silvanus Thompson uses the phrase "Dynamo-electric machinery" in the most general etymological sense of the term, as meaning machinery for converting the energy of mechanical motion into the energy of electric currents, or *vice versâ*, excepting such induction machines as Holtz, Voss, &c. He thinks this reduces the ambiguity to a minimum, and leaves the word "motor" to be applied, if desired, to the steam-engine, water wheel, &c., from which the mechanical motion is derived. The terms "magneto-electric machine," as applied to a dynamo fitted with permanent field-magnets, and "electro-magnetic machine" to a series, separately-excited, shunt, or compound-wound dynamo (generator or receiver) are very handy expressions, and should not be discarded.

16. We have dealt hitherto chiefly with definitions and nomenclature, and have given a few examples: others will occur to every member present. We now come to abbreviations and notation with symbols. The want of uniformity here, and the need for systematising, is still more obvious, but perhaps more difficult to accomplish. Every one admits the great advantage in being able to write down the symbols for chemical elements and their actions and reactions one with the other in the form of simple equations, which any one may comprehend who knows the subject, without a detailed description of what each letter or symbol stands for. Electricians should not rest satisfied until they are supplied with a similar universally-accepted notation, whereby electrical phenomena and actions may be similarly treated. The author submits a sample of what he considers would be useful in this respect. Many of them are taken from Munro and Jamieson's "Pocket-book of Electrical Formulæ," where an effort was made to use the same notation and abbre-

viations throughout, except in such cases as that of quoting direct from some other author.

It will be observed in this list that in most cases the first English or Greek letter of the word has been used. Those relating to the metric system have been copied from the French edition of Hospitalier's "Electrician's Pocket-book," which are no doubt copied from the list decided upon by the International Commission on the Metre, with a few omissions and additions by the author.

The Greek letters π, μ, ϵ are universally adopted—π for the ratio of the circumference of a circle to its diameter, μ for the coefficient of friction, and ϵ for the base of Napierian logarithms.

Metric Abbreviations

m. for metre.
cm. ,, centimetre.
mm. ,, millimetre.
m^2 ,, metre-square.
m^3 ,, metre-cube.
c^2 ,, centimetre-square.
c^3 ,, centimetre-cube.
gm. ,, gramme.
mg. ,, milligramme.
kg. ,, kilogramme.
kgm. ,, kilogrammetre.
&c. &c.
temp. ,, temperature.
res. ,, resistance.
g.d. ,, gramme-degré.
kg.d. ,, kilogramme-degré.

Electrical Abbreviations, Notation, and Symbols

When a capital letter is used for the symbol, then small capitals or italics with suffixes, 1, 2, 3, &c., may be used for parts making up a whole. For example—L for length, L_1, L_2, L_3, &c., or l_1, l_2, l_3, for different lengths, or parts of L.

Fundamental and Derived Mechanical Units

L for Length.
M ,, Mass.
T ,, Time.
V or v ,, Velocity.
A or a ,, Acceleration.
F ,, Force.
δ ,, dyne; *e.g.* 10δ = 10 dynes.
W ,, Work.
w ,, weight.
ft.lb. ,, foot pound.
H.P. or HP ,, Horse-power.
I.H.P. ,, Indicated horse-power.
B.H.P. ,, Brake horse-power.

Other Common Symbols allied to Mechanical Work

S for Speed or Stress.
D or d ,, Diameter.
r ,, radius.
ω ,, angular velocity = $2\pi n$ in radians per second.
g ,, acceleration due to gravity.
N or n_1 n_2, &c. ,, number of revolutions.
–^{s} ,, second; *e.g.* 3^{hr} 5^m 10^s = 3 hours 5 minutes 10 seconds.
τ_1 τ_2 τ_3, &c. ,, temperatures, absolute.
or $t_1°$ $t_2°$ $t_3°$, &c. ,, ,, common.

Practical Electric Units

The astronomical method of putting the small letters above the line of the figures, as in the case of the example 3^{hr} 5^m 10^s (3 hours 5 minutes 10 seconds), has not been followed in the following examples, as mathematicians object to the system, the letters appearing as if they were powers. Neither will they readily agree to suffixes, as suffixes have been already adopted by them to distinguish between things of the same kind. The author has therefore written the distinguishing letters on a level with the figures: for example, 10ω stands for 10 ohms (the methods 10^ω and 10_ω being both objectionable).

C.G.S. for centimetre, gramme, second.
R ,, Resistance.
ρ ,, specific resistance.
ω for ohm; *e.g.* 10ω = 10 ohms.
Ω ,, megohm; *e.g.* 10Ω = 10 megohms.
C ,, Current.

Important Electrical Definitions

A ,, Amperes; *e.g.* 10A = 10 amperes.
a ,, milliamperes; *e.g.* 10a = 10 milliamperes.
E ,, Electro-motive force, or E.M.F.
v ,, volts; *e.g.* 10v = 10 volts.
K ,, Capacity.
σ ,, specific inductive capacity.
Φ ,, farads; *e.g.* 10Φ = 10 farads.
ϕ ,, microfarads; *e.g.* 10ϕ = 10 microfarads.
Q ,, Quantity (coulombs).
P ,, Power.
W' ,, Watts, or Watt power.[1]
W ,, Work in Joules.
H ,, Heat in ,,
J ,, Joule's equivalent = 42×10^6 ergs, or work spent on ·2405 gm. of H_2O raised by 1° cent.

$$C = \frac{E}{R} \text{ (Ohm's law).}$$

$$E \times C = C^2 R = \frac{E^2}{R} = W' \text{ (Watt powers).}$$

$$E\,C\,T = C^2 R\,T = \frac{E^2 T}{R} = E\,Q = W \text{ (Joules).}$$

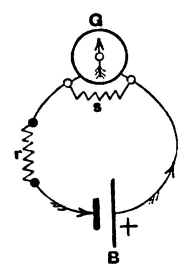
$$\frac{E\,C\,T}{J} = \frac{C\,R\,T}{J} = \frac{E^2 T}{J\,R} = \frac{E\,Q}{J} = \frac{W}{J}$$
$$= W \times {\cdot}2405 = \text{g.d. or gramme degrees.}$$

z = Electro-chemical equivalent.

Magnetism

N for North pole of a magnet, painted red.
S ,, South ,, ,, ,, blue.
m ,, magnet strength (of pole) or quantity of magnetism.
l ,, distance between the poles of a magnet.
M or ml ,, moment of a magnet.
ℑ or I ,, Intensity of magnetisation.
s ,, cross section of a magnet.
mp ,, magnetic potential.
μ ,, magnetic permeability.
κ ,, magnetic susceptibility.
H ,, Horizontal intensity of terrestrial magnetism.
θ ,, angle of deflection.
d_1 d_2 d_3 ,, divisions deflection, as in mirror galvanometer.
r ,, radius (mean) of a coil or solenoid.
n ,, number of anything; *e.g.* turns of wire in a coil or galvanometer.

Take Tangent Galvanometer Formulæ, as an example to illustrate the above:—



$$\text{Current, } C = H \frac{r}{2\pi n} . \tan \theta.$$

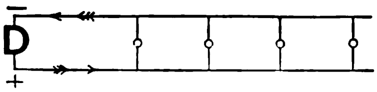
G for Galvanometer or galv. res.
s ,, shunt res. for galvanometer
r ,, resistance coils
B ,, Battery or battery res.

$$\therefore R = B + \frac{G\,S}{G + S} + r.\text{[2]}$$

[1] By adopting the term "Watt power," there can be no doubt what a Watt means.
[2] See Munro and Jamieson's "Electrical Pocket-book," p. 65.

Dynamo Circuits Contractions

Example:—



 or D for Dynamo.

T +	,,	Terminal positive.
T −	,,	Terminal negative.
E.M.	,,	Electro-magnet.
or F.M.	,,	Field Magnet.
c.p.	,,	candle-power of a lamp.
A.M.	,,	Ampere meter.
V.M.	,,	Volt-meter.
S.W.G.	,,	Standard wire gauge.

For use in Formulæ

R_a R_m R_e	,,	Resistance of armature, magnets, and external circuit respectively.
C_a C_m C_e	,,	Current in armature, magnets, and external circuit respectively.
L_s	,,	coefficient of self-induction.
L_m	,,	coefficient of mutual induction.

In the above notation the first letter of the most important words has been used wherever it was found practicable to do so, and the recurrence of the same letter under similar circumstances avoided as much as possible. In cases where no ambiguity can occur, such as H for the heat in Joules, and H for the horizontal intensity of the terrestrial magnetism; *m* for metre, and *m* for magnetic strength of pole; V for velocity, and v for volts, it will be observed that the same letters appear in each case.

M. Hospitalier, the Secretary for the French Committee on this subject, came over from Paris specially to take part in the discussion, and related what had already been done by him in Paris.

Prof. Forbes, Mr. John Munro, Prof. Ayrton, Dr. Fleming, Prof. Hughes, Prof. Silvanus Thompson, and others took part in the discussion, and generally agreed that a uniform system was much required. The paper, they said, had given a very fair start to this being accomplished.

The author replied that he was glad the Society had agreed so readily to form a thoroughly representative committee, and hoped that their work would be not only speedily accomplished but satisfactory to all concerned.

THE JUBILEE OF THE STATISTICAL SOCIETY

THE Statistical Society has been holding a series of meetings during the present week in celebration of the jubilee of its foundation. The meeting is really an International Congress of Statistics, some of the most eminent foreign statisticians being present as the guests of the Society; among others Sig. Bodio, of Rome; MM. Keleti, Körösi, and Prof. Neumann-Spollart, of Buda-Pesth; Prof. Levasseur and M. de Foville, of Paris; Gen. F. A. Walker, of the United States, Gen. Liagre, and others. The meetings have been held in the theatre of London University, and several subjects of much statistical importance have been introduced for discussion. One of them was the claim of statistics to be considered as a science, discussed at some length in the address of the President, Sir Rawson W. Rawson. Statistics, as usually treated in this country, little more than the mere calculating of numbers, is a mere mechanical operation; but which, treated as some of the most eminent statists have treated it, as dealing with the structure of human society, then it certainly becomes amenable to scientific methods. Sir Rawson Rawson referred further to the want of organisation in the collection and publication of official statistics in this country, and rightly advocated reform in this respect. Among the other papers read on Monday were—a sketch of the history of the Society, by Dr. F. J. Mouat; "Statistical Developments, with special reference to Statistics as a Science," by Dr. W. A. Guy, F.R.S.; and on "Statistics and their Enemies," by M. de Foville. One of the principal papers on Tuesday was by Mr. R. Giffen, on "Some General Uses of Statistical Knowledge," in which, among other things, he referred to the rapid increase of the population of Europe during the last century as compared with the increase in China and other Asiatic countries (except India) and in Africa. Should the present rate of European increase continue, the population of our continent in another century will be 1000 millions, whilst that of the United States would be 800 millions. Mr. Giffen maintained that the increase in Europe had been accompanied by a corresponding increase in the means of subsistence and improvement in the position of all classes.

Mr. J. S. Jeans read a paper "On Uniformity of Statistics." He held the chief *desiderata* required with a view to the improvement and co-ordination of the statistical work undertaken by different Government bureaux were: (1) an agreement as to the major facts necessary to be collected for each special department of statistics; (2) uniformity in the processes by which these facts were got together; (3) co-ordination of the methods whereby the materials thus collected were systematised and made use of; (4) the adoption, as far as possible, of the calendar year as the universal statistical period, so that when comparisons were made they should alway relate to the same dates; (5) the general adoption of the metrical system of weights, measures, and currency.

Herr Körösi spoke "On the Unification of Census Record Tables." The voluminous and polyglot census results of the world were, he found, practically non-comparable, and he proceeded to sketch a uniform scheme of record tables by which we should arrive at one bound at the highest aim of statistics—the possession of a uniform description of the different nations and of all mankind as regarded sex, age, civil state, illiteracy, occupations, &c.

Mr. F. Y. Edgeworth, in a paper entitled "The Methods of Statistics," confined himself to the treatment of numerical means. He showed that if we take several means of phenomena belonging to one and the same class (*e.g.* statures of men), each mean derived from numerous observations, the set of values thus presented would in general fulfil a certain simple mathematical law. The general formula involved a constant or coefficient peculiar to each class of phenomena, which must be discovered by experience. When this operation had been performed we had an apparatus for testing whether any given mean was or was not exceptional, indicative that the set of things of which the *datum* was the mean might (as compared with other phenomena of the same general class) be regarded as belonging to a distinct species. A pretty illustration of important principles was afforded by the statistics of a wasp's nest, "the image of trade which wasps entering and issuing from their nest present." It appeared that the exports and imports of this miniature commerce fluctuated with mathematical regularity. As further illustrations of the variety of interests amenable to the general law, he adduced the attendance of the members of a club at a *table d'hôte*, and the frequency of dactyls in the Latin hexameter. The conditions postulated by the Calculus of Probabilities were particularly well exemplified by the fluctuations of the Virgilian rhythm. In conclusion, he alluded to the simpler methods of statistics, and maintained that the mathematical, as compared with the more elementary, organon could produce the same effect with less trouble, or, with the same trouble, greater effect.

M. Emile Levasseur, Member of the Institute and Professor at the College of France, initiated a discussion on the graphic method applied to statistics, exhibiting diagrams and cartograms or statistical maps illustrating his views. Prof. Marshall, of Cambridge, who followed, advocated the use of a standard gauge for historical curves in order to simplify references to the graphic method of statistics, and pointed out dangers in the employment of curves arising from their deceptive appearance to the untrained eye. He suggested a ready means of testing the values of curves under comparison.

Yesterday was entirely occupied by a conference and discussion on the subject of an International Statistical Institute, the establishment of which was virtually agreed to.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—At the annual election at St. John's College on June 22, the following awards were made to students of Mathematics, Natural Science, and Medicine:—

Foundation Scholarships.—Mathematics: Love, Fletcher (each raised to 100*l*.), Bushe-Fox, Kirby, Mossop, Foster Hill. Natural Science and Medicine: Shore, Rolleston, Seward.

Exhibitions.—Mathematics: Holmes, Middlemast, Pressland, Roseveare, Bushe-Fox, Foster, Flux. Natural Science and Medicine: Rolleston, Olive, Jones. Natural Science: Evans, Rendle, Lake.

Proper Sizarships.—Mathematics: Norris, Varley.

Hughes Prizes.—Mathematics: Love. Natural Science: Shore.

Wright Prizes.—Mathematics: Fletcher, Bakre, and Flux (equal).

Herschel Prize (for Astronomy).—Bushe-Fox.

Hockin Prize (for Electricity).—Not awarded.

The Hutchinson Studentship (NATURE, May 28, p. 90) was awarded to Ds. Rapson (First Class, Classical Tripos 1883–85, and Indian Languages Tripos 1885) to assist him in the prosecution of his studies in Sanskrit literature.

The next Adams Prize will be adjudged in 1887. The subject is Ellipsoidal and Spheroidal Harmonic Analysis, attention being particularly drawn to the reduction of the formulæ in this calculus to practical forms adapted to numerical calculation. Since, with the exception of spherical harmonics, this method has remained almost barren in physical investigations, actual illustrations of its utility are invited. The essays must be sent in by December 16, 1886, and any Cambridge graduate may compete. The successful candidate will receive 170*l*.; he must print the essay at his own expense.

The Mathematical Board recommend that four separate examiners be appointed for the final portion of the Mathematical Tripos, in the hope of inducing more specially qualified professors and specialists to undertake this advanced work.

The Annual Report of the Observatory gives a very satisfactory record of progress. Among the 3253 observations with the transit circle were 2442 of zone stars on 100 nights, the greater number at five or seven wires, and all read off with four microscopes. The reductions of observations are in a forward state.

At the Botanical Gardens during the past year the collection of insectivorous plants has been greatly improved. A number of new or rare species have flowered—some for the first time in this country. A speciality has been made of Salvia, and four species from this garden have been figured in the *Botanical Magazine*.

A grant not exceeding 100*l*. is to be made to C. S. Sherrington, M.B., of Gonville and Caius College, from the Worts Travelling Scholars Fund, to enable him to proceed to Valentia to investigate the experiments now being made by Dr. Ferrand on inoculation as a preventive against cholera.

SCIENTIFIC SERIALS

IN the *Journal of Botany* for May and June Mr. W. B Grove continues his paper on "new or noteworthy fungi," which is well illustrated. Several new species are described, and one new genus, *Diplococcium*, near to *Cladotrichum*.—Mr. S. Le M. Moore identifies *Bacterium fœtidum*, Thin, found in association with profuse sweating of the soles of the feet, with the ordinary micrococcus of surface soil.—Mr. H. N. Dixon adds a new species to the British moss flora, *Catharinea dixoni*, from Northampton.—Mr. R. D. Fitzgerald and Mr. H. N. Ridley describe new Orchids; and Rev. B. Scortechini a new genus of Myrtaceæ, *Pseudoerigenia*, from the Malay Peninsula.—Dr. H. Trimen sends some notes on the flora of Ceylon, and Rev. W. H. Purchas contributes notes on Dovedale plants.

Rivista Scientifico Industriale, May 15.—A new explanation of the red after-glows (continued), by Prof. Carlo Marangoni.—On the diathermicity of fluids, by A. Volta.—Some electric phenomena associated with rarefied gases, by Emilio Piazzoli.—Variations in the electric resistance of solid and pure metal wires according to the temperature (concluded), by Prof. Angelo Emo.

Bulletin de l'Académie Royale de Belgique, April 4.—Crystallographic note on some specimens of calcite from the Carboniferous limestone of Blaton.—Note on the recent appearance of a school of whales (*Balæna biscayensis*) on the east coast of the United States, by M. P. J. Van Beneden.—Account of the discovery of a gigantic Mosasaurian (Hainosaurus) in the chalk formation of Mesvin-Ciply near Mons, Belgium, by M. E Dupont.—On Riccati's equation and its double generalisation, by M. J. de Tilly.—State of the vegetation during the month of March at Liége and Longchamps-sur-Geer, Belgium, by Baron de Selys Longchamps.—On the presence of Condroz graywacke in the neighbourhood of Beaumont, Entre-Sambre-et-Meuse, by M. Michel Mourlon.—On the porphyries of Bierghes, by M. A. Renard.—On the tension of saturated vapours: a modification of the atomic law of Dalton, by M. P. de Heen.—The Roumanians in the Middle Ages: a historical puzzle, by M. A. D. Xenophol.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"The Action of Tidal Streams on Metals during Diffusion of Salt and Fresh Water. Experimental Research, Part II. (Gravimetric)." By Thomas Andrews, F.R.S.E. Communicated by Prof. G. G. Stokes, Sec.R.S.

In a paper last session on "The Electromotive Force during Diffusion in Tidal Streams" (see *Proc. Roy. Soc.*, No. 232), the author recorded the electrical part of this investigation. The present communication contains the concluding gravimetric experiments of the research. The effects attending the diffusion of the salt and fresh water in tidal estuaries, on parts of the same metal, of known composition and general properties, were estimated in each case for a period of *one year*, during which bright plates of the following metals—viz., wrought iron (combined carbon, none), "soft" Bessemer steel (c.c. 0·15), "soft" Siemens-Martin steel (c.c. 0·17), "soft" cast steel (c.c. 0·46), "hard" Bessemer steel (c.c. 0·51), best cast metal, "No. 1" (c.c. 0·39), common cast metal, "No. 2" (c.c. 0·67), were constantly exposed to conditions of galvanic action similar to those obtaining in some tidal streams. The results demonstrate that electric disintegration of the nature alluded to in this and the former paper (viz., the galvanic destructive action on parts of even the same metal, arising from difference of electrical potential during diffusion between the surface and lower waters in a tidal stream) is, on comparison with other investigations by the author, apparently of much greater extent than the loss either from simple corrosion in sea water alone, or than that which ensues from the action on each other of dissimilar metals of this group (such as wrought irons, cast metals, and steels) in galvanic connection in sea water. Compared with simple corrosion in sea water only, the increase in loss varied from about 15 up to 50 per cent., according to the nature of the metals. The results of the experiments in this and the former paper indicate, therefore, that the tidal action on any vessel or metallic structure, of sea and fresh water whilst diffusing is (in the case even of the same metal thus exposed to the simultaneous action of top and bottom waters) considerably more destructive in its nature and character than the action of sea water alone. Moreover, the author has found it (in other experiments) extending over long periods to considerably exceed (in some instances varying from about 55 to 120 per cent.) the loss caused by galvanic action between dissimilar metals of the iron and steel group in circuit in sea water.

Geological Society, May 27.—Prof. T. G. Bonney, F.R.S., President, in the chair.—George Ormond Kekewich was elected a Fellow of the Society.—The following communications were read:—On the so-called diorite of Little Knott (Cumberland), with further remarks on the occurrence of Picrites in Wales, by Prof. T. G. Bonney, F.R.S., Pres.G.S. The Little Knott rock and its microscopic structure were briefly described by the late Mr. Clifton Ward, who named it a diorite, but called attention to its abnormal character. The author gave some additional particulars, and showed that, although the rock varies in different parts of the same outcrop, and is not one of the most typical representatives of the picrite group, its relations on the whole are with this rather than with the true diorites. He also called attention to the extraordinary number of boulders which have been furnished by this comparatively small outcrop, and discussed the relation of their distribution to the former extension and effects of ice in the Lake District. He briefly noticed the occurrence of additional boulders of picrite in Anglesey, and described specimens from two localities (Caemawr and Pengorphwysfa) where a similar rock has been discovered *in situ* by Prof. Hughes. Hence it is probable that the Anglesey boulders are derived from localities in that island, and not from Cumberland. From a re-examination of specimens collected by the late Prof. Sedgwick and Mr. Tawney, preserved in the Woodwardian Museum at Cambridge, the author showed that the rock must occur *in situ* in two localities in the Lleyn peninsula—in the neighbourhood of Clynnog and of Aberdaron. Lastly, he described a very remarkable picrite boulder, discovered by Dr. Hicks, which rests on "Dimetian" rock at Porthlisky near St. David's.—Sketches of South-African Geology; No. 2, a sketch of the gold-fields of the Transvaal, South Africa, by W. H. Penning, F.G.S. The gold-fields of the Transvaal have been defined as covering nearly all the eastern and northern districts of the State, though but a small portion of the area is productive. In this paper the author described only the Lydenburg and De Kaap gold-fields, leaving those of Pretoria and Marabastadt for a future communication. The auriferous region is known to extend 350 miles to the northward beyond the Limpopo River, so that the gold-bearing rocks are found throughout at least 7½ degrees of latitude and 3 of longitude. The area of the two gold-fields mentioned, comprising together about 3000 square miles, was defined; and the author, after noticing some old gold-workings, proceeded to give an account of the physical features of the country. He especially called attention to the circumstance that most of the rivers rise to the west of the highest range, and flow eastward through it. The oldest gold-bearing rocks consist of unfossiliferous schists, shales, cherts, and quartzites, classed by the author as Silurian. Amongst these a great mass of coarse granitic rock is intruded, consisting of quartz and felspar, with but little, if any, mica. This granite, in the De Kaap valley, forms an ellipse seventeen miles long by ten broad, with a narrow northerly prolongation. Both the granite and the stratified rock are traversed by intrusive dykes, chiefly of diorite. These beds have been much disturbed and then cut down, probably by marine denudation, to a level plain 1700 or 1800 feet above the sea. Upon them rest unconformably a great sequence of conglomerates, sandstones, and shales, the "Megaliesberg beds" of a former paper, but now provisionally classed as Devonian. These rocks also are traversed by dykes of diorite and other kinds of trap. The "High Veldt beds" overlie the "Devonian" with some unconformity. Several sections and observations illustrative of these facts were described, and details were given of the different gold-mines in each of the great systems noticed, and also in alluvial deposits. It was shown that much gold was derived originally from veins in the older or Silurian rocks, and that some of that met with in the newer system occurred in conglomerates or other detrital beds. But there are also gold-bearing quartz-veins intersecting the latter.—On some erratics in the boulder-clay of Cheshire, &c., and the conditions of climate they denote, by Charles Ricketts, M.D., F.G.S.

Royal Meteorological Society, June 17.—Mr. R. H. Scott, F.R.S., President, in the chair.—Lieut. A. Leeper, R.N., was elected a Fellow of the Society.—The following papers were read:—A few meteorological observations made on a voyage up the Nile in February and March, 1885, by Dr. W. Marcet, F.R.S. The author, on a voyage up the Nile from Cairo to Assouan, made a series of meteorological observations, and in the present paper gives the results of those relating mainly to nocturnal radiation and the temperature of the water of the Nile.—The mean direction of cirrus clouds over Europe, by Dr. H. H. Hildebrandsson, Hon.Mem.R.Met.Soc. The author has collected a number of observations on the movements of cirrus clouds over various parts of Europe, and after discussing them has arrived at the following results: (1) the mean direction at all stations lies between south-west and north-west; (2) in winter the cirri come from a more northerly direction, and in summer from a more southerly; (3) in winter the northerly component is greater on the Baltic and the north coast of the Mediterranean; (4) the mean directions of the upper currents nearly coincide with the mean tracks of storm-centres; (5) the upper currents of the atmosphere tend in general to flow away from those areas in which a barometrical depression exists at the earth's surface towards those in which there is an elevation of pressure.—On the influence of accumulations of snow on climate, by Dr. A. Woeikoff, Hon.Mem.R.Met.Soc.—Note on the weather of January, 1881, by Mr. E. Harding, F.R.Met.Soc. It will be remembered that the weather of January, 1881, was remarkable for the prolonged and exceptionally severe frost, the heavy gale of the 18th and 19th, and the snowstorms. The author has prepared isobaric charts for the North Atlantic and adjacent continents for January, 1881, and compared it with similar charts for January in other years. He shows that the severe weather in 1881 was due to a reversal of the normal conditions, the atmospheric pressure being high in the north and low in the south.—Results of meteorological observations made in the Solomon Group, 1882-84, by Lieut. A. Leeper, R.N.—Graphic hygrometrical table, by Mr. D. Cunningham, M.Inst.C.E., F.R.Met.Soc.

Geologists' Association, June 5.—Wm. Topley, F.G.S., President, in the chair.—A paper was read by Mr. Herbert Goss, F.L.S., on some recently-discovered Insecta and Arachnida from Carboniferous and Silurian Rocks. The author stated that in 1879 only 103 fossil insects from the Carboniferous rocks of the whole world were known, but during the last five years a great number had been discovered, including about 1400 from Commentry, France, a few from Saarbrück, Klein Opitz, Lugau, and elsewhere on the Continent of Europe, and a considerable number from various parts of the North American Continent. The specimens were enumerated, some of the most remarkable forms were referred to in detail, and attention was drawn to their affinities with existing types. Many of the specimens were of gigantic size and in a fine state of preservation, and whilst the majority of them appeared referable to forms allied to existing genera of *Hemiptera*, *Neuroptera*, and *Orthoptera*, a considerable number consisted of synthetic types intermediate between these orders, uniting in themselves certain peculiarities of structure now characteristic of distinct orders. Attention was also called to the recent discovery of fossil scorpions in the Upper Silurian of the Isle of Gothland and Scotland, and the wing of a cockroach in the Middle Silurian of Jurques, Calvados, France. Prior to these discoveries no remains of terrestrial animals had been obtained from any strata older than the Devonian, and the result of their discovery in Silurian strata was to leave the *Insecta* the oldest known class of land animals, and the *Blattidæ* the oldest family of insects. The evidence afforded by Palæontology was therefore, as far as it went, in support of the views as to the origin of insects and the order of succession of the various groups previously arrived at from a study of the embryology of the class.

Edinburgh

Royal Society, June 1.—Robert Gray, Vice-President, in the chair.—The Astronomer-Royal for Scotland showed the solar spectrum, as observed last year by him, drawn to scale 80 feet long. He contrasted it with the spectrum as seen by Fievez, and with that as seen by himself some years ago, a special object being to determine the effect of the present cosmic dust.—Prof. Tait gave a number of perfectly general methods of enumerating the amphicheiral knots of any order, and pointed out the curious fact that amphicheirals may in many cases be transformed into other amphicheirals, sometimes in more than one way.—Mr. Hugh Robert Mill, B.Sc., communicated a paper on the chemistry of Japanese lacquer (*Urushi*), by Mr. Hikorokuro Yoshida, chemist to the Imperial Geological Survey of Japan. Lacquer juice was found to consist of a monobasic acid (Urushic acid), a small proportion of a nitrogenous diastatic matter, gum arabic, and water. The hardening of lacquer was shown to be due to the oxidation of the urushic acid to oxyurushic acid by the action of the nitrogenous substance in the presence of air and moisture, a number of experiments distinctly proving that it was not a case of hydration. Coloured lacquers are made by the addition of metals, their sulphides, or oxides, to the juice, which exerts no action upon them, except in the case of *roiro* or black lacquer, the colour of which is due to the presence of urushiate of iron produced by the addition of iron filings to the juice.—In a paper on atmospheric electricity at Dodabetta, Prof. C. Michie Smith pointed out that the forenoon observations show a mean curve of atmospheric potential rising to a maximum at about the period of maximum temperature. There is probably a much less marked night maximum, with, of course, a minimum between each maximum. From observations made on some exceptionally fine days, an afternoon curve was constructed. The afternoon observations, however, were usually much modified by mists, but the important fact was established that the potential was regularly less than the normal in a dissipating mist, and much above the normal in a condensing mist.—The Astronomer-Royal for Scotland exhibited a series of star-photographs.

Paris

Academy of Sciences, June 15.—Note on MM. Paul and Prosper Henry's apparatus for photographing the heavenly bodies, by M. Mouchez. The author presented to the Academy the already executed chart of a section of the Milky Way, including about 5000 stars from the sixth to the fifteenth magnitude comprised in the space between 2° 15′ right ascension and 3° declination. To complete the representation of the 41,000 superficial degrees of the firmament there will be needed 6000 similar sections forming 1500 of our ecliptical charts. Were the work undertaken by six or eight observatories well situated in the two hemispheres, the whole might be concluded in about five or six years. Such a work, containing the photographs of over 20 million stars down to the 14th or 15th magnitude, and bequeathing to future astronomers an exact picture of the starry regions at the close of the nineteenth century, would certainly be the greatest astronomic undertaking ever carried out.—Remarks on the study of the various floras and faunas in their relations to physical geography and the geology of the globe, by M. Emile Blanchard.—Remarks on M. Alfred Grandidier's "Avifauna of Madagascar," completing the third and last volume of that naturalist's great work on the "Physical and Political History of Madagascar," by M. Alph. Milne-Edwards.—Note on the fourth part of the Map of Algeria to the scale of 1 : 50,000, and on the second and third sheets of the Ordnance Map of France, presented to the Academy by M. Perrier.—Experimental researches on the diphtheric affections of animals, by M. G. Colin. —Observations of Palisa's new planet 248, made at the Paris Observatory (equatorial of the west tower), by M. G. Bigourdan. —Observations of the same planet made at the Observatory of Algiers (0·50 m. telescope), by M. Ch. Trépied.—Experiments on the propagation of waves along the course of rapid streams: confirmation of the formulas given by M. Boussinesq in his theory on the gradually varied movements of fluids, by M. Bazin. —Note on spectroscopic observations through the medium of radiant matter: mutual extinction of the spectra of yttrium and sanarium, by M. William Crookes. From the numerous anomalies presented during his present experiments, the author draws the important inference that the conclusions of spectrum analysis *per se* are liable to serious error unless at each step the spectroscopist is controlled by the chemist, who represents the last court of appeal.—On the action of cadmium on the nitrate of ammoniac, by M. H. Morin.—Note on the sulphur derived from the persulphuret of hydrogen, by M. Maguenne.—Note on the methylate of soda, by M. de Forcrand.—On the degree of volatility in the chloruretted nitrites, by M. L. Henry.—On the pretended elective fermentation, by M. Maumené.—On the geniculated ganglion of birds, by M. L. Magnien. From his researches the author finds that in birds there exists a facial ganglion, which must be assimilated to the geniculated ganglion of the higher vertebrate animals.—Note on the nervous system of the Buccinidæ and the Purpuridæ, by M. E. L. Bouvier.—Physiology of the composite Ascidians belonging to the family of the Diplosomidæ, by M. S. Jourdain.—Considerations on the Echinidæ of the Jurassic formations in France, by M. Cotteau. Of the fifty genera belonging to the Jurassic formations twenty-four are peculiar to this geological system; four only persist to the Tertiary epoch, and two alone (Cidaris and Stomechinus) survive to the present time.—An attempt to determine the variations in the length of time during which the human body rests on both feet while walking, by M. Demeny.—On the respiration of plants, by MM. G. Boneier and L. Mangin—Note on the artificial production of Strengite ($Fe_2(PO_4)_2 + 4H_2O$), by M. A. de Schulten.—Symmetrical disposition of the archaic formations on both sides of the Guadalquivir Valley, by M. J. Macpherson.

BERLIN

Physiological Society, May 15.—Dr. Höltzke spoke of the results of his investigations into intraocular pressure. It having been established that glaucoma was developed in the eye through pathologically increased pressure, the question of physiological pressure in the eye was of high practical importance. Yet was Herr Grünhagen the first, by means of a canula introduced into the anterior chamber of the eye, and a fine mercurial manometer connected with it, to measure the magnitude of this pressure in the eye of a cat and to determine its variations. He found the living cat's eye showing a pressure of 26 mm., which, on the death of the animal, sank to 10 mm. Everything increasing the blood-pressure was found to augment at the same time the intraocular pressure, while, on the other hand, everything lowering the pressure in the province of the carotid artery was found to lessen the pressure in the chamber of the eye. Stimulation of the trigemini raised the intraocular pressure considerably, as did likewise stimulation of the medulla oblongata, which pushed the pressure up to as high even as 200 mm. The effect of atropine was a diminution of pressure. A few later observers had, with somewhat modified manometers, attained like results for the influence of the blood-pressure and deviating results for that of the nerves and the alkaloids. Dr. Höltzke had in his investigations, which first of all referred to the effect of the alkaloids atropine, eserine, and pilocarpine, laid special weight on the improvement of the methods, and on one hand had, as a trustworthy measurer of pressure, made use of a double manometer, which he produced and explained to the Society, and on the other hand had confined the application of the alkaloids above mentioned to one eye, while the other eye was utilised in the way of control in the process of the measurements which were always carried out in both eyes. As the result of the measurements it was ascertained that eserine produced at first a considerable augmentation of the pressure, and then an abatement of it to a point below the normal value. Pilocarpine produced similar, but more reduced results; while atropine called forth quite the contrary effects. The speaker had further determined the pressure, still more directly concerned in the case of the production of glaucoma, in the vitreous humour, by means of a special canula, and with the same measurer of pressure. In this case he had found the pressure, both under normal conditions, as also under the operation of the alkaloids, and the changes of pressure in the blood, to be always similar to the pressure in the anterior chamber of the eye.—Dr. Virchow described the relation of the blood-vessels of the vitreous humour in cyprinoids. After having shown that the occurrence of blood-vessels in the vitreous body, and its absence from the retina was not a distinguishing character of the amphibia, seeing that blood-vessels in the vitreous humour were wanting in the case of many amphibia and reptiles, as also in the lowest fishes, while in other classes of amphibia such blood-vessels were to be found. The speaker commented minutely on the differences in the ramification and diffusion of these blood-vessels, as also the varying arrangement of their capillaries, and demonstrated them on preparations of carps, bleaks, and roaches, as well as by enlarged photographs.—Dr. Weyl reported on the negative results of experiments having for their object to ascertain the mode of nitrates in the animal body. It was a well-known fact that nitrates occurred in human urine, but were regularly wanting in the urine of dogs. By feeding dogs with ammoniacal citric acid a nitrate formation was not produced, not even when, along with the ammonia, a fixed alkali was administered by way of combining the acids arising under the flesh aliment. Only in a pathological case, in which a dog that had received ammonia died of a disease of the intestine and the kidneys, was nitrate found in the urine; consequently neither the mode of the formation of nitrates in the organism nor the cause of the difference between man and dog in this respect had been ascertained. For the demonstration of nitrates in the urine the speaker recommended distilling the urine with sulphuric acid, and treating the distillation with one of the many reagents of nitric oxide.—Dr. Friedländer demonstrated a case of carcinoma hitherto never observed in a pulmonary cavern. The carcinoma adhered firmly to the wall of the tubercular cavity, sent a stalk through the next branch, and at the stalk hung a somewhat large carcinomatous swelling in the bifurcation. The carcinoma was a horny carcinoma which was regularly observed at those places where stratified flattened epithelium occurred; on other membranes horny cancer had hitherto never been observed. So much the more striking, therefore, was it to find horny carcinoma in the lungs. This riddle perhaps found its explanation in two observations noted down in the literature of the subject, according to which defects in mucous membranes caused by abscesses, once in the lungs and once in the corpus uteri, became healed over by flattened epithelium instead of by cylindroid or ciliated cells. It was possible that the cavity occurring in this case also had covered itself with flattened epithelium which had become the starting-point for the horny carcinoma.

Physical Society, May 21.—Dr. Kayser demonstrated a new cathetometer constructed by Herr Bamberg, explained the arrangement of it, and set forth as its special advantages the facility of placing it vertically and the circumstance that after precise adjustment, by merely changing the eye-pieces, the instrument could be used both as a microscope and a telescope, without at all altering its position for the least as for the greatest distances.—Prof. Neesen sketched a very simple arrangement for demonstrating the effect of the lightning-conductor, which was particularly well qualified for class experiments.—Dr. König discussed the principle according to which he was getting a new spectro-photometer made, which he showed to the Society, provisionally put together. The instrument consisted in the main of an objective tube containing a lens and a diaphragm turned towards the source of light with two slits lying above each other, a prism for decomposing the two bundles of incident rays, and a second collimator tube, on the lid of which closing the end appeared two spectra showing an interval between them. Before the lens of the ocular collimator was placed a twin prism, the two prisms of which with their refracting edges of 1° to 2° were cemented together. By this twin prism each spectrum was decomposed into two spectra, and the dimensions of the twin prism were determined in such a manner that on the lid of the collimator one spectrum was situated above, the other below, while in the middle the second spectrum of the upper slit coincided with the second spectrum of the lower slit. In the lid of the ocular tube let a small opening be made cutting off a small piece of determinate wave-length from the double spectrum; on looking through it the field of vision would be seen divided by a line (the refracting edges of the twin prism) into two halves, both of the same colouring. Before each of the two slits of the objective tube through which the light entered was placed a Nicol prism in such a position that perpendicularly polarised light entered one slit and horizontally polarised light the other. The middle compound spectrum consisted, therefore, of a perpendicularly and a horizontally polarised spectrum, and in the field of vision the two like-coloured halves were also polarised perpendicularly to each other. If now the field of vision was viewed, not directly, but through a Nicol prism, then, according to the position of this prism would the one half at one time, the other half at another time, be withdrawn from sight; and if the two entering rays of light or their spectra possessed different degrees of intensity, by turning the ocular-Nicol the two halves of the field of vision could be made equal, and from the rotation the relative degrees of intensity of the two bundles of rays could be determined.

VIENNA

Imperial Academy of Sciences, April 16.—Studies on the fauna of eighteen smaller and larger Austrian freshwater basins, by O. E. Imhof.—On the action of potassium permanganate on hyposulphite of soda, by M. Gläser.—On orthoclase as a dry mineral in basalt, by V. v. Zepharowich.—On jointed milk-sap vessels in the fruit of *Lactarius deliciosus*, by A. Weiss.—On the relation of Weber's theory of electro-dynamics to Hertz's principles of the unity of electric forces, by E. Aulinger.—A contribution to aknowledge of the fishes of Turonian system of Bohemia, by G. Laube.—On the astronomical data found in Assyrian inscriptions, by T. Oppert.—On a new method for determination of the size of molecules, by F. Exner.—On a new trinitrophenol, by T. Zehenter.—Astronomical researches on the Egyptian eclipse referred to in the Bible, by E. Mahler.

April 23.—On spectrographical experiments on normal light sources, and on the applicability of the latter for photo-chemical measurement of light-sensibility, by T. M. Eder.—The knowledge of the anatomical structure of our Loranthaceæ, by G. Marktanner-Turneretscher.—Researches on chelidonic acid, by L. Haitinger and A. Lieben.

May 7.—On the manufacturing and qualitative composition of zirkon, by E. Linnemann.—Systematic zoological studies, by F. Brauer.—On artificial uric and methylated uric acids, by T. Horbaczewsky.—On polaristrobometric methods, especially on "polarimètres à pénombres," by F. Lippich.—Contributions to a knowledge of the cobalt ammonium compounds, by G. Voltmann.—On the knowledge of the structure of the Libanon and Antilibanon, by E. Suess.—On the solution of Keppler's problem, by Th. von Oppolzer.—On the chlorhydrines of buteryl-glycerin, by A. Lieben.—On a crocodile skull found in the Tertiary deposits of Eggenburg, Lower Austria, by F. Toula nd A. Kail.

May 14.—On the product of oxidation of propylene oxide by silver oxide, by E. Linnemann.—Preliminary communication on the fluorescence of the dyeing matters of fungi, by A. Weiss. —The knowledge of the structure of the muscles of insects, by R. von Limbeck.—On the sinus cavernosus of Dura mater, by C. von Langer.—On papaverine, by V. Barth and G. Goldschmidt

May 20.—Prof. Stefan was elected Vice-President of the Mathematical Class; Prof. E. Suess, Secretary; Prof. L. Boltzmann (Gratz), Prof. V. von Zepharovitsch (Prague), and Prof. C. Claus (Vienna) were elected Members; Prof. Escherich, Prof. A. Vogl, and Franz Exner (Vienna), Correspondents; Prof. A. Bayer (Munich), Prof. T. D. Dana (New Haven), Foreign Correspondents.

May 21.—Anniversary Meeting.—The opening address was held by the Curator's substitute, A. von Schmerling. Then the reports were read by the General Secretary, Prof. Siegel, and by the Secretary of the Mathematical Class, Prof. Stefan. Obituary notes were given by the latter on Hochstetter, Fitzinger, F. von Stein, and Siebold. A prize of 1000 florins was awarded to R. Maly (Gratz), for his paper, "Researches on the Oxidation of Albumens by Potassium Permanganate."

STOCKHOLM

Academy of Sciences, May 18.—For the *Transactions* of the Academy were accepted: Researches on the disjunctive electromotive power on the electrodes during the passage of electricity through air of greater or lesser density, by Prof. Edlund; and Ueber die Säugethiergattung Galeopithecus: eine morphologische Untersuchung, by Prof. W. Peche.—Prof. Edlund exhibited and described a specimen of meteorograph of Thorell's construction, made by Herr Sörensen for the Emperor of Brazil.—Prof. Warming gave an account of the botanical researches undertaken by Messrs. L. Y. Neumann and G. A. Tiselius in the Swedish provinces of Jemtland and Medelpad; and (2) contributions to the knowledge of the structure of the pericarp, by Miss Alida Olbers.—Prof. Toréel exhibited and described a geological map of Sweden, on the scale 1 : 600,000.—The Secretary, Prof. Lindhagen, presented for publication in the *Transactions* the following papers:—The transversal oscillations in a thin crystalline lamina with three plans of symmetry and elliptical limitation, by E. Sundberg.—Alpha-oxazonaphtalin alpha-sulphonacid and some of its salts, by Dr. J. E. Alèn.—On two isomeric beta-monochlor-naphthalin-sulphonacids, by Herr K. Arnell.—On mononitro-beta-naphtha-acids, by Dr. A. G. Ekstrand.—Some annotations on microscopic researches on plants, by Dr. A. Malm.—Contributions to the flora of fungi in the southernmost parts of Norway, by Dr. E. Henning.—On Sowerby's whale, by Dr. A. Malm.

CONTENTS

THURSDAY, JULY 2, 1885

TWO BOTANICAL TRANSLATIONS FROM THE GERMAN

I. *Text-Book of General Botany.* By Dr. W. J. Behrens. Translation from the Second German Edition. Revised by Patrick Geddes, F.R.S.E. (Edinburgh: Young J. Pentland, 1885.)

II. *A Guide for the Microscopical Investigation of Vegetable Substances.* From the German of Dr. Julius Wilhelm Behrens. Translated and Edited by Rev. A. B. Hervey; A.M., assisted by R. H. Ward, M.D., F.R.M.S. (Boston: S. E. Cassino and Co., 1885.)

I. A STUDENT of science in our Universities on running his eye along his bookshelves can hardly fail to be struck by the large proportion of translations which find their place there; in physics and in chemistry the proportion of them is large, but in biology and especially in botany the original productions of this country hardly hold their own against their foreign competitors. It must be freely admitted that there was a time, not long ago, when botanical laboratory work had fallen to a low ebb in England; the botanists of this country had failed to keep pace in this branch of their subject with their contemporaries on the Continent, and it was chiefly by the translation of the text-book of Sachs that laboratory work received a new stimulus on this side of the Channel. The translation of that work some twelve years ago has been followed by others of standard books, and we have reason to expect that their number will be further increased within a short period. Any reasonable person will welcome the translation of standard and classical works; their production is beneficial, and they may at times even bring about wholesome revolutions. But though the most important translations produced recently are from the German, it does not necessarily follow that all German text-books are good, and the first of the two books above named is an illustration of the truth of this.

Perhaps the greatest difficulty in the construction of an elementary text-book which aims at the general treatment of a science is suitably to balance the several parts of the subject, bringing out at length those parts of the science which are important to elementary students, and placing in the background those branches which are of less importance; it is on this rock that writers of text-books have most often split, and this text-book of Dr. Behrens is no exception. But it is also essential that a text-book shall be accurate in its facts; it will be seen from the quotations below that Dr. Behrens's book fails repeatedly in this respect.

The external morphology of the higher plants, including the structure of the flower and the principles of classification, occupies the first 160 pages; the treatment is neither better nor worse than that usual in text-books of the present day. Then follows, under the head of "Physiological Botany," an exposition of 70 pages in length on "flowers and insects," and transport of seeds. Anatomy and physiology judiciously welded together occupy 80 pages, while the whole series of "Lower Plants," including the Vascular Cryptogams, are dismissed in less than 40 pages, barely half of the space devoted to "flowers and insects, &c." If we take a rough estimate of the balance of the book by the number of pages devoted to the several branches it is clear the lower plants come off the worst, and a quotation will illustrate the result. On page 332 the following is the whole account given of the Florideæ:—"The Florideæ are sea-weeds containing red or brown colouring matter. They are distinguished from the sea-wracks by the circumstance that their spores are generated in capsules (cystocarps, *f*, Fig. 390), which arise in the axils of the leaf-like lobes of the thallus (*s.d*)." Then follows a short description of *Batrachospermum*. Not only is this description insufficient and useless to a student, but it is also obviously inaccurate. Of the other inaccuracies a few may be cited. In Fig. 371 the pit-membranes in the wood of *Pinus sylvestris* are altogether omitted; the flattened stems of *Phyllocladus* are described as leaves in the explanation of Fig. 408, notwithstanding the tall talk on morphology on pp. 237-8. On p. 350 we read: "In the highest Cryptogams only are the sporangia formed by leaves, or homologues of leaves; in the Phanerogams this is always the case;" and, on p. 101, "as *all* Phanerogams have either one or two seed-leaves, &c." The above quotations by no means exhaust the inaccuracies of the book.

In not a few cases statements are made which can only confuse the student. Thus on p. 352 we read: "In the Metasperms the two generations of the vascular Cryptogams are represented by one." And again, on p. 314, "Spores are entirely destitute of an embryo, having plumule, radicle and cotyledons." A man who can write such sentences shows that he is not in sympathy with the student.

Perhaps the most prominent error in the book is one of omission. In describing the stomata a special paragraph is devoted on p. 283 to their function, but not a word is said of transpiration; on turning to the description of transpiration on p. 305 the stomata are not mentioned! And this is a book which aims, as stated in the preface, at placing the student "at the newest standpoint of the science"!

Enough has now been said to show that the book is far from being a model text-book; but it must not be concluded that it is entirely without merit; many of the illustrations are good, and the exposition is for the most part clear, while historical notes interspersed here and there in the text lend additional interest. It is, however, obvious that neither in point of accuracy nor of balance is the book so near an approach to the ideal elementary text-book as to merit the honour, or deserve the trouble of translation.

The above notice has been extended to greater length than the importance of Dr. Behrens's text-book deserved, because the publication of this translation marks in a certain sense an epoch in the progress of botany in this country. For the last twelve years we have been dependent in great measure upon Germany for our larger text-books; we have in that respect been leading a parasitic existence, or rather passing through a period of *healthy symbiosis*, such as that of the embryo on the parent plant; the time is fast approaching when we may expect the young plant to assert its independence, when text-books designed to meet our own peculiar requirements shall be written by native authors. Meanwhile let the choice of books for translation be confined to those that are sound and good, let us guard jealously against any tendency to a *saprophytic* habit, with its attendant degeneration; the translation of an unsound text-book may be regarded in a sense as marking a saprophytic tendency, and the appearance of the translation of this book of Dr. Behrens is perhaps the first indication of such a saprophytic habit.

Lastly, would it not be possible, and much more advantageous, to transmute the energy now devoted to translation into original production? It is admitted that a teacher acquires both facility of exposition and clearness of view by writing down his ideas in the form of a text-book. It is for us to see that we do not continue our "healthy symbiosis" unduly, and thereby lose that power of original exposition for which so many English men of science have been properly celebrated.

II. The second work under review is a translation of a book by the same author, and it is one of those works now being produced in rapid succession which aim at assisting the student in his practical work in the laboratory. The keynote is struck by the following passage from the preface to the German original: "For a work to be useful in those microscopical inquiries which are most important in the botanical laboratory, it need teach neither optics nor histology." It may fairly be admitted that within the cover of this book the student will find clearly laid before him all that it is essential he should know of the theory and structure of the modern microscope, together with useful instructions as to the methods and reagents in use in the botanical laboratory. Dr. Behrens boldly challenges criticism in his preface, when he says "the chapter of this work which deals with the microscopical investigation of vegetable substances furnishes an *exhaustive* treatment of these matters." Whatever may be our opinion as to the correctness of this statement it must be allowed that the work now before us is the result of an earnest effort, and represents wide and laborious sifting of a scattered literature not easily accessible to most students. There is quite a pathetic ring in one sentence in the preface; referring to the literature of the subject in the University Library at Göttingen, the author says: "With hardly a noteworthy exception, I have seen and read it all." It is only those who know how voluminous and how scattered are the writings on this subject who can form an idea of the magnitude of this task.

The first two chapters, dealing with the microscope and microscopical accessories, have been subjected to considerable alteration and extension by the editors. Naturally German stands and objectives are not so accessible in America as those made on the spot; the editors have devoted considerable space to the description and illustration of the microscopes of American manufacture, so that this part of the book partakes, both in appearance and contents, of the character of an optician's catalogue. A few paragraphs have been added on the subject of "nose-pieces;" but there is no mention of that invaluable nose-piece of Zeiss which is calculated to save the time of workers in no small degree—viz. that which can accommodate four objectives, and on which the tubes carrying the objectives are cut of such length as to bring each in turn approximately into focus: the value of this arrangement is obvious.

Chapter III. contains useful directions for the preparation of microscopic objects, cutting sections, mounting, drawing, &c. The most important part of the book, and that which will assuredly be the most generally useful, is that comprised in the last 200 pages, and it is almost a matter of regret that this latter half has not been published separately from the first 260 pages, which have an interest chiefly for the beginner, while for the advanced student they will be little better than lumber. Pp. 267-311 are devoted to the enumeration and preparation of micro-chemical reagents, while Chapter V. deals with the microscopical investigation of vegetable substances. It is to be noted that no reference is made to the inventor of chlor-iodide of zinc beyond his name, which, according to the notice of the meeting at which his solution was first described ("Flora," 1850, p. 643), is spelt "Schulze" not "Schultz" as it stands in the text. There is no mention of the demonstration of protoplasmic continuity, even in sieve tubes, nor is the substance of the "callus" of sieve tubes or its reactions described. These omissions do not greatly affect the value of the book; they would not have been mentioned had not Dr. Behrens professed to give us an "exhaustive" treatment of the subject. One chief merit of the work is that copious references are given to the sources from which Dr. Behrens has drawn his information; this will greatly add to its usefulness, and the translation may be accepted as a valuable addition to the laboratory handbooks already before the English-speaking public.

F. O. B.

RUSSIAN CENTRAL ASIA

Russian Central Asia, including Kuldja, Bokhara, Khiva, and Merv. By Henry Lansdell, D.D. (London: Sampson Low and Co., 1885.)

DR. LANSDELL, already favourably known to the public by his interesting volumes "Through Siberia," gives in the present work a mass of information on a subject to which the attention of Englishmen has of late been perforce directed—the Russian dominions in Central Asia. In the two goodly volumes recently published he gives the narrative of a journey undertaken in the year 1882, in the course of which he traversed Kuldja, Bokhara, Khiva, and Merv. Turkistan has been rarely visited by Englishmen, and, as Dr. Lansdell believes, in certain parts he may claim to be the first. The principal object of his journey was a philanthropic one—the distribution of religious literature, especially in the prisons of the Russian empire; but in writing this book he has kept in view the requirements of students as well as of general readers, providing for the former by touching upon the "geography, geology, fauna and flora, the characteristics of the people, their government, language, and religion"—to which not only numerous notes but also whole chapters are devoted, as well as "appendices, derived from works only published in the Russian language, which treat on the fauna and flora of Turkistan."

It would be impossible in the space to which this notice must necessarily be restricted to give an adequate idea of the great amount of matter which Dr. Lansdell has collected in these two volumes, so that we must content ourselves with a brief glance at a few of the more salient features.

To geographers the account of the Thian Shan Mountains will be among the subjects of interest. These mountains, estimated by Réclus as forming a mass twenty-five times larger than the Swiss Alps, and a protuberance on the earth's surface larger than the united mountains of all Europe, begin in Mongolia, and develope by the addition of successive ridges until they occupy from north to south above eight degrees of latitude. The heights of the several ranges vary from about 10,000 to 14,000 feet above the sea, and in the Pamir range exceed 15,000. The number of glaciers exceeds 8000. The principal lakes are the Alakul, the Balkash, and the Issikul, the waters of which are brackish; the first and second are believed to have once been connected. Volcanoes have been stated to exist in the Thian Shan, but this appears to be incorrect. Much information of interest is given about the Ili Valley, a meeting ground of the Tatar and Mongol races. From this region Dr. Lansdell diverged eastwards from the course of his journey to reach Kuldja, a town within the Chinese frontier, for some time in Russian occupation. He then continued his journey in a westerly direction, passing through Semirechia, of which region he gives many particulars of interest, dwelling especially on the patriarchal life of its nomad inhabitants. From the Kirghi Steppe he passed into Turkistan. The climate of portions of the Aralo-Caspian region does not appear inviting: the summer temperature is from 68° to 77° F., the winter from 5° to 23°. In the lowlands rain falls rarely in summer, and in only a small amount at any season. Hence there is a general desiccation. The beds of tributary rivers are dry; the main streams lose themselves in sands or terminate in brackish marshes; the smaller lakes have evaporated, leaving behind them beds of salt; the larger are much reduced in size. The land is barren; trees are scarce; vegetation is stunted, and limited in its species. The geology, as might be supposed, has not been exhaustively worked, but from a small work of M. Mouchketoff the author has obtained an outline, from which it appears that in one part or another of the district almost every formation, from the oldest to the newest, is represented, and that the mountain-chains consist largely of igneous rocks.

Dr. Lansdell spent some days in Bokhara, which town no English traveller had visited since the time of Wolff's adventurous journey. The fear of the Russian is, however, now upon this people, and he appears to have met with little difficulty, though subjected to some surveillance. On his way to the city he visited the Emir, then at Kitab, and had a gracious reception. The description of the author's invention of a court costume for the ceremony of presentation is amusing: the chief components were a cassock, a D.D. hood, some masonic jewels, and a square college cap. From Bokhara Dr. Lansdell travelled through Khiva, and thence by a rarely-traversed route, which, after following the general direction of the Abu-Daria for some distance, runs in a west-south-westerly direction to Krasnovodsk, near the Karaboghaz Bay of the Caspian. Thence he returned to England, having accomplished in 179 days a journey of 12,000 miles—laborious, with considerable hardships, and not without some danger, though the Russian influence has rendered many places, formerly all but inaccessible, comparatively safe.

Dr. Lansdell does not profess to be a scientific traveller, but he is a careful observer, noting with an experienced eye the physical peculiarities of the regions through which he travelled; and he has been at immense pains to gather together a large mass of information concerning the flora, fauna, and ethnology of Central Asia,[1] which has been to a great extent accumulated by Russian men of science, and which, from being written in their language, is practically inaccessible to most Europeans. The appendices on the flora and fauna of Russian Turkistan occupy 148 pages of rather small print, and there is in addition a very full bibliography of the same district which extends to twenty-five pages. But much information, both from books and from personal observation, is also incorporated into the narrative of travel. Dr. Lansdell's picture of the desiccation of the western part of Bokhara, of the moving sands between the Oxus and the Karakul, of the "barren and dry land" of the Aralo-Caspian region, and of the Karaboghaz Gulf—a great area of evaporation which, should any physical change close its narrow and shallow communication with the Caspian, would soon become one vast salt-pan—cannot fail to interest the student of physiography. In a word, the ethnologist, geologist, and naturalist will find these volumes not only very pleasant reading, but also most valuable for reference.

OUR BOOK SHELF

Bulletin of the Bussey Institution. Vol. II., 1884. (John Allyn, 30, Franklyn Street, Boston, U.S.)

THE *Bulletin* of the Bussey Institution has many claims to be considered as original in its design and in the character of its reports. It contains a large amount of information upon out-of-the-way topics, mostly treated upon from the chemical side, and in all cases communicated by Prof. F. H. Storer, Dean of the Institution, and Professor of Chemistry.

The Bussey Institution is apparently a branch of Harvard University, having special endowments, and its objects comprise the teaching of young men intended to become practical farmers, land agents, gardeners, florists, or landscape gardeners.

The investigations conducted by Prof. Storer, reported in the *Bulletin* before us, are highly interesting to such students, and are characterised by a keen practical bias. The first paper is devoted to results of analysis of the leaves of *Rumex crispus* and the common milk-weed (*Asclipias cornuti*), with a special view to their economic value. The second paper is upon an ingenious plan of ascertaining the rate at which various fertilisers may be scattered by hand, or, in the Professor's own language, "about how much of a given fertiliser would a man naturally throw from his hand in sowing an acre of land?" Surely no learned professor ever set himself a more homely task! Next we find "Experiments on Feeding Mice with Painters' Putty and with other Pigments and Oil." This is almost revolting, and raises a feeling of pity for the mice, together with a certain sense of loss of appetite on the part of the reader if he is indulging in an ante-prandial study of scientific novelties. Mice, however, *do* eat putty, and, more curious still, red lead

[1] See an article by Dr. Lansdell, NATURE, May 21, p. 56.

mixed with putty, without injury. They thrive on the linseed oil used in the manufacture of this most unsavoury side-dish and the whitening which forms the other ingredient of "pâté de putty" seems to neutralise the evil effects of the lead. The bearings of these facts are important from a sanitary point of view, as Prof. Storer shows that the effects of mice eating away the packing of valves, of drains, and closets is an immediate frustration of the best efforts of plumbers and sanitary engineers to keep human habitations free from sewer gas. Not content with mice, the Professor tried similar experiments upon rats, when it was found that "rats when kept upon a rather short allowance of oats, ate putty freely. Finally "the surviving rat was fed with 'plain putty' for a day or two, after which he received and ate (poor wretch) each day for two days a ball of putty made with a mixture of equal parts of slaked lime and whiting. He was next given a ball of putty made from a mixture of one part of oxide of zinc and three parts of whiting, together with 2½ grammes of oats, and although he ate very little of the ball he died soon afterwards." The chief result of these experiments appears to be the injury rats and mice may do to houses and the curious protecting effect of whitening as an antidote to such active poisons as red and white lead and carbonate of baryta. Experiments upon the germination of weed seeds and a special instance of the resistance of clover seeds to water form two very interesting notes bearing directly upon well-known phenomena often ascribed by the ignorant to spontaneity of growth. The extraordinary irregularity of periods necessary for the germination of certain weed seeds is very clearly shown. "Of 400 seeds of shepherd's purse (*Capsella bursa pastoris*) three germinated on the fifth day and three on the seventh day, then none until the 145th day, when four germinated. Seven seeds germinated on the 1173rd day, or after an interval of about three years and two months—in all 18¾ per cent. to that date." Many similar cases are cited. Another article is upon "cherry stones eaten by domestic pigeons," which appears unpromising, but is rendered interesting by this versatile observer. Prof. Storer is evidently a man who is not likely to allow any natural phenomenon to pass unnoticed.

JOHN WRIGHTSON

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Clifford's Common Sense of the Exact Sciences

It does not seem to me necessary to reply to the charges made against Clifford by Prof. Tait in your issue of June 11—charges which, when freed from "mystery and insinuation," amount to accusations of plagiarism and inaccuracy—for Clifford's reputation is unlikely to be in any way affected by what Prof. Tait may write. But I do feel it necessary to make a remark on the last paragraph of his review. He therein accuses me of "mystery and insinuation," weapons which should not be employed in connection with Clifford's name. He does not do me the scant justice of publishing the footnote on which he passes these strictures. That footnote runs as follows:—

"A still more serious delay seems likely to attend the publication of the second part (*kinetic*) of Clifford's 'Elements of Dynamic,' the manuscript of which was left in a completed state. I venture to think the delay a calamity to the mathematical world."

When I wrote the footnote, I knew—

(1) That the manuscript was in existence, a fact with which any one who had examined the bibliography attached to the mathematical works must have been acquainted.

(2) That this manuscript, unlike that of the "exact sciences," had not at that time found a publisher, and therefore was more likely to be seriously delayed.

(3) That the mathematical world had been so far forgetful of its own interests as to raise no demand for its publication.

My note was written with the express purpose of recalling the attention of those who valued Clifford's work to the existence of this manuscript, in order that a general demand for its publication might produce a publisher. Those who find "mystery or insinuation" in this, or in whom this can "strike a jarring chord," must be singularly constituted individuals. The note had on the face of it an obvious purpose; that purpose, I am happy to know, it has to some extent helped to accomplish.

University College, June 12 K. P.

On "K. P.'s" note, which has been communicated to me by the courtesy of the editor, I desire to make one or two remarks.

In writing my notice of Clifford's book I endeavoured to state clearly the impression which its perusal had produced in my own mind, and to say a few fitting words as to the special qualifications of the author. I must have sadly failed in this endeavour if in what I have written there can be found either mystery or insinuation, still more so if there can be found "accusations of plagiarism and inaccuracy." But of course even an Act of Parliament has to be construed after the letter, the declared intention of its framers notwithstanding. On reperusing my notice, however, I still think that it expresses what I meant to say, and that it cannot bear the construction put on it by "K. P."

The remarks I made on the foot-note to the Preface accurately described the impression which it produced on me, and which I am sure it is likely to produce on the majority of thoughtful readers. So strongly did I feel this impression that, when I finally returned my notice for press, I specially requested the editor to try to obtain for me an elucidation of the mystery. This has been—in part at least—supplied by Mr. Tucker's note.

Whether "R.," who writes in NATURE of this week, be really a "(so-called) metaphysician" or no, he certainly expresses himself in the language of that school; for he mildly characterises as "not sufficiently guarded" the statement that a figure, obtained in a certain way, will be a cube:—whereas it obviously may be any rectangular parallelopiped whose edges are commensurable. But I did not blame Clifford for having made this statement; I merely said that it "ought not to have escaped correction." Perhaps even that expression is too strong. I have lately learned by experience that over-zeal on the part of a press-reader may sometimes render abortive the most sedulous care on the part of an author. Over and over again I have had proof-sheets, marked "*press*," returned to me with a learned query at the phrase "feet per second, per second"; and in one or two instances the supposed blunder has been *rectified* after all in spite of me. P. G. TAIT

June 26

Recurrence of Markings on Jupiter

In connection with my remarks on this subject (NATURE, xxxii., p. 31), and the suggestive coincidences which appear amongst certain drawings obtained in about the years 1857 and 1859, 1870 and 1872, and 1885, as to large elliptical markings in the southern hemisphere of Jupiter, I would further add that in about 1843 a remarkably large spot was visible, which may possibly be connected with the phenomena of more recent occurrence. Prof. Piazzi Smyth mentions in the *Observatory*, vol. iii., p. 450, that, in consulting some old observations preserved in the note-books of the Rev. H. C. Key, he found "a view of Jupiter, with not only the dark belts admirably drawn, but between them, in stronger black colour, a long oval spot. This spot, too, was so precisely the shape and size of the red spot which has of late been attracting the surprised attention of observers, that I could not but jump to the almost self-evident conclusion of their both referring to the same body, appearance, or phenomenon." The drawing alluded to was made on June 4, 1843, and Mr. Key described it as a "horizontal black spot in the light space between the two principal belts." In Chambers' "Descriptive Astronomy" (2nd ed., p. 107) it is stated, "In 1843 a very large black spot was observed by Mr. Dawes," and this object is doubtless identical with that figured by Mr. Key. It will be important to compare the observations and to learn whether these spots were situated in approximately the same latitude as the red spot of our own time.

The latter has been growing much darker and more conspicuous during the last few months, and it seems very probable that this object may resume a good deal of its former prominence during the opposition of 1886. With my 10-inch reflector, power 252, I recorded the spot as passing the central meridian of Jupiter on June 26, 1885, at 7h. 59m., and to-night, June 28, at 9h. 37m. A comparison of these times with the earliest I obtained during the present apparition (1884, September 21, 18h. 28m.) shows that in the interim of 279d. 15h. 9m. the spot has completed 676 rotations with a mean period of 9h. 55m. 39·0s., which is almost identical with the periods found during the two previous oppositions—viz. 9h. 55m. 39·1s. But I am hoping to obtain another observation of the spot before the planet leaves us for the season. W. F. DENNING

Bristol, June 28

Occurrence of "Torpedo Marmorata" off the Coast of Cornwall

AMONG the fishes included in the British fauna, but whose title to this designation has been considered but doubtfully proved, is the *Torpedo marmorata*, or a form having the spiracles fringed at their edges. It is true that Pennant figures this species, but he omits to mention whether his example was from the British seas or brought from the French coast by Walsh; and subsequent authors on ichthyology are not sufficiently precise in their descriptions to enable one to judge of which form they are adverting to. All the specimens which I have seen in the various British museums have been of the cramp fish, with smooth-edged spiracles, *T. nobiliana*. On June 26 an example of *T. marmorata* was trawled in Mevagissey Bay, and obtained by Mr. Matthias Dunn, who most kindly sent it at once to me, and it arrived at Cheltenham on the evening of the 27th. It was a female, quite fresh, and weighed 3 lb. 10 oz.; its length was 17½ inches, and its breadth across the disk 12 inches. It contained two ova in an early stage of development. FRANCIS DAY

Cheltenham, June 27

Composite Portraits

IT is always desirable to guard new discoveries and inventions by explicit investigation of the nature of the facts discovered and the mode of action of the invention.

The system of composite portraits ingeniously invented by Mr. Galton rightly attracts much attention, and those who have had their interest excited by Mr. Galton's curious portraits of thieves, ruffians, and consumptives, will be interested further by the portrait of American scientific men in NATURE, vol. xxxii. p. 176.

But in using this system as an instrument of discovery it must not be hastily assumed that by its means true averages are secured. At least, they cannot be averages in every respect Take, for example, the hair. The outer limit is determined by the greatest extent to which the hair has spread outwards on the plate in a number of sitters sufficient visibly to affect it—say three or four. But the inner limit is, in the same way, determined by the limit in the three or four in whom it stretched farthest in. Thus the result must be to give far more than the average amount of hair when the portrait is compounded from a great number of sitters.

As regards the nose, the eyes being the fixed starting-points, the root of the nose will be nearly a fixed point in the photograph; but the tip is limited by shading, and three or four short noses will be sufficient to determine where the tip is to be.

Again, the eyes being fixed points marked on the ground glass of the camera, and breadth between the eyes being different in different persons, it follows that those who have the eyes near together will be photographed on a larger scale than the rest. This enlargement will broaden the composite result. But the tip of the nose, like the tips of the really long noses, will be lost in the dark upper lips of others.

Proof that I am to an important extent correct in these remarks is to be found in your page of American portraits. They present a very remarkable non-American appearance about the nostrils, a vertical elongation accounted for by what I have pointed out. Also the ears are large and vague, the position of the ear relatively to the eye being variable; and there is a more than average breadth of face in three out of the four portraits.

I do not wish to detract from the value of these portraits, rightly understood, but assuredly they give prominence to certain types of face when these are mixed with others—namely, to broad faces with short noses, long lips, large ears, and a superabundance of hair—and it may be useful that attention be attracted to this.

It will be seen that composite portraiture is not suitable for anatomical objects whose generic characters are to be recorded in explicit statement. But for that and many other purposes, a trustworthy though more laborious and less elegant substitute may be found by determining the mean positions of a number of fixed points in figures accurately obtained.

JOHN CLELAND

Ocular Images and After-Images

MR. NEWALL'S experiment with the glowing match I have been in the habit of performing with my cigar or cigarette, and I have become familiar with the lurid ghost he describes, but the point that first interested me is one not mentioned in his letter, and has reference to the primary serpentine image. This I find to consist of a dark red head and a bright yellowish-red body—the light viewed at rest being of a mean tint, as if, owing to difference in rate of telegraphy, it underwent a process of analysis in its movement over the retina.

I have paid considerable attention to the dying phases of powerful retinal impressions, such as result from too bold a gaze at the sun or his vicar, the paraffin lamp, and am convinced that there is more to record than a mere fading away of a patch of colour. On careful scrutiny the patch is seen to be bordered with a series of coloured bands, which each in turn overspreads it; the order of succession being, unlike that of the primary image in the above experiment, towards the red.

I submit this for confirmation, being conscious that the region of these observations is so largely dominated by memory and imagination as to render it difficult at times to distinguish the psychical from the physiological. W. M. LAURIN

June 25

A Query as to Swallows

DURING a recent stay in Suffolk I found a belief prevalent there that swallows lay in necessary stores for their autumn migration by packing small flies under the feathers beneath the wings. My informant told me that he had shot a swallow once in order to ascertain whether this was actually the case; and that he had, as he expected, found many small flies beneath the down. Knowing how liable swallows are to parasitic invasions, I asked of what kind the flies were, and was told "Little gnats, and such like." Is this opinion to be found elsewhere, and is there any ground for it? E. H.

THE COMPOUND LOCOMOTIVE

VERY soon after the compound working of steam in marine and stationary engines became an accomplished fact, and the great saving of fuel thereby was apparent, the question of applying the compound principle to the locomotive attracted the attention of the locomotive engineers of this and other countries. At first it was received with very little favour, which is evident even at the present time, there being only two locomotive engineers in this country who are now either trying it experimentally or have it permanently in use on the lines under their control. This has been mostly caused by the idea that the additional gear necessary for the compound working with two or more cylinders would render the engines more liable to break down. Again it was thought, with very good reason, that such engines would have great difficulty at starting, for the reason that during the first revolution of the driving wheels all the power necessary to start the engine would have to be generated in the high-pressure cylinder. This difficulty was soon surmounted in engines fitted with only two cylinders working compound, by the addition of an arrangement by which the engine could be worked as an ordinary locomotive at the commencement, and when fairly started the compound arrangement could then be applied.

The usual arrangement adopted in the early trials of compound locomotives consisted of two outside cylinders of different sizes; the steam having passed through the smaller cylinder was conducted to the larger one, after going through a sort of intermediate receiver in the smoke-box. The arrangement to work the engine non-compound consisted of a sort of slide valve controlled by the driver, by which means the direction of the steam from the boiler was so regulated that in one position the engine worked compound, and in the other in the ordinary way ; this was called the compound valve, and was placed on the boiler with the necessary pipes leading to it, making the engine look very unsightly. In both positions the waste steam was exhausted in the usual way up the chimney.

Many combinations of the above arrangement have been tried both in this country and on the Continent. The earliest trials in England were made on the Eastern Counties Railway, now part of the Great Eastern system ; on the Continent trials have been made extensively. In all cases the economy of fuel was at once apparent, but there was something in the arrangement which stopped its progress ; this most probably being the general complication of the machinery, combined with a difficulty of management when at work.

In 1878 Mr. F. W. Webb, the able locomotive superintendent of the London and North-Western Railway, commenced to make experiments with an old locomotive converted to the compound principle ; this engine had two cylinders of different sizes. The results of the trials were of such a promising nature, that he went thoroughly into the subject, and eventually brought out an entirely new arrangement with three cylinders, which he patented. This arrangement is a really good practical solution of the question of compounding locomotive engines, and visitors to the International Inventions Exhibition will there see the sort of way it has been accomplished. The compound locomotive, the *Marchioness of Stafford*, built at Crewe Works, is a really fine engine and a credit to the builders.

In attacking this problem Mr. Webb had several objects in view besides the saving of fuel by working the steam compound. His arrangement has enabled him to do away with two of the chief sources of anxiety pertaining to the management of locomotives.

In most non-compound locomotives designed to take heavy loads at a high speed the arrangement of coupling the driving and trailing wheels together by means of outside connecting-rods is a necessity ; in order that all the available power of the engine may be exerted without slipping, the wheels are coupled, so that it may be transmitted by two pairs of wheels instead of one. These connecting-rods are a source of danger at high speeds, and when they break, which they sometimes do, the prospect of a serious accident is by no means distant. Again, in all engines having inside cylinders a two-throw cranked axle is required ; this axle has to transmit the whole power of the engine ; it has to withstand the constant vibration caused by points, crossings, and roughness of the road, besides the heavy straining caused by the powerful steam-brakes now in use. The breakage of this axle has been the cause of many serious accidents. In Mr. Webb's compound engine both of these sources of danger are done away with, and in place of the two-throw cranked axle we find a single-throw cranked axle, amply strong enough to be practically unbreakable, and giving a length of bearing otherwise impossible. The arrangement of the cylinders is as follows :—The engine has two outside high-pressure cylinders and one inside low-pressure cylinder. The high-pressure cylinders are attached to the frames about midway between the leading and central wheels, and are connected to two cranks at right angles on the trailing wheels. The low-pressure cylinder is placed between the frames at the leading end, and is connected to a single-throw crank on the axle of the middle pair of wheels. The valve motion is that designed by Mr. David Joy, which does away with all excentrics and rods, and considerably reducing the number of working parts per cylinder. This gear is singularly easy to adapt to the altered circumstances required in Mr. Webb's arrangement, and must have considerably helped him when designing the engine.

The working of the engine is as follows :—The steam is taken from the boiler through the regulator in the dome to the smoke-box, where it is divided, and taken by means of a pipe to each high-pressure cylinder ; here it does a certain amount of work, and afterwards is returned in a parallel pipe into the smoke-box ; each pipe is taken round the smoke-box and then enters the valve-chest of the low-pressure cylinder. Thus the steam is somewhat heated during its progress through the pipes in the smoke-box, the pipes themselves serving the purpose of an intermediate receiver. When the steam has completed its work in the low-pressure cylinder it is finally exhausted up the chimney.

The *Marchioness of Stafford* belongs to the class of most powerful compound locomotives yet built at Crewe, and is of course fitted with all Mr. Webb's latest improvements ; the reversing gear is of special design, and only fitted to this class of engine. It is desirable in any compound engine to be able to vary the cut-off of the steam in the high-pressure cylinders without affecting the cut-off in the low-pressure, or the reverse ; at the same time it is necessary to have the reversing gear of a locomotive all worked by one lever or wheel. Mr. Webb's arrangement will no doubt answer the purpose fully, the driver being able to vary the cut-off of the steam into the cylinders either individually or all at the same time according to circumstances.

These engines have now been at work some time, and are giving good results, both as regards fuel consumption and steadiness of running at high speeds. There are now thirty-four compound engines at work on the London and North-Western Railway, taking their turn in working some of the most important trains on the system, doing the work thoroughly well with a considerably less consumption of coal than that required by the ordinary locomotive.

Following Mr. Webb in solving the question of compounding locomotives we find Mr. T. W. Worsdell, the locomotive superintendent of the Great Eastern Railway, at work in the same direction, but evidently for a means of reducing the consumption of fuel, and not, as Mr. Webb has done, to try and make the locomotive at the same time less liable to break down at high speeds.

In Mr. Worsdell's design we have two inside cylinders of different sizes, with an arrangement to turn steam direct from the boiler into the low-pressure valve chest either when the high-pressure crank happens to be on one of the dead centres, or to augment the power of the engine in starting the train. This valve, compared with the old compound valve of the earlier experimental compound engines, is extremely simple, and is so arranged that when the driving wheels have made a complete revolution the engine will automatically commence to work compound. This engine is well designed and is a thoroughly good specimen of locomotive engineering, but we think Mr. Webb's engine is to be preferred, if only on the grounds that it does away with double-throw cranked axles and outside coupling rods. No doubt, as far as coal consumption goes, both engines will be very nearly equal, this being merely a question of proper proportions given to the cylinders and valves. Both gentlemen are to be congratulated on having broken through the bounds of locomotive practice and having succeeded in their different designs.

When we think of the millions of miles run each year by locomotives in this country alone, and that the compound working of the steam enables us to save three or four pounds of coal per mile run, the enormous saving is at once apparent, leading us to the conclusion that the compound locomotive has a great future.

THE GEOLOGICAL SURVEY OF BELGIUM

SINCE the publication of our note on this subject (NATURE, vol. xxxii. p. 154) letters have reached us representing both sides of the controversy; but into the controversy itself we do not propose to enter. The question whether this party or that is most orthodox and geologically accurate is not one that greatly concerns the world at large; but all who watch with interest the progress of national scientific undertakings cannot but feel regret that a geological survey which has already achieved such important results as that of Belgium should have been suspended. The Belgian Senate has followed in the wake of the Chamber of Representatives, and the Government is understood to be now engaged in the formation of a new Commission to deal with the reorganisation of the Survey. Meanwhile the field-work is suspended. Geologists everywhere will rejoice if by any means the Commission can succeed in producing better maps and memoirs; but those who are familiar with the publications of the Survey will not be very sanguine as to its success in this respect. They do not need better maps or memoirs, and can only regret that the further progress of the work should have been arrested for this year. The loss of a working season is itself a serious injury. The Belgian authorities would have acted more wisely had they kept the field-work going while they made any necessary investigations as to methods of procedure. We sincerely hope they may see their way to start the Survey again with as little delay as possible.

SYSTEM OF ORTHOGRAPHY FOR NATIVE NAMES OF PLACES

TAKING into consideration the present want of a system of geographical orthography, and the consequent confusion and variety that exist in the mode of spelling in English maps, the Council of the Royal Geographical Society have adopted the following rules for such geographical names as are not, in the countries to which they belong, written in the Roman character. These rules are identical with those adopted for the Admiralty charts, and will henceforth be used in all publications of the Society.

(1) No change will be made in the orthography of foreign names in countries which use Roman letters: thus Spanish, Portuguese, Dutch, &c., names will be spelt as by the respective nations.

(2) Neither will any change be made in the spelling of such names in languages which are not written in Roman character as have become by long usage familiar to English readers: thus Calcutta, Cutch, Celebes, Mecca, &c., will be retained in their present form.

(3) The true sound of the word as locally pronounced will be taken as the basis of the spelling.

(4) An approximation, however, to the sound is alone aimed at. A system which would attempt to represent the more delicate inflections of sound and accent would be so complicated as only to defeat itself. Those who desire a more accurate pronunciation of the written name must learn it on the spot by a study of local accent and peculiarities.

(5) The broad features of the system are that vowels are pronounced as in Italian and consonants as in English.

(6) One accent only is used—the acute—to denote the syllable on which stress is laid. This is very important, as the sounds of many names are entirely altered by the misplacement of this "stress."

(7) Every letter is pronounced. When two vowels come together each one is sounded, though the result, when spoken quickly, is sometimes scarcely to be distinguished from a single sound, as in *ai*, *au*, *ei*.

(8) Indian names are accepted as spelt in Hunter's Gazetteer.

The amplification of the rules is given below:—

Letters	Pronunciation and Remarks	Examples
a	*ah*, *a* as in *father*	Java, Banána
e	*eh*, *e* as in *benefit*	Tel-el-Kebír, Oléleh, Yezo, Medina, Levúka, Peru
i	English *e*; *i* as in *ravine*; the sound of *ee* in *beet*. Thus, not *Feejee*, but	Fiji, Hindi
o	*o* as in *mote*	Tokio
u	long *u* as in *flute*; the sound of *oo* in *boot*. Thus, not *Zooloo*, but	Zulu, Sumatra
	All vowels are shortened in sound by doubling the following consonant	Yarra, Tanna, Mecca, Jidda, Bonny
	Doubling of a vowel is only necessary where there is a distinct repetition of the single sound	Nuulúa, Oosima
ai	English *i* as in *ice*	Shanghai
au	*ow* as in *how*. Thus, not *Foochow*, but	Fuchau
ao	is slightly different from above	Macao
ei	is the sound of the two Italian vowels, but is frequently slurred over, when it is scarcely to be distinguished from *ey* in the English *they*	Beirút, Beilúl
b	English *b*	
c	is always soft, but is so nearly the sound of *s* that it should be seldom used	Celebes
	If *Celebes* were not already recognised it would be written *Selebes*	
ch	is always soft as in *church* ...	Chingchin
d	English *d*	
f	English *f*. *ph* should not be used for the sound of *f*. Thus, not *Haiphong*, but	Haifong, Nafa
g	is always hard. (Soft *g* is given by *j*)	Galápagos
h	is always pronounced when inserted	
j	English *j*. *Dj* should never be put for this sound	Japan, Jinchuen
k	English *k*. It should always be put for the hard *c*. Thus, not *Corea*, but	Korea
kh	The Oriental guttural	Khan
gh	is another guttural, as in the Turkish	Dagh, Ghazi
l, m, n	As in English	
ng	has two separate sounds, the one hard as in the English word *finger*, the other as in *singer*. As these two sounds are rarely employed in the same locality, no attempt is made to distinguish between them	
p	As in English	
q	should never be employed: *qu* is given as *kw*	Kwangtung
r, s, t, v, w, x	As in English	Sawákin
y	is always a consonant, as in *yard*, and therefore should never be used as a terminal, *i* or *e* being substituted. Thus, not *Mikindány*, but	Mikindáni
	not *Kwaly*, but	Kwale
z	English *z*	Zulu
	Accents should not generally be used, but where there is a very decided emphatic syllable or stress, which affects the sound of the word, it should be marked by an *acute* accent	Tongatábu, Galápagos, Paláwan, Sarawak

THE UNIVERSAL MERIDIAN[1]

II.

"IF, now, we examine the question of changes to be introduced into existing charts, these would, in accordance with our proposal, be imposed on the whole world; they might be greatly reduced, especially if people restricted themselves to what would be sufficient for a beginning, that is, by tracing on the existing plans only sufficient to allow us to make an immediate use of the international meridian. Later on, and in proportion as new plates were engraved, a more complete scale would be given; yet, in my opinion, it would always be of advantage to keep the two frameworks—the national and international—according to the example of what is done in several atlases.

"If, at the present time, it is necessary to facilitate external relations, it is also good for each people to maintain all the manifestations of its personal life and to respect the signs representing its traditions and its past.

"I do not insist on the details of the establishment of such a meridian. All we have to support before you is the principle of its acceptation.

"If this principle were admitted by the Congress, we are charged to inform you that you would there find a ground of agreement with France.

"Undoubtedly by reason of our long and glorious past, our great publications and our considerable hydrographic labours, a change of meridian would entail on us heavy and cruel sacrifices. Yet if one came to us, setting us an example of self-sacrifice, and thereby proving his sincere desire of the public weal, France has already given such proof of her love of progress that no doubt need be entertained of her concurrence in such an enterprise.

"But we should have to regret our inability to associate ourselves with a combination which, in order to safeguard the interests of one part of the contractors, sacrificed the higher scientific character of the institution, a character which in our opinion is indispensable if it would claim the right of imposing itself on all, and if it would secure to itself a definitive success."

Immediately after this discourse the general discussion was entered into, in which all the English and American delegates, and the Americans distinguished in science who had been invited, successively argued against the proposal of the French delegate. The latter had to reply successively to half a score of speeches embracing various phases of the question according to the various provinces of the speakers. It is, perhaps, allowable to say that notwithstanding the authority, talent and number of the distinguished speakers contending against the principle of the neutrality of the meridian, the principle withstood all those shocks without being shaken, and without suffering any scientific breach. The meridian proposed by France will remain always as representative of the impartial, scientific, and definitive solution of the question. We think it was a honour to our country to have defended this cause.

Before the vote, M. Cruls, the learned director of the Observatory of Rio de Janeiro, and delegate of Brazil, informed the French delegation that he had received instructions from the Emperor to vote with France. We were very glad at this concurrence of sentiment, and begged to be allowed to congratulate the august foreign associate of the Institute of France on his resolutions.

The following are the principal passages in the speech in which M. Cruls set forth the reasons of his vote:—

"Down to the present one point, and that of great importance, has been settled by the discussion—the necessity, namely, of fixing a single initial meridian. This point has, in fact, obtained the adhesion of all the delegates present at the Conference. This necessity recognised, it is proper to take a step farther, and to determine which shall be this meridian. An election of this kind forms at this moment the object of our debates, and a question on which we should have to pronounce our opinion.

"Our honourable colleague, Mr. Rutherfurd, delegate of the United States, has made a motion proposing the adoption of the meridian of Greenwich—a motion for the moment eliminated from our debates, its author having decided to withdraw it temporarily.

"The motion which was made at the last sitting, and formed the subject of numerous and interesting debates, is that formulated by our honourable colleague, M. Janssen, delegate of France, proposing that the meridian to be adopted should have a neutral character, and should not touch either of the great continents of Europe and America. This proposal has been strongly combated by the delegates of England and the United States, and valiantly defended by the delegate of France, and the debates thus arising on the question have furnished us with the opportunity of witnessing a scientific tournament of the highest interest. The speakers we have had the honour of hearing seem to me to have exhausted the whole series of arguments for and against; and at this stage I presume that the debates have enabled us, in full knowledge of the case in dispute, to form each his own opinion on the question on which we are called to vote.

"For my part I am anxious to have clearly defined the attitude which in my opinion Brazil is called upon to take in the midst of this assembly. This attitude is one of absolute neutrality so far, be it understood, as it is a question of choosing a national meridian—a question which may provoke among certain nations very legitimate personal rivalries.

"Now, till the day when the Conference assembled for the first time, I was in hopes that these debates, entered into under the influence of a generous aspiration, and with the single object of arriving at the establishment of a measure, the necessity of which is warmly proclaimed by manifold interests of diverse nature, might conduct us to a complete and definitive solution of the question. Unhappily, and to my great regret, I am compelled to add that the differences which have manifested themselves in the midst of the assembly do not allow this hope to be maintained.

"That which for my part I am not able to lose from view is the fact that it is indispensable that the solution of the question for which the Conference is assembled should be complete; or the end of this Conference would not be attained. Now, since the delegates of France have from the beginning of our debates manifested their opposition to the adoption of any meridian invested with a national character, an opposition which gave rise to the motion presented by M. Janssen, it follows that any measure voted by the Conference and tending to the adoption of a national meridian would, by the very fact of the abstention of France, be an incomplete measure, not corresponding with the object pursued by the Conference. I hasten to add, for fear of any erroneous interpretation being given to my words, that the same objection would apply, if, for example, the meridian of Paris were proposed, and any great maritime nation, such as England, the United States, or any other abstained from its adoption. In such a case, likewise, my line of conduct would be fully indicated.

"In short, I will say that the immense benefits which would accrue to the whole world from the adoption of a single prime meridian would be forthcoming in all their plenitude only in so far as the measure was unanimously accepted by the most important maritime nations. In every other case I am for my own part absolutely convinced that the measure would be in part inefficacious, its adoption not being general, and that everything would have to be done over again in a more or less distant future.

[1] Lecture by Dr. Janssen at the Paris Geographical Society. Continued from p. 151.

"Well, the debates at which we have assisted prove to me superabundantly that such will always be the unsatisfactory issue so long as the meridian of any great nation is proposed.

"In presence, then, of this difficulty, which on that supposition appears to me insuperable, the only solution which by its very nature will not excite burning questions of national jealousy is that of a meridian having a character of absolute neutrality. If the adoption of such a meridian were admitted in principle, I am certain that a discussion engaged in on the ground of pure science and directed according to the best conditions which such a ground is calculated to secure would soon lead to a practical solution.

"In such a discussion the arguments having any force should be, above all, drawn from science, the only source of truth alone able to enlighten us so as to guide us to a sound judgment and to a decision based solely on considerations of a purely scientific order.

"Such a practical solution seems to me, moreover, to be suggested by what our honourable colleague, M. Janssen, told us on this subject. The principle of the neutral meridian once adopted, the conditions it would require to fulfil and the determination of its site would remain to be discussed. Of two things—one, whether the meridian should be exclusively oceanic, and so by its very nature it would be neutral; or, second, whether it should cut some island, and in such a case there could be no obstacle, by means of an international diplomatic convention, in the way of rendering neutral the particle of ground on which it would be proper to establish an observatory, which in reality would be confined to a very small affair—of these two solutions both of which would satisfy the conditions requisite for the meridian, from the double point of view of its character of neutrality and the demands of science, I prefer for my part the second. I confine myself to intimating by these few words how it would be possible to arrive at a practical solution, since at this moment I have to occupy myself simply with the adoption of the principle of the neutral meridian.

"I conclude, then, by declaring that I shall vote in favour of the adoption of a meridian invested with the character of absolute neutrality; and in doing so I hope thus to contribute my part to the end that our resolutions may bear the impress of independence which they require in order to impose themselves spontaneously and naturally, generalise themselves in the future and rally from the beginning the adhesion of men of science, without distinction of nationality, who at this hour await our decisions."

I have to add that before the vote M. Galvan, the very distinguished representative of the Dominican Republic, who had studied at Paris under our most eminent masters, very cordially informed me that the attitude of France in this matter appeared to him to conform with that which the world was in the habit of seeing it take in all questions of general interest, and that it would give him such happiness once more to contribute in bringing a testimony of admiration to the nation—to the *puissante initiale de l'intellectuelle*, to use his own expression—by voting with France.

As to the vote, it was according to our expectations, seeing that, as I have said, almost all the delegates had received instructions to vote for the meridian of Greenwich.

The principle of the neutral meridian being rejected, we abstained from taking part in the discussion in the choice of the national meridian called to become international. As we already said, we did not come to Washington to sustain a candidature, but a principle.

Before the vote, M. Valera, delegate of Spain, announced that he was charged by his Government to say that, in voting for Greenwich, Spain expressed the hope that England and the United States would accept the French system of weights and measures. This declaration led Gen. Strachey to say that he was authorised to announce to the Conference that England had asked to join the Metric Convention.

We cannot pass over in silence the part taken in this discussion by the eminent Foreign Associate of the Institute of France, Sir William Thomson, who was then in America, and had very naturally been invited to our sittings. Sir William Thomson expressed his desire of an accord in regard to the meridian and the metrical system. The following are among the few words he spoke on this subject:—

"I cherish the sincerest and most ardent desire that the delegates of France and those of the other nations who by this vote supported the previous resolution, will be able to adopt the resolution now before the Conference. It appears to me that we have here to do with a sacrifice, and I am convinced that the honourable delegate of France who last spoke, M. Lefaivre, will clearly apprehend that there is no question of asking a sacrifice of France which she is not disposed to make.

"In the admirable speech delivered by M. Janssen before this Conference (a speech I had not the pleasure and satisfaction of listening to, but which I read with the greatest interest) he declared that France was willing to make a much greater sacrifice than that now in question. The amount of sacrifice involved in changing certain usages is always more or less considerable, in view of the fact that it is impossible to say that such an innovation can be effected without derangement. It may, however, be asserted that the sacrifice France is prepared to make would be much more considerable than that ensuing from the adoption of the resolution now before us.

"If the resolution relative to a neutral meridian had been adopted, all nations would have been called on to make the sacrifice involved in a change of meridian not yet determined, and the relations of which to the meridians now in use could not have been so easy as would be those of the meridian of Greenwich with the meridians at present employed.

"I am of opinion that if the delegates of France could see their way to the adoption of this resolution, they would have no cause to regret it.

"I highly approve of what has been said in regard to a common metrical system. My opinion on this subject is firmly established, and I shall by no means express it if the President thinks it would be inexpedient to enter on this subject; but it seems to me that England makes a sacrifice in abstaining from adopting the metrical system. The question cannot, however, be presented under this form. We have not to consider here whether England would gain or lose by adopting the metrical system.

"Such is not the way of looking at the question, considering that the adoption of the metrical system by England is a question restricted to her own convenience, to her own usages, and that whether she adopted it or not, her decision could not in any way affect other nations. It could result neither in advantage nor disadvantage of other countries."

When the meridian of Greenwich was adopted, the Assembly considered that it devolved on it to define the principle according to which the longitudes should be numbered. Should they be counted in one single direction in accordance with the almost unanimous opinion of the distinguished members of the Conference of Rome, or should they continue to be counted in the two opposite directions, as far as the anti-meridian? The latter method was adopted.

The method of counting longitudes east and west, starting from a central meridian—the method actually in general use—was evidently introduced and actuated by the use of national meridians. But when, instead of looking merely at one country in particular, the entire earth is contemplated, and it is desired to bring the general system of longitude into relation with a universal time, it is difficult to understand how in counting the longitudes, one should stop in the middle of the way, while in counting the time one goes the whole round of the day, reckoning the hours from 0 to 24, according to the decision of the Congress.

We are unwilling to believe that the advantage of not having to make any change in use and wont, not even to the extent of a few figures on English maps, was the ground of this decision on the part of the majority.

This majority, for the rest, consisted in a preponderance of but three votes, and among the opposite voters or abstentionists we observe all the great Powers, with the exception of Russia.

The question of a meridian being completely settled, the assembly had to address itself to the second part of its programme—that relating to universal time.

The commercial and maritime relations so developed at the present day by the progress of the marine and telegraphy render the inconveniences attending a diversity of origins in horary measures more sensible every day. It has, therefore, come to be desirable to establish a division of time having the same point of departure for the whole world. To attain this object the local time of a determined point is taken, and by a convention is made the universal time. In this system the influence of longitude is entirely eliminated. The same instant receives the same name all over the earth, and the acts of international life are dated in as close relation to each other in point of time as though they were acts transpiring all within the same town. As to the point to be chosen for giving the universal time, it is plain that it ought to be the same as that adopted for giving the departure of longitudes. The two systems cannot be separated.

As a matter of course, this universal time cannot claim to take the place of local time, nor of so-called national time. The local time, which is the expression for each place, at least very approximately, of the course of natural phenomena, the eternal regulators of the acts of life, can never be displaced. In the case of certain arrangements, such as that of railways, for example, is it found highly convenient to extend the use of the local time of the capital to the whole country, when this latter has not a too considerable range of longitude. Such is the case in France.

The Congress adopted in principle the establishment of a universal time defined in the manner I have just described. But, separating itself again on this point from the Congress of Rome, it assigned as the origin of the universal day the midnight of Greenwich, which, according to the proposals of the Washington Congress, should become the beginning of the day for international transactions all over the world.

The divergence of resolutions adopted at Rome and Washington in reference to the origin of the international day brings clearly into view the inconveniences of the vexatious disagreement still actually existing between the origin of the astronomical day placed at midday, and that of the civil day placed at the preceding midnight. This inconvenience grows greater and greater in proportion as the ephemerides and astronomical studies extend. We therefore eagerly associated ourselves to the resolution expressed by the Congress relative to the unification of the two systems, by making the astronomical day commence at midnight, like the civil day.

Astronomers will, we hope, understand that, being a far less numerous body, and much more conversant with these matters, it is on them that it devolves to make a slight sacrifice, so as to allow a progress very desirable at the present day to be effected.

After the discussion of these various questions, the labours of the Congress approached their term; it was then that the French delegation made the proposal it had been charged to present—a proposal having reference to an important extension of the decimal system.

The Congress of Washington, by its importance and by its object, which aimed definitively at the continuation of that great French work of unification and of progress inaugurated at the end of the last century, offered an altogether appropriate opportunity to ask for the world a new extension of those applications of the decimal system which constituted the whole merit and the whole success of our reform of weights and measures.

This extension had relation to the measurement of angles and of time.

At the date of the establishment of the metrical system the decimal division was, as is known, extended to the measure of angles and time. Numerous instruments were even constructed according to the new system. As far as time is concerned, the reform, introduced too drastically and without sufficient discretion, it may be said, clashed with too inveterate usages, and was rapidly abandoned; but in regard to the measure of angles, where the decimal division presents so many advantages, the reform held its ground much better, and has maintained itself in certain practices to this day. Thus, for example, the division of the circumference into 400 degrees was adopted from the beginning by Laplace, and it is currently employed in celestial mechanics. For the measurement of the arc of the meridian, whence the metre was derived, Delambre and Mechain availed themselves of repeating circles divided into 400°. Finally, in our days, Col. Perrier, Chief of the Geographical Service at our Ministry of War, makes use of instruments with decimal division, and at this moment calculates even logarithmic tables with eight decimals appropriated to this mode of division.

It is above all, however, when it is required to execute long calculations on angular measures that the decimal division presents immense advantages. On this point nothing but unanimity may now be said to reign among learned men.

The Conference of Rome, which assembled so many astronomers, geodesists, and eminent topographers—that is, just the men of most weight and having the greatest interest in the question—issued on this subject a resolution the high authority of which it is impossible to disregard.

It is now, then, evident that the decimal system, which has already rendered so many services in the measurements of length, of volumes, and of weights, is called upon to render analogous services in the domain of angular magnitudes and of time.

I am aware that this question of the decimal division has to contend with legitimate apprehensions, principally in reference to the measure of time. People are afraid of doing violence to secular customs and overturning consecrated usages. On this aspect of the business I think we ought to be fully assured. The lessons of the past will be put to profit. It will be understood how it was for having endeavoured to push a reform beyond the due domain of science, and for having done violence to the habits of daily life, that disaster was experienced during the epoch of the Revolution. It is proper to resume the question, but it is proper to resume it with an appreciation of the limits which good sense and experience will always indicate to wise and experienced men.

I think the character of the reform would be sufficiently indicated by saying that the question is principally to make a new effort towards the application of the decimal system in the scientific world.

We met at first with a sufficiently warm opposition. The President was of opinion that the proposal should not be offered for discussion, but I have to acknowledge that he finally yielded very courteously, "out of deference," he said, "to the delegates of France, and because we are happy to do them honour in all things."

The majority decided that the proposal should be discussed. The French delegate then spoke, and the meeting passed to the definitive vote. The success was then complete, for the proposal was adopted by twenty-one votes, without one dissentient voice.

Such is the work of the Congress.

This work is considerable. Its importance, however, is derived much more from the principles enunciated by the Congress than from the solutions it adopted.

The establishment of a single meridian and of a universal day, the unification of the astronomical and civil days, the extension of the decimal system,—these are reforms which the progress of science and of international relations rendered opportune and desirable.

In the application, however, of the principles, the Congress has been less successful.

In the choice of a primary meridian it allowed itself to be too much carried away by the practical and immediate advantages of a meridian already in very extended use, and disregarded the conditions which would have assured to its work a universal and definitive adoption.

In regard to ourselves we have in this question adhered to the part prescribed to us by our past, our traditions, and the very character of our national genius. Our proposal was precisely that which we should have adopted ourselves if we had had to take the initiation of this reform. The nation which created the metrical system could propose none other than it did. If our purely scientific and disinterested opinion did not unite the majority around it, the reverse was not for France, but for science. But science is the sovereign of modern times and one cannot now detach himself from it with impunity. It is vain to say that the meridian of Greenwich is *de facto* the universal meridian, that it reigns to-day over almost all the navies of the globe, and that its adoption only consecrates a fact which has already established itself and transforms into law the institutions of fact.

I reply that that is all true. I even add, if it is desired, that such is only what is merited by the great labours of the English marine—labours which we, the initiators of hydrography, more than any others appreciate at their true value. But however considerable may be these labours and however great the numbers of those availing themselves of them, yet with the experience of the past and in the name of history I say that these merits will not be able to prevent the inevitable consequences resulting from the personal character of this meridian. And in point of fact, has not France—she, too—had a great geographical career? The meridian of the Island of Ferro, which soon, in the hands of Gillaume Delisle and of our great geographers of the eighteenth century, became French—did it not bear sway in cartography for more than two centuries, and that with an authority not even equalled to-day by that on the other side of the Channel?

And yet the meridian of the Isle of Ferro, after that brilliant career, is to-day more and more abandoned, and the fair attempt of the seventeenth century finds itself entirely compromised!

What is the cause, then, which has led to this vexatious result? Apparently a mere trifle. It is because, as we have already said, instead of leaving the meridian of the Isle of Ferro in conformity with its first intention, instead of maintaining it in the purely scientific character which it received from the hands of Richelieu, that great spirit who so well understood that an institution of a universal order must bear no personal investiture, this character was imprudently changed by bringing the position of this meridian into relation with that of Paris, in place of bringing the position of this capital, like any other point, into relation with it.

That is the mistake which compromised the fortune of this reform so firmly and so judiciously established by its illustrious author. Now, this mistake, is it not committed to-day by once more taking a national meridian and making it the universal point of departure for longitudes? Is one not then justified in foreseeing that the same causes would produce the same effects, with this difference, nevertheless, that in the advanced state of civilisation prevailing to-day among the nations, a particular supremacy, of whatever nature, would be much more promptly abandoned than it was two centuries ago?

It is, accordingly, much to be feared that the establishment of the new meridian, if it even succeed in getting established, would again be but an attempt without a future.

France who finds in the history even of her own past the double lesson of the progressive abandonment of her national meridian and of the ever growing appreciation of the scientific and impersonal system of weights and measures, ought to make known to the Congress a counsel dictated by her own experience.

Does this attitude, however, sufficiently absolve us? Have we discharged towards the world and towards ourselves the debt due by a generous and enlightened nation which has always been delighted to take the initiative in tasks conducive to the general well-being? I do not think so; and, were it allowed me to express a wish, it would be that we should on this occasion again join example to precept. I should like that the France of the nineteenth century, considering herself the heir of the France of the seventeenth, would, with the benefit of the experience she has in that interval acquired, resume the fair attempt of Richelieu and herself establish the neutral meridian.

This institution, well conceived and planted on exclusively scientific bases, would gradually rally to it the adhesion of all. England herself, who, if possessing a lively national sentiment, has likewise an appreciation of what is just and great, would end by attaching herself to it. and then would this reform so long desired, always attempted in vain, and again quite recently compromised, be finally secured to the world and to science.

Be that as it may, and outside the question of the meridian, which is not yet settled, let us not forget that the accession of England to the Metrical Convention and the resolution for the extension of the decimal system are results demonstrating that our presence at Washington was not useless either to science or to progress.

THE VOYAGE OF THE "CHALLENGER" [1]

I.

NINE years have slipped away since the memorable expedition of the *Challenger* came to a close. During this interval from various published accounts of the voyage, the route around the world, the places called at, the life on board, the impressions, social or biological, left on the minds of the voyagers—are all now more or less familiar to us. There have likewise appeared numerous detailed quarto reports from different experts, into whose hands the great natural history collections amassed during the expedition were placed for description. We know precisely the additions made by the naturalists of the *Challenger* and their collaborateurs to our knowledge of the foraminifers, corals, medusæ, ostracods, brachiopods, echinoids, shore fishes, birds, and many other groups, and from the list of memoirs yet to come we can see how ample a store of detail is still to be produced. We know also how vast an amount of additional information has been gathered by the expedition regarding the physics and chemistry of the ocean. But as yet there has been no condensed official record of it all. The general public, and even the man of science, cannot be expected to master the series of special reports; life is too short for this, even if the power of comprehension were adequate. Admirable and exhaustive as the reports are, and indispensable for experts in the various branches of which they treat, each of these must necessarily appeal to a comparatively small

[1] "Report on the Scientific Results of the Voyage of H.M.S. *Challenger* during the years 1873-76." Prepared under the direction of the late Sir C. Wyville Thomson, and now of John Murray. "Narrative," vol. I., 1885

circle of readers. What has been needed is such an official summary of the whole work of the expedition as will convey to the general public a sufficiently clear and detailed account of the whole results of the voyage of the *Challenger*, and will enable the man of science to realise what has been done in other departments than his own special domain.

Such a summary has now been prepared and published as the "Narrative of the Cruise." It is called a volume, though in reality it consists of two stout quartos, comprising altogether upwards of 1100 pages. The first thought that will naturally occur to any intelligent person who takes an interest in these subjects, and who hears that at last the official narrative of the *Challenger* expedition is issued, will be that this at least is a part of the publications that he would like to possess, or at least would expect to find readily accessible as an authoritative and convenient record of what the expedition has done. His zeal

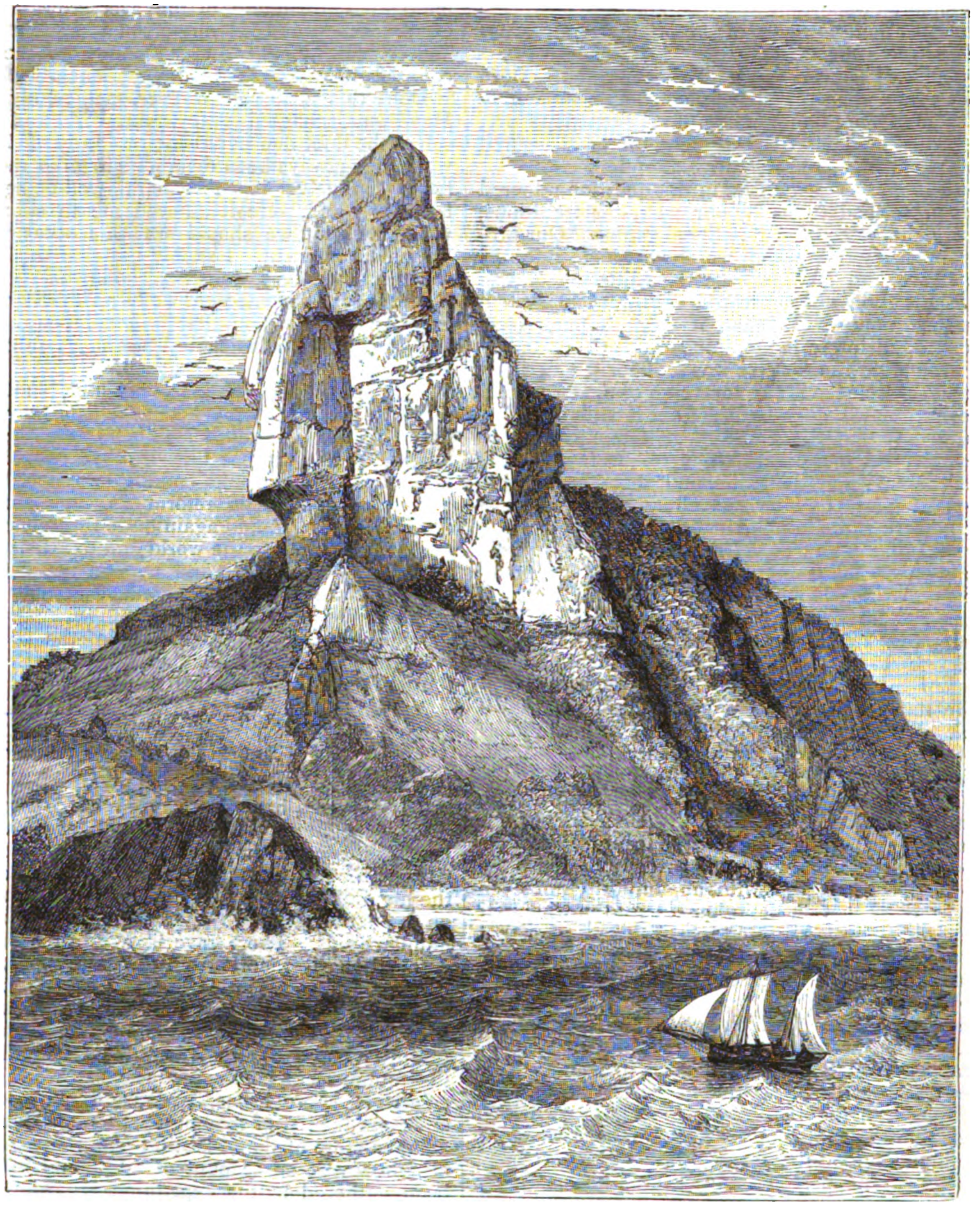


FIG. 1.—The Peak of Fernando Noronha, sketched from the Deck of H.M.S. *Challenger*, September 3, 1873.

for the acquisition of knowledge, however, may not improbably be damped when he learns that the book will cost him 6*l*. 16*s*. 6*d*. Why such a prohibitory price should have been affixed to this work is one of those mysteries of Government publication which it is hopeless to understand or explain. There can be no question that this Narrative volume is the one of the whole series most likely to sell. There are, no doubt, hundreds of institutions and private individuals that would gladly purchase it if the cost were within their means, but to whom the acquisition of the whole series of Reports, or even a small proportion of them, is impossible. The official rule has been, we believe, to print off only 750 copies of each Report, to charge the whole cost of production upon that number, and then to destroy the copper plates and lithographic stones, so that on the supposition that the whole edition is sold, no loss from its publication will be incurred by the national exchequer. This may or may not be a judicious rule for the reports of specialists for which no great sale can be expected; but surely it is not a wise one in the case of the Narrative volume, for which a much wider circulation may confidently be expected. It is understood that the type and plates of this volume are kept up, so that if the present edition is sold off another may be printed. But as the cost of production has been charged upon the first edition, every copy subsequently produced will cost nothing but the mere paper, printing, and binding. Government cannot, of course, wish to make profit out of the book as a commercial speculation. Would it not have been more in accordance with common sense and trade economy to have issued a much larger edition at first, and to have spread the cost of production over the whole of it? Had the book been sold at half its present price its sale would probably have been more than doubled. That,

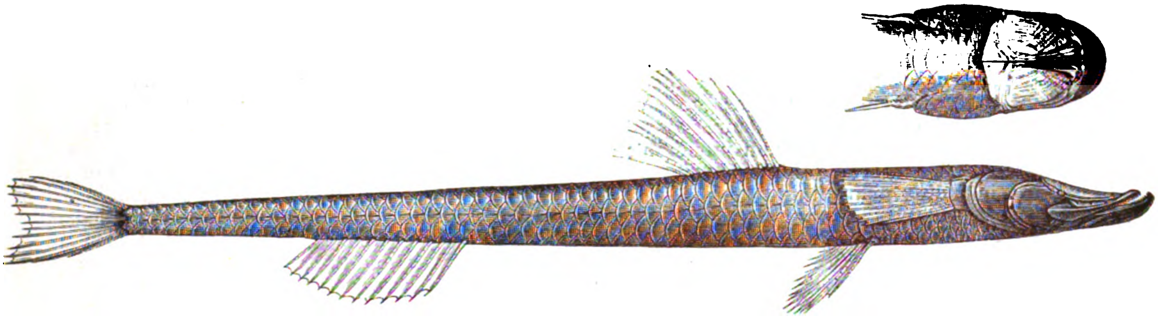


FIG. 2.—*Ipnops Murrayi*, Günth., 1600 to 1900 fathoms.

even as it is, the whole edition will be sold we confidently believe. But that will be no justification whatever for making the price so high. After so large a sum of money has been spent upon the expedition first and last, it seems perfectly childish to publish the results in such a form that even the most generally useful and intelligible part of them are out of the reach of most of those who really feel an interest in them.

There is another question which my Lords of the Treasury will have to face in regard to this Narrative volume. Many requests have been made to that pachydermatous body for gifts of different reports; many more would no doubt have been made but for the known determination on the part of the authorities to refuse them. Now, it is tolerably certain that public libraries all over the country will ask for at least copies of the "Narrative of the Cruise," and the whole of the first edition would probably barely suffice to supply their demand. That their requests will be again

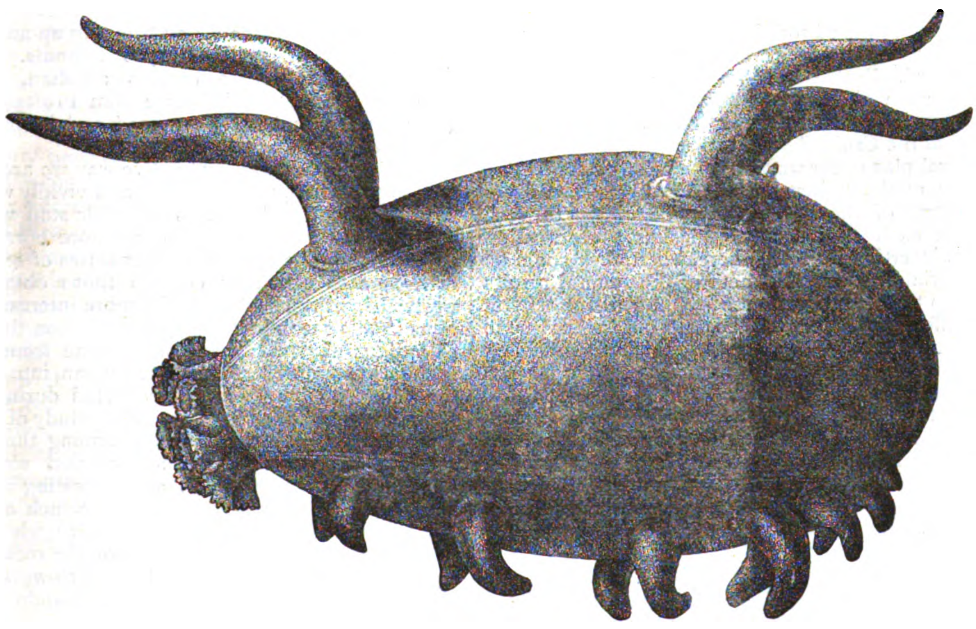


FIG. 3.—*Scotoplanes globosa*, Théel.

refused goes without saying. But it will be noteworthy if these public institutions are content with the refusal. The country has a right to insist that the results of an expedition on which so much public money has been spent shall be made as widely accessible as possible, and will no doubt brush roughly aside the stereotyped official objections. A more flagrant case of the stupidity into which a blind adhesion to red-tape rule may lead a Department that no doubt means well could hardly be found than this Narrative volume and its price of 6*l.* 16*s.* 6*d.*

With this preliminary protest we gladly pass on to notice the book itself. First of all, like the previously published Reports, the "Narrative" is admirably got up. The paper, print, illustrations, and binding are so vastly superior to ordinary Stationary Office productions that we wonder more than ever how the Treasury officials were ever prevailed upon to sanction such expenditure, even though with the prospect of charging a high price. The book is in two parts, each of which forms a thick, heavy quarto of more than 500 pages. It contains 14 chromo-lithographic plates, giving illustrations of deep-sea deposits, Antarctic icebergs, and various aborigines and their handiwork; 35 photographic plates, among which the glaciated pavement at Halifax, the lava-cascade at Kilauea, and some of the representations of growing vegetation are particularly good; 43 charts of the route of the voyage and of stations visited, including a large and valuable physical chart of the world on which all the newest information as to ocean depths is given, together with the track of the *Challenger* and the nature of the bottom observed in the different soundings; 22 diagrams showing the vertical distribution of temperature in the ocean, and embodying in a graphic and intelligible form a vast amount of detail regarding this fascinating subject; 340 woodcuts, including many illustrations of the more novel or interesting natural history "finds" of the voyage, and some of them remarkable for the exquisite beauty and fidelity with which they have been executed; and, lastly, which will surprise the reader accustomed only to the prosaic solidity of Government publications, there are tail-pieces to the several chapters—mermaids filling the tow-net for the naturalists above, scenes from the life of the cruise on deck and on shore, and little bits of fancy that remind one sometimes of Edward Forbes.

The general scope of this "narrative" was sketched out by Sir Wyville Thomson, and in his preface to the first volume of the "Zoological Reports" he referred to it as actually in progress. He died, however, before he had made any progress with it, the world losing in him the enthusiastic and kindly spirit that planned the whole expedition, saw it successfully completed, and organized the systematic working out of its collections. Since his lamented death the work has been vigorously prosecuted by his successor in the editorial supervision of the Reports, Mr. John Murray, who, in conjunction with Staff Commander Tizard, Professor Moseley, and Mr. J. Y. Buchanan, and with the co-operation of the various specialists employed, has compiled this voluminous "Narrative of the Cruise."

The general plan of the work may be briefly stated. The leading idea of the writers has been to give a chronological account of the voyage from beginning to end, recording at each station any remarkable observation there made, inserting here and there, where they could be most appropriately given, abstracts of the general results arrived at up to the present time by the various experts to whom different portions of the vast collections made during the cruise have been entrusted, and describing fully the various equipments of the *Challenger* for the scientific work for which the expedition was designed.

Some of these features of the book have, of course, already become more or less familiar from the publications of Sir Wyville Thomson himself, and of Professor Moseley, Lord George Campbell, Mr. Wild, and others. But they have never been presented so fully nor illustrated so amply. Unfortunately all the scientific work connected with the expedition is not yet completed, so that it was not possible to give in the "Narrative" a summary of the whole results achieved. But as far as the work had advanced up to the time of its publication, the volume now issued contains a digest of it, prepared by the various specialists by whom it has been accomplished. When the whole *Challenger* results have been published, we hope that in a future edition of the "Narrative," a conspectus of the entire work of the expedition may be completely given.

The introductory chapter presents an outline of the history of research in the ocean. This is followed by a detailed account of the fittings of H.M.S. *Challenger*, which will be useful as a record of the state of deep-sea investigation in 1872. The proper narrative then begins with the departure from Portsmouth, the various trials of the apparatus and training of the crew in the kind of work which was to be prosecuted during the cruise, and a full description of the instruments employed and the methods of observation with them. This, though to most readers rather a dry subject, is here treated with a fulness not elsewhere to be found. The account of the thermometrical observation and of Professor Tait's subsequent researches, with the actual instruments employed, is a valuable part of the book. Listening to these detailed descriptions of what they were trying to do and how they attempted to do it, we are hardly aware that we have been carried through more than a hundred closely printed pages, and from the shores of Old England to the Peak of Teneriffe. But the real work of the expedition was now to begin with the running of a section across the North Atlantic. A good deal of information from previous observation was already in existence regarding the depths and form of the bottom of this ocean. But no such series of soundings had ever been made across it as was now to be carried out by the *Challenger*. Twenty-four soundings, fifteen dredgings, two trawlings, and thirteen serial temperature soundings, were taken between Teneriffe and the West Indies. A brief description of the more interesting features of these researches is given, and then, as we are carried onward to Bermuda and as the various treasures of the deep are brought before us, some species of brachiopods hauled up from the bottom afford an opportunity of hearing Mr. Thomas Davidson discourse regarding his examination of the whole of the brachiopoda collected during the cruise. At Bermuda we hear again of the wonderful Æolian rocks, which from the early descriptions of Captain Nelson down to those of Sir Wyville Thomson have attracted the notice of geologists. Running up to Halifax, Nova Scotia, we catch a glimpse of the wonderfully glaciated rocks of that region, and on the return voyage to Bermuda we watch the officers of the Expedition gauging the temperature and depth of the Gulf Stream, and bringing up an Arctic fauna from depths of 1250 to 1700 fathoms. Among the novelties taken are a curious ascidian, which gives occasion for a short discourse from Professor Herdman regarding the tunicata discovered and brought home by the *Challenger*.

In this pleasant and instructive way we are led on from station to station, noting clearly and vividly what the ship passed through and what its scientific staff were engaged in. From Bermuda we are once more borne across the Atlantic and take part in another series of soundings and dredgings to check or confirm those obtained in the westward passage. Among the more interesting observations in this second traverse were those on the occurrence of various abysmal brittle stars, some from a depth of 2850 fathoms, and Mr. Theodore Lyman, into whose hands the whole of the ophiurans collected during the cruise were placed, gives us a *résumé* of his study of them. After some time spent in observations among the Azores and Cape Verde Islands, we are carried southwards to St. Paul's Rocks, of which an interesting account was, long ago, given by Darwin, and to which attention has recently been called by the Abbé Rénard, whose investigation of the microscopic structure of the rock has already appeared in the Reports of the *Challenger* expedition. We catch a tantalising glimpse of Fernando Noronha, regarding which little new information can be obtained, since the Governor refuses permission to make collections. So, casting a wistful look at its colossal peak (Fig. 1) we are transported to the coast of Brazil, and thence back again into the centre of the South Atlantic where the lonely rocks of Tristan da Cunha rise above the waves. This section of the voyage is full of interest. The naturalists are evidently getting more practised in their duties, the crew more expert in the labours of sounding, trawling, and dredging, and the hauls are more generally successful than in the earlier weeks of the cruise. The dredgings and trawlings along the American coast are specially important, bringing to light many new forms belonging to nearly all the invertebrate groups, and the first specimens of a new genus of nearly blind fish (*Bathypterois*). A *résumé* of all that has been added to our knowledge of the radiolaria is here inserted, with some excellent woodcuts which bring the structures of these beautiful organisms clearly before the eyes. On the way to Tristan da Cunha another new genus of fish (*Ipnops*, Fig. 2) is brought up having a quite unique structure of eye which appears to be designed for detecting the presence of very small quantities of light at great depths, at the expense of all apparatus for forming an image. From Tristan da Cunha, of which an interesting description is given with good illustrations, the section of the South Atlantic is continued to the Cape of Good Hope. The tow-nets did not yield such a rich assemblage of life as in the more tropical parts of the ocean, but the account of this section is enlivened by a summary from Dr. Hjalmar Théel of Upsala, giving the results of his examination of the holothurioidea collected during the whole cruise. One of the curious new forms described by him is shown in Fig. 3. From the Cape of Good Hope the *Challenger* strikes away south-eastward into the Antarctic regions, but a notice of the further progress of the cruise must be reserved till next week.

(*To be continued.*)

NOTES

THE death is announced at Lund, Sweden, of the distinguished physicist, Prof. A. W. Eklund, at the age of ninety years.

WE learn from *Science* that at the meeting of the American Association at Ann Arbor on August 26, the University will furnish electricity, either from a dynamo, from a storage-battery, or from primary batteries, as may be needed by members reading papers on electrical subjects. An evening reception on a day not specified will be given the association at the court-house, together with a lawn-party on the University grounds at the close of one of the regular sessions. The Excursions Committee has nearly completed arrangements for a trip, free of all expense, to the Saginaw Valley, including a steamboat run down the river, and view of the cities of Saginaw, East Saginaw, Bay City, and West Bay City, and the enormous industries in salt and lumber manufacture which have given the Saginaw Valley a world-wide celebrity. This valley produces annually a billion feet of lumber, and the excursionists will see half a billion piled on the docks. In conjunction with these vast lumber operations will be seen the production of salt on a scale unequalled in the world, and employing the various improved processes. The Committee has also arranged for excursions to Detroit and Mackinack Island, with side trips to Salt Marie, Pectoskey, and Marquette. Those wishing to make any special inquiries or arrangements should address Prof. J. W. Langley, local secretary, Ann Arbor.

A BARONETCY has been conferred upon Mr. Isaac Lowthian Bell.

THE Indian Government has sent a geological surveyor to report on the scientific aspects of the Cashmere earthquake of May 13. Further shocks are reported with renewed violence on June 24 and 25. A correspondent of a Calcutta journal, writing on the second day after the first great shock, says that the force of the earthquake appeared to have concentrated itself at certain spots, nd there to have spent itself. These spots look as though a large amount of gaseous matter under the earth had, with the strength of dynamite, been struggling for an outlet, and had torn and lacerated the ground at the point where it found an exit. Thus villages are seen with the huts all destroyed, the earth adjacent being cracked and split, and the air putrescent from the bodies of cattle buried under the houses, while not twenty yards distant a sloping, wooded hill seems untouched. In other places the side of a vertically-scarped hill has been sliced off as if by the guillotine, the earth so severed lying at the base. Some hill-sides are only partially disconnected, and a deep incision remains. Other hills present the appearance of an ordinary landslip. Near the village of Lalledourah three enormous chasms have been formed, one about three-quarters of a mile broad and 20 feet deep. Not far distant a tract of land 800 yards square has subsided, forming a trench 100 yards long, 50 feet deep, and 30 feet wide. The latest returns regarding the damage give the loss of life at 3081 persons, besides 25,000 sheep and goats and 8000 cattle. The number of dwellings destroyed is estimated at 75,000.

A VIOLENT shock of earthquake was felt at Douai, Dognies, and Flers-en-Escrebieux on Wednesday, June 22. The phenomenon was preceded by a rumbling sound, which is described as having resembled the distant report of a cannon. It occurred at ten minutes past four in the morning, when most of the inhabitants were still in bed. Many of them were awoke by the shock, and were so alarmed that they rushed in their night-clothes out of their houses into the streets and roads. The oscillation of the ground stopped a great many of the clocks. No very serious damage was done.

THE New York correspondent of the *Standard* telegraphs that the receipts from Prof. Tyndall's lectures in the States in the year 1872 now amount to a fund of 32,400 dollars. The Professor desired that the money should be devoted to the sustentation of science fellowships; but a difficulty arose in satisfying the conditions of the deed of gift, and meanwhile the money has accumulated. Acting, however, upon a suggestion from the trustees of the fund, Prof. Tyndall has now directed that the money shall be equally divided between the Universities of Columbia, Harvard, and Pennsylvania.

THE ninth anniversary meeting of the Sanitary Institute of Great Britain will be held, by the kind permission of the Board of Managers of the Royal Institution, in their Lecture Theatre, Albemarle Street, on Thursday, July 9, at 3 p.m. The chair will be taken by Sir John Lubbock, Bart., M.P., D.C.L., F.R.S. An address will be delivered by Prof. W. H. Corfield, M.A., M.D., entitled "The Water Supply of Ancient Roman Cities," and the medals and certificates awarded to the successful exhibitors at the Exhibition held at Dublin, in 1884, will be presented.

THE Organising Committee of the General Meeting of the Italian Meteorological Society, which meets in Florence from September 8 to 14, was held on May 15, under the Presidency of Prince Corsini, who was elected President of the General Meeting, the Vice-Presidents being Profs. Cecchi and Neucci, and the Secretary, Sig. Giovannetti; the Committee then divided into two Sections, one for scientific purposes, the other for practical and executive purposes.

THE Norwegian Government have contributed a sum of about 200*l.* for the prosecution of various researches during the summer, amongst which may be mentioned the zoological studies of Prof. R. Collett in East Finmarken; the entomological, malacological, and hydrographical studies of Dr. Schneider in the province of Tromsö; the researches of Dr. Johannsen on the appearance of struma in the vicinity of the lake Mjósen; and the algological studies of Herr Foslie on the south coast of Norway. A sum of 350*l.* has also been granted to the Society of Science at Christiania, as well as the usual annual grant to Dr. Sophus Tromholt for the prosecution of his studies of the aurora borealis.

ACCORDING to the Paris Correspondent of the *Times*, the Academy of Sciences, whose turn it is this year to award the Institute's biennial prize of 20,000f., has pronounced in favour of Dr. Brown Séquard.

ACCORDING to the Swedish papers, on the evening of June 19 a crane was shot at Orkened, in Scania, which had a parchment card tied to its neck with the following lines written in ink :—

I come from the burning sand
From Sudan, the murderers' land,
Where they told the lie,
That Gordon would die.

The bird had previously been wounded in the wing, and was very exhausted.

THE Japanese have at last, after much hesitation, promulgated a patent law. As in America, with respect to copyright, it was argued that with no patent protection the Japanese got the benefit of the inventions of the whole world. The new law appears, like many other recent Japanese laws, to be compiled from similar laws of other countries—a clause from England here, from France there, from Germany in another place, as seemed advisable in the circumstances. The term of protection is fifteen years; "articles that tend to disturb social tranquillity, or demoralise customs and fashions, or are injurious to health," and medicines cannot be patented; the inventions must have been publicly applied within two years, and patents will become void when the patented inventions have been imported from abroad and sold—an illiberal provision which prevents the patenting of foreign inventions in Japan unless the inventor also manufactures them in the country, and which therefore renders the new law practically useless to any but the Japanese inventor. The fees are low, amounting to about three pounds sterling for fifteen years' protection, the one payment down being sufficient, while there are no annuities or annual payments for keeping the protection in force, as in many European countries. The punishments for breaches of the regulations are sufficiently severe to act as a warning against infringement.

THE attention of all interested in the study of philology, comparative folk-lore, and cognate subjects, should be directed to a magazine which is now being published at Kandy in Ceylon. It has just completed its first year, and is called the *Orientalist*, the sub-title being "a monthly journal of Oriental literature, arts and sciences, folk-lore, &c." It is edited by a Singhalese gentleman, Mr. Goonetibleke, and its contributors are for the most part Singhalese. The last three numbers of the first volume are now before us, and among the contents we observe articles "on the terms of relationship in Singhalese and Tamil," the influence of the Portuguese and Dutch on these two languages, contributions to a descriptive catalogue of Sanskrit, Pali and Elu works extant in Ceylon, the progress of the Singhalese in literature, arts, and sciences. But folk-lore has, so far, been the strong point of the new magazine; it has published numerous articles on Singhalese proverbs and folk-lore; sometimes a popular tale amongst a particular Eastern people is started by a contributor, and is then pursued through other peoples having a parallel tale. These tales are translated in full, and are frequently accompanied by the originals. The address of the editor is Trincomalie Street, Kandy, Ceylon, and Messrs. Trübner are the agents for Europe.

WRITING to the *Times* on the subject of *Edelweiss*, Mr. Burbidge, of the Trinity College Botanical Gardens, Dublin, points out that the plant is easily grown in English gardens from seed. It is sown in common garden earth in a cold frame, and when large enough each little plant is placed in a small pot in a mixture of loamy earth and old lime rubbish, or the plants, he says, are equally well pleased by a niche in a sunny rock garden, provided a supply of their favourite lime rubbish or old mortar be afforded them. Contrary to the generally received opinion, the *Edelweiss* is really a plant of extremely easy culture from seeds as here directed, and, further, good fresh seeds of it are quite readily obtainable from the usual sources of seed supply.

WE have received the first number of the *Bulletin* of the Society of Natural History of Brookville, Indiana, an association organised in 1881, according to the report, with excellent results in an enlarged interest in the study of nature, the establishment of a valuable museum, and the founding of a large and excellent library. Amongst the contents we notice papers on the stone mounds on the Whitewater; on the flora, fossils, and land and fresh-water mollusca of Franklin County, and on the fauna changes of the same district. The last paper is especially interesting, as showing the effects on the fauna of civilisation and its accompaniments, such as draining, cutting down forests, &c.

WE have received the fifteenth annual report of the Wellington College Natural Science Society. The observations conducted by the society have been carried on as usual, and the more important of them are published in detail; beyond this the report offers no new features for special comment.

WE notice in the issue of the St. Petersburg *Izvestia* (xx. 6) two papers by MM. Popoff and Katatanoff on the customs of the Katchin Tartars of Minusinsk, with a notice, by M. Potanin, on wild plants used as food in Siberia. These last are numerous. The Katchin Tartars eat the grains of *Fagopyrum tataricum*; in the government of Irkutsk, during years of scarcity, the peasants add to their flour the *Polygonum convolvulus*. In Northern Mongolia the grains of *P. viviparum* (*oorgene* with the Mongols) are a common addition to food. The "ibseck," used by the Katchin Tartars, seems to be the *Cirsium acaule*, whose roots are eaten in Northern Mongolia. In Northern Siberia (Turukhansk, Yakutsk regions) the inhabitants eat the anti-scorbutic roots of the *Cochlearia sisymbroides*, Dec., var. *Czekanowskiana*, (Trautvetter). The exact determination of this plant is due to Czekanowski's expedition, for Middendorff had confounded it with the poisonous *Veratrum lobelianum*, Bernh., and he even saw in its eating a proof for the disparition of poisonous qualities of certain plants in a northern climate. When there is no pine-trees the Yakutes used to add to their sour milk a flour of dried roots of *Butomus umbellatus* instead of pine-bark. Great stores of these roots are usually made by Yakutes, who also use the grains of *Plantago media* and *P. canescens*, Adams. In the Khangai, M. Potanin was also shown a species of *Plantago* the fruits of which are eaten by the Khalkas Mongolians; but altogether, he observes, a confounding of *Polygonum* with *Plantago* has possibly been made by previous authors. We may add to this list that the *Lilium martagon* is eaten in large quantities in Transbaikalia, and that it is a common thing with the Buriates to pillage in the autumn the provisions of bulbs of this Lily made by the Arvicolæ, and to appropriate these provisions for themselves.

THE Stokes-Watson spark apparatus for showing the combustion of metals under the microscope, by the passage of the electric spark through them, made by Messrs. Watson and Sons, of High Holborn, from the design suggested by Prof. Stokes, was exhibited by Messrs. Watson at the *conversazione* of the Royal Society, Burlington House, on May 6, and again by them on Friday, June 5, at the Royal Institution. It is a most interesting apparatus, the different metals in combustion showing beautiful colours, and as the apparatus can be added to any ordinary microscope, no doubt it will become very popular.

THE Trilobites recently found in Eastern Siberia belong, according to Prof. Friedrich Schmidt, to very different ages. Those found in boulders on the Olenek (*Agnostus*, *Olenus*, *Anomocaxe*) belong to the Cambrian, and are closely akin to those collected by Richthofen in China. From the Lower Silurian, the *Chasmops* of the Podkamennaya Tunguska is especially worthy of notice. It belongs to the Trentock level, as far as we may judge from corals from the same locality described by Prof. Lindström. Finally, Mr. Schmidt has received from Krasnoyarsk several samples of a new genus, the *Proetus*, which is closely akin to species from the sub-divisions F and G of Barrande.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus innus* ♂) from North Africa, presented by Capt. A. B. Hawes; two Common Badgers (*Meles taxus*) from Staffordshire, presented by Col. E. M. M. Buller; a Red Brocket (*Cariacus rufus* ♂) from Para, presented by Mr. H. E. Weaver; two —— Fruit Pigeons (*Carpophaga* ——) from the Samoan Islands, presented by Mr. T. H. Bowyer Bower, jun.; a Common Cuckoo (*Cuculus canorus*), British, presented by Mr. G. Lyon Leith; two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Mr. L. W. Buller; a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, deposited; a Red-vented Parrot (*Pionus menstruus*) from South America, purchased; a Molucca Deer (*Cervus moluccensis*), a Thar (*Capra jemlaica*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JULY* 5–11

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 5

Sun rises, 3h. 53m.; souths, 12h. 4m. 17·6s.; sets, 20h. 15m.; decl. on meridian, 22° 46′ N.: Sidereal Time at Sunset, 15h. 11m.

Moon (at Last Quarter) rises, 23h. 25m.*; souths, 5h. 45m.; sets, 12h. 16m.; decl. on meridian, 3° 2′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 30	12 45	21 0	23 19 N.
Venus	5 13	13 16	21 19	21 28 N.
Mars	1 39	9 47	17 55	22 15 N.
Jupiter	8 25	15 27	22 29	11 19 N.
Saturn	2 55	11 5	19 15	22 32 N.

* Indicates that the rising is that of the preceding day.

July	h.	
9	21	Mars in conjunction with and 5° 7′ north of the Moon.
10	23	Saturn in conjunction with and 4° 7′ north of the Moon.

GEOGRAPHICAL NOTES

IN concluding his notes on the Kurile islands, to the first instalment of which we have already referred, Prof. Milne has some interesting observations on the geology of this little known archipelago. The two islands, Iturup and Kunashiri, he says, form the two first of the series of stepping stones which connect Japan by means of Kamtschatka with Asia. They seem also to be the older members of the group. They contain a greater proportion of rounded hills and of deeply cut valleys than any of the islands farther north, and may therefore be regarded as older than those which are built up almost entirely of finely formed volcanic cones. The neighbouring island of Urup presents appearances similar to these two. He is inclined to think the formation of an island like Iturup commenced as a number of volcanic peaks forming islands, and that these have been subsequently united by elevation, indications of which there are in the stratified rocks and terrace formations. All the appearances, however, which he has ascribed to a raising of the land, might, he observes, be also explained by a raising and lowering of the sea, such, for instance, as that which Mr. Croll points out, might be produced by the accumulation of ice during a glacial period at the pole; and the fact that the height of the terraces increase as we go northwards appears to confirm this view. The steepest slope which he has observed in any portion of a volcanic cone was that of a small cone rising from the upper crater of Cha-cha-nobori, which had an inclination of 37°. This would indicate that it was formed of extremely fine materials, and that the last eruption by which these materials were formed had not been very violent.

IT is announced from Lisbon that the Portuguese explorers, Capello and Ivens, who left Loanda some time ago, have discovered the sources of the Lualaba, Luapula, and Chambeze, the upper waters of the Congo.

AMONG the recent scientific missions ordered by the French Minister of Public Instruction we find the following:—M. Bordas, to study the zoology of the Madagascar Islands, of the Seychelles, and Comoros; M. Clermont-Ganneau, to examine the epigraphy of the islands in the Red Sea, situated at the entrance to the Gulf of Akaba; M. Morgan, mining engineer, on a geological and mineralogical mission in the Orange Free State, the Transvaal, Zululand, and Natal; Lieut. Palat, to explore the route from Senegal to Algeria by Medina, Timbuctoo, Mabrouk, and the Touat.

THE island in the North Pacific which appears now to be definitely added to the British Empire is not, as was at first supposed, Quelpaert, but another Corean island, or rather group of islands, known as Port Hamilton, about forty-five miles to the north-east of the former, and about thirty miles off the Corean coast, in the Broughton Channel, separating the peninsula from Japan. The position of the group is 34° 1′ 23″ N. lat., and 124° 57′ 30″ east of Paris. The port is surrounded by three larger islands, and several smaller ones. The largest of all is on the west, and runs from north-west to south-east; it is hilly, but the height of the main eminence is not given by Sir Edward Belcher. Between the two main islands is Observatory Island, and the whole inclose an excellent harbour. The islets, except in one or two channels, which serve as entrances to the bay, are connected by barriers or reefs, above which the water is shallow. The islands are poor in wood, but water is good and abundant, and the sea abounds in fish. There are no cattle, but pigs, fowls, and some vegetables are found. The group was visited in 1846 by Capt. Belcher, and in 1855 by a French frigate.

AT the last meeting of the Geographical Society of Paris Baron Benoist-Méchin described a recent journey in the Merv oasis. This was a continuation of previous communications to the Society of the great journey made by the Baron and some companions from Peking through Manchuria, thence through Siberia, south to Samarkhand, Merv, and so into Persia. M. Simonin made a communication on the pictorial writing of the North American Indians; it appears that, of all the tribes, only the Cherokees and the Creeks possess a writing. The former have newspapers and books in their language, and write with seventy-seven phonetic characters in a syllabary invented by a Cherokee in 1830. The Creeks have nineteen characters. The notorious Sioux chief, Sitting-Bull, has written his autobiography in pictorial writing. His "Cæsar's Commentaries" are written on the back of a book which belonged to the Commissariat of the Third United States Infantry Regiment, and contain a recital of his adventures between 1864 and 1870. Each figure is roughly traced in ink, the men and horses being represented as a child might draw them; colours have in some cases been added to render the picture more vivid. The *Comptes Rendus* also contains the continuation of a paper by M. d'Aoust on the causes of earthquakes, and the itinerary of a journey in the basin of the Ruovouma by M. Angelvy, an engineer in the service of the Sultan of Zanzibar.

THE latest *Bulletin* (9me année, No. 2) of the Royal Geographical Society of Belgium is mainly occupied by a paper by M. Hennequin on the agricultural maps of Belgium, with reference to certain maps recently produced by the military cartographic institute for the Ministry of Agriculture. A brief account of Guatemala by M. Leclercq is compiled from the official publications of that republic, and a paper by M. Haron on the commune of Manage (Hainaut) is an interesting study in local geography. It deals, under successive divisions and subdivisions, with the commune on four main heads—physical, economical, and political geography.

THE last *Zeitschrift* of the Berlin Geographical Society contains the following papers:—The conclusion of "Achelis's" article on the methods and task of ethnology; rivers and lakes as the products of climate, by A. Woeikof, and a map of Paul Acherson's journey in the Libyan desert, with the accompanying descriptive account of the journey.

A LONG-DELAYED letter from the Bishop of Central Oceania gives, *Science* states, details of the honours rendered by the civil and religious authorities to the relics of the companions of La Pérouse. These last survivors of that unfortunate expedition were massacred by the Samoans on the Islet of Tutuila on December 11, 1787. Father Vidal, of the mission, had been searching twelve years for the remains, which were finally identified in October, 1882. The authorities in France, on being notified, caused a beautiful mortuary tablet to be prepared, and forwarded to the admiral on duty at that station. A monument was erected, upon which the tablet was fixed, and a small chapel built near it. The whole was dedicated by Bishop Lamaze and Commandant Fournier, of the French Navy, with solemn ceremonial and minute-guns on the ninety-seventh anniversary of the event.

LIQUID FILMS[1]

THE molecules in the interior of a liquid are surrounded on all sides by others which they attract, and by which they are themselves attracted, while those on the surface have neighbours on one side only. In consequence of this difference in their surroundings there is in all probability a difference in the grouping of the interior and exterior molecules which is attended by corresponding variations in the physical properties of the liquid of which they are constituent parts. Thus it was shown by M. Plateau that the viscosity of the surface of a liquid is in general different from that of its interior. The most striking example of this phenomenon is afforded by a solution of saponine. Two per cent. of this substance dissolved in water does not effect any marked change in the properties of the great mass of the liquid, but produces a most remarkable increase in the surface viscosity, so that forces which suffice to create rapid motion in bodies which are completely immersed, fail to produce any appreciable movement if they lie in the exterior surface. The first attempt to obtain a numerical estimate of the difference of the resistances experienced by a body oscillating in turn in the interior and in the surface of the liquid was made about two years ago by Messrs. Stables and Wilson, students in the Yorkshire College. In the case of a horizontal disc suspended in water, the logarithmic decrement diminishes to about one half as the surface is approached. In a saponine solution, on the other hand, it is 125 times greater in the surface than in the interior, and about 38 times greater in the surface than at a depth of 0·1 mm. below it. Even in the latter case the greater part of the resistance is due, not to the friction between the disc and the liquid, but to that experienced by the supporting rod in the surface, so that in all probability the surface viscosity is more than 600 times greater than that of the mass of the liquid.

The immense change in the resistance which takes place when the disc is immersed to a depth of 0·1 mm. only confirms the general opinion that any peculiarity of grouping or arrangement due to proximity to the surface extends to a very small depth. A liquid must thus be conceived as surrounded by a very thin layer or skin, the properties of which are different from that of the liquid in the interior, and to which rather than to any ideal geometrical boundary the term "surface" might be applied. It may, however, prevent confusion if it is called the *surface-layer*.

Many attempts have been made to measure the thickness of the surface-layer. In particular, M. Plateau studied a thinning soap film with a view of determining whether or no the pressure exerted on the enclosed air by the film when very thin is the same as when it is comparatively thick. Had any such difference been observed it might have been taken as *primâ facie* evidence that the tenuity was so great that all the interior portions of the film had drained away, and that the thickness did not exceed that of the two surface-layers.

This experiment has been criticised by Prof. Reinold and myself, but it is not intended in this lecture to enter upon the general question of the thickness of the surface-layer, or the interesting theoretical problems which are closely connected with it, as we are at present engaged in an investigation which we hope may throw further light upon the subject. There are, however, two preliminary questions on which we have arrived at definite conclusions.

[1] Lecture at the Royal Institution by Prof. A. W. Rücker, M.A., F.R.S.

In any experiments which have for their object the detection of small changes in the properties of a soap film as it becomes thinner, it is essential that we should be able to assert with certainty that no causes other than the increasing tenuity have been in play, by which the effect looked for might either be produced or masked. Changes in the temperature or composition of the film must especially be prevented.

The liquid ordinarily employed for such investigations is the "liquide glycérique" of M. Plateau. In dry air some of the water of which it is in part composed would evaporate, while in moist air, in consequence of the hygroscopic properties of the glycerine, additional water would be absorbed. Though these facts were well known, and though they are evidently possible sources of error, no attempt (as far as I am aware) had been made before our own to determine what precautions it was necessary to take to prevent the results of experiments such as M. Plateau's being affected by them. The first question then that we set ourselves to answer, was—to what extent is the composition of a soap film altered by changes in the temperature or hygroscopic state of the air which surrounds it?

The method adopted in answering this inquiry was to measure the electrical resistance of soap films formed in an inclosed space containing a thermometer and hair hygrometer. If the observations led to the conclusion that the resistance of film varied inversely as its thickness, they would prove that no change in composition had taken place, and that the film at the thinnest had afforded no evidence of an approach to a thickness equal to that of the surface layers. If the specific resistance was found to vary according to some regular law as the thickness altered, there would be a strong presumption that the thickness was not much greater than, and was possibly even less than that of the two surface-layers. If, lastly, the changes were irregular, they might safely be ascribed to alterations in temperature or constitution.

To obtain the desired facts it was necessary (1) to devise a method of forming the films in a closed chamber, (2) to measure their thickness, and (3) to determine their electrical resistance.

The films were formed in a glass box at the lower extremity of a platinum ring which communicated by means of a tube with the outside. In the earlier experiments a cup of the liquid was raised by rackwork to the ring and then withdrawn, leaving a film behind it. The latter was blown out by air which had been dried and passed through tubes containing "liquide glycérique." When large enough it adhered to a second platinum ring placed vertically below the first, and on some of the air being withdrawn it assumed the cylindrical form.

The thickness was measured by means of the colours displayed, two independent determinations being obtained by two beams of light incident at different angles. Newton's Table of Colours was revised, and it was found that the differences between the thicknesses given by him and those determined by new experiment were far greater than the error of experiment of a single observer. Hence, if accurate measurements are required by means of Newton's scale, every experimenter must reconstruct that scale for himself.

At first the electrical resistance was determined by means of Wheatstone's bridge. The edges of the film where it is close to its solid supports are often, however, the seat of phenomena which might affect the results. Thin rings of white or black appear which alter the resistance considerably, and which introduce errors for which it is almost impossible to make any accurate allowance. This fact, combined with the advantage of avoiding errors due to polarisation, and of being able to select any particular part of the film for examination instead of the whole, led us to adopt a different method. Gold wires attached to a movable support were thrust into the film, and the difference of potential between these when a current was passing through the film was compared with that between the extremities of a known resistance included in the same circuit.

The result of these observations was to prove that the specific resistance of the films altered in an irregular manner, varying between 200 and 137 ohms per cubic c.m. A closer inspection showed that abnormal results were always accompanied by abnormal variations in the thermometer or hygrometer. When those films were selected which had been observed when such variations were especially small, it was found that the range of variation of the specific resistances was only between 137 and 146, and that the mean value was 143, that of the liquid in mass being 140·5 (at the same temperature). It was also proved that between thicknesses varying from 1370 to 374 millionths of a millimetre, no regular change in specific resistance could be detected, the actual variations lying within 2·5 per cent.

The conclusion was thus arrived at that the specific resistance of the liquid of which a soap film is formed does not differ from that of the same liquid in mass, at all events when the thickness is greater than 374×10^{-6} mm., and that comparatively small changes in the temperature or hygroscopic state of the air in contact with the film are attended with great alterations in the specific resistance, which indicate a considerable change in composition.

The method of experiment made it possible to determine the amount of this change. Solutions were made up representing "liquide glycérique" which had lost or gained given percentages of water, their specific resistances were determined at various temperatures, and approximate formulæ obtained by which the percentage of water present could be calculated if the specific resistance and temperature were known.

The results of the application of this method of analysis to a film are shown in the accompanying figure. The abscissæ represent time, the ordinates of curve I. represent the average thickness of the film. It will be observed that the film continued to get thinner during the whole time that it was under observation. The electrical observations, however, proved that at first the product of the resistance and thickness steadily increased, indicating a continuous loss of water. Curve II. shows the number of parts of water in 100 of the solution lost

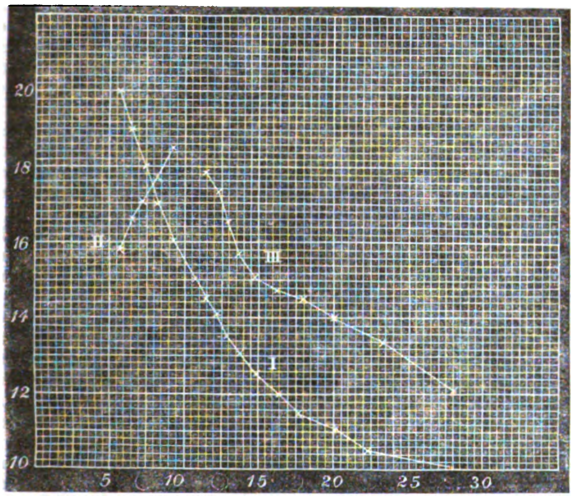


FIG. 1

at the times indicated by the abscissæ. After a while a piece of blotting paper which had been hung up inside the case was moistened with water. While this was being done the observations were interrupted. On their renewal it was found that although the film thinned as steadily as before, the product of the resistance and thickness diminished instead of increasing. Curve III. shows the steady absorption of water which followed the moistening of the air. These experiments proved that it is possible for a film to undergo great changes in composition without any indication of the fact being afforded by the colours it displays. They show that if the composition of the "liquide glycérique" is to be kept constant, all change in the temperature and hygrometric state of the air must be as far as possible prevented. In later experiments this condition has been secured by placing the film box in the centre of a water tank, and by keeping an endless band of linen hung up within the case, and which dips into the liquid, continually moistened. Observations made with this apparatus show that these precautions which are certainly necessary are also sufficient.

The second point to which special attention has hitherto been given by Prof. Reinold and myself is the measurement of the thickness of very thin films. If the thickness is less than a certain magnitude, the films appear black, and thus their colour gives only a limit to and not a measure of their thickness. Black films display many remarkable properties. In general there is a sudden change in thickness at the edge of the black indicated by the omission of several colours, or sometimes of one or two orders of colours. It is only under rare conditions that a gradual change in thickness can be observed from the white to the black of the first order.

To determine the thickness of the black its resistance was measured, and the thickness calculated *on the assumption that the specific resistance was the same as that of the liquid in mass.*

The observations were made in several different ways and proved that the thickness of the black portion remains constant in any given film, however much its area may alter. Thus, in the case of a group of films measured by Wheatstone's bridge, the average resistance of a black ring 1 mm. in breadth was 1·761 megohms when the total breadth was 2 mm., and 1,761 megohms when the total breadth lay between 10 and 12 mm.

Again, the resistance of the part of the film between the needles used in the electrometer method was practically the same when the black had extended over the whole film (40 mm. long) as it had been when only the upper 11 mm. were black. The final measurement differed from the mean by only 0·1 per cent. Again, in another film the resistance of the black per millimetre remained the same to within 2·5 per cent. for an hour and a half.

On the other hand the experiments also proved that the thickness of the black was different in different films. The values found varied between $7{\cdot}2 \times 10^{-6}$ and $14{\cdot}2 \times 10^{-6}$ mm. These differences are quite outside the possible error of experiment. If they were due to changes in the constitution of the liquid of which the films were formed, it is very improbable that the specific resistance of individual films would not have shown progressive changes. As has been stated, none such were observed. The mean thickness of the five films made of "liquide glycérique" which were observed was $11{\cdot}9 \times 10^{-6}$ mm., while that of thirteen films made of soap solution without any glycerine was $11{\cdot}74 \times 10^{-6}$ mm.

The assumption made in these calculations that the specific resistance of a film, the thickness of which is ten or twelve millionths of a millimetre, is the same as that of the liquid in mass, is not justified by the previous experiments, which had proved it to hold good only to the much greater thickness of 370×10^{-6} mm. It was therefore desirable to check the results by an independent method. For this purpose fifty or sixty plane films were formed side by side in a glass tube which was placed in the path of one of the interfering beams in a Jamin's Interferential Refractometer. The compensator was adjusted so that it had to be moved through a large angle to cause one interference band to occupy the position previously held by its neighbour, *i.e.* to alter the difference of the paths of the interfering rays by one wave-length. This angle was determined for the red light of known wave-length transmitted by glass coloured with copper oxide. When the films had thinned to the black they were broken by means of a needle which had been included in the tube along with them, and which was moved, without touching the tube, by a magnet. The rupture of the films produced a movement of the interference fringes which was measured by the compensator, and from which, in accordance with well-known principles, the thickness of the films could be deduced.

The mean thickness given by seven experiments on films made of "liquide glycérique" was $10{\cdot}7 \times 10^{-6}$ mm., that obtained from nine experiments on films made of soap solution was $12{\cdot}1 \times 10^{-6}$ mm. The mean of these, or $11{\cdot}4 \times 10^{-6}$ mm, differed only by $0{\cdot}4 \times 10^{-6}$ mm., from the mean thickness deduced from the electrical experiments.

The last point to which reference is necessary is one which lies outside the main line of the enquiries above described, but which is nevertheless not without interest. In the course of the observations it was noticed that the rate of thinning of a film seemed to be affected by the passage of the electric current through it. Some experiments made on this point last year proved the fact beyond the possibility of doubt. The current appears to carry the matter of the film with it, so that it thins more rapidly if the current runs down, and less rapidly if the current runs up than if no current is passing. This may be shown as a lecture experiment.

A vertical rod which can be moved up and down by rackwork is passed through the centre of the cover of a glass film-box. To the lower extremity is attached a horizontal platinum wire, from which another similar horizontal wire is suspended by two silk fibres. A film is formed by lowering the whole into the liquid with which the lower part of the vessel is flooded. The light reflected from the film is passed through a lens, and an image formed upon a screen. When the bands of colour are seen descending from the upper part of the film, a current from fifty Grove's cells is passed through it. If the current flows downwards the bands of colour move more quickly than before; if it flows upwards their motion is checked and they begin to ascend. The cause of this curious fact is still unknown. It may either be analogous to the phenomenon known as the "migration of the ions," or it may be a secondary effect due to a change in the surface tension.

The general relation of the results attained by these investigations as to the question of the size of molecules is interesting. Sir William Thomson has expressed the opinion that 2×10^{-6} mm. and $0 \cdot 01 \times 10^{-6}$ mm. are superior and inferior limits respectively to the diameter of a molecule. Van der Waals has been led, from considerations founded on the theory of gases, to give $0 \cdot 28 \times 10^{-6}$ mm. as an approximate value of the diameters of the molecules of the gases of which the atmosphere is composed. The number of molecules which could be placed side by side within the thickness of the thinnest soap film would, according to these various estimates, be 4, 26, and 720 respectively. The smallness of the first of these numbers, especially when it is remembered that the liquid used on some occasions was of a highly complex character, containing water, glycerine, and soap, points to the conclusion that the diameter of a molecule is considerably less than 2×10^{-6} mm.

THE FAUNA OF THE SEASHORE[1]

THE marine fauna of the globe may be divided into the littoral, the deep-sea, and the pelagic faunas. Of the three regions inhabited by these faunas, the littoral is the one in which the conditions are most favourable for the development of new forms through the working of the principle of natural selection. As Prof. Lovén writes, "The littoral region comprises the favoured zones of the sea where light and shade, a genial temperature, currents changeable in power and direction, a rich vegetation spread over extensive areas, abundance of food, of prey to allure, of enemies to withstand or evade, represent an infinitude of agents competent to call into play the tendencies to vary which are embodied in each species, and always ready by modifying its parts to respond to the influences of external conditions." It is consequently in this littoral zone where the water is more than elsewhere favourable for respiration, and where constant variation of conditions is produced by the tides, that all the main groups of the animal kingdom first came into existence; and here also, probably, where the first attached and branching plants were developed, thus establishing a supply of food for the colonisation of the region by animals.

The animals inhabiting the littoral zone are most variously modified, to enable them to withstand the peculiar physical conditions which they encounter there. Hence the origin of all hard shells and skeletons of marine invertebrata, various adaptations for boring in sand, the adoption of the stationary fixed condition, and similar arrangements. Almost all the shore forms of animals, however inert in the adult condition, pass through in embryological development free-swimming larval stages which are closely alike in form for very widely different groups of animals. Thus the oyster and most other mollusca of all varieties' and shapes when adult develop from a free-swimming pelagic trochosphere larva, and so do many annelids. Such larvæ cannot be of subsequent origin to the adults of which they are phases. If such were the case, they would not have become so closely alike in structure. In reality they represent the common ancestors from which all the forms in which they occur were derived, and as all these larvæ are pelagic in habits and structure, it follows that the inhabitants of the shores were derived from pelagic ancestors. The earliest plants were also probably free-swimming.

In the case of the cirripedia there can be no doubt, from the history of their development, that they were originally pelagic, and have become specially modified for coast life; and in the case of the echinoderms the only possible explanation of the remarkable similarity of the larval forms of the various groups of widely differing adults is that these pelagic larvæ represent a common ancestor of the group. The madreporarian corals all spring from a pelagic larvæ. The colonial forms probably owe their origin and that of their skeletons to the advantage gained by them in the formation of reefs, and the increase in facilities of respiration consequent on the production of surf. In the deep sea they are very scarce.

The vertebrata are sprung from a very simple free-swimming ancestor, as shown by the ciliated gastrula stage of Amphioxus. The ascidians afford another evident instance of the extreme modification of pelagic forms for littoral existence.

The peculiar mode of respiration of vertebrata by means of gill-slits occurs in no other animal group except in Balanoglossus, which will probably shortly be included amongst vertebrata. Possibly gill-slits as a respiratory apparatus first arose in a littoral form, such as Balanoglossus, and hence their presence at the anterior end of the body, that nearest to the surface in an animal buried in sand. The connection of Balanoglossus with the echinoderms through Tornaria is very remarkable. Possibly Amphioxus once had a Tornaria stage, and has lost it just as one species of Balanoglossus has lost it, as Mr. Bateson has lately discovered.

The littoral zone has given off colonists to the other three faunal regions. The entire terrestrial fauna has sprung from colonists contributed by the littoral zone. Every terrestrial vertebrate bears in its early stages the gill-slits of its aquatic ancestor. All organs of aërial respiration are mere modifications of apparatus previously connected with aquatic respiration, excepting, perhaps, in the case of Tracheata, tracheæ being most likely modifications of skin-glands, as appears probable from their condition in Peripatus. The oldest known air-breathing animals are insects and scorpions, which have lately been found in Silurian strata. Prof. Ray Lankester believes the lungs of scorpions to be homogeneous with the gill-plates of Limulus. Birds were possibly originally developed in connection with the seashore, and were fish-eaters like the tooth-bearing Hesperornis.

The fauna of the coast has not only given rise to the terrestrial and fresh-water fauna; it has from time to time given additions to the pelagic fauna in return for having thence derived its own starting-points. It has also received some of these pelagic forms back again, to assume a fresh littoral existence.

The deep-sea fauna has probably been formed almost entirely from the littoral, not in the remotest antiquity, but only after food derived from the *débris* of the littoral and terrestrial faunas and floras became abundant.

It is because all terrestrial and deep-sea animal forms have passed through a littoral phase of existence, and that the littoral animals retain far better than those of any other faunal region the recapitulative larval phases by means of which alone the true histories of their origins can be recovered, that marine zoological laboratories on the coast have made so many brilliant discoveries in zoology during late years.

The lecturer concluded by appealing for as istance, in the way of subscriptions, to the funds of the Marine Biological Association of Great Britain, the object of which is to construct a marine laboratory on the English coast for the purpose of researches such as those referred to. England is at present without any such laboratory, although nearly all Continental countries possess them.

[1] Abstract of lecture at the Royal Institution by Prof. H. N. Moseley, M.A., F.R.S.

THE PHILOSOPHICAL SOCIETY OF GLASGOW

THE *Proceedings* of this Society for 1884-85 have just been issued in a volume of 408 pages, with six plates and two maps. The following are the principal contributions:—On feeling and perception of relation, by Dr. H. Muirhead, President; on the proper motions of the stars, by Prof. Grant; on the first editions of the chemical writings of Democritus and Synesius, by Prof. Ferguson; on the composition of ocean water, by Prof. Dittmar; on the regulation of the supply of water to cities and towns, by Mr. W. Key; on a shadowless gas ventilator, by Mr. George A. Buchanan; on African colonies and colonisation, by J. E. Carlyle; a memoir of the late Mr. James Napier; on a new musical instrument, by Mr. Thomas Machell; on a description of a new Rotiferon, by Mr. W. Milne; on a theory of storm-travel, by Mr. P. Alexander; on national and local precautions against cholera, by Dr. James Christie; on an air or gas thermometer, by Mr. J. J. Coleman; on some experiments on the influence of cold on the putrefactive process, by Mr. J. J. Coleman and Prof. McKendrick; on the liquefaction of air and other effects of extreme cold, and on artificial light and other phenomena of high temperature, by Mr. J. J.

Coleman; on sanitary arrangements and house-building in towns, by Mr. James Sellars; on Egyptian obelisks, by Mr. T. L. Patterson; on producing cast iron or ingot iron from crude or pig iron, by Mr. W. Gorman; on the heat-restoring gas furnace and heating by radiation, by Mr. W. Gorman; on uncertified deaths, by Dr. Glaister; on the spread of disease by manure poisoning, by Dr. E. Duncan; and on the form of the human skull, by Prof. Cleland. The two maps, prepared by Mr. Ravenstein, and presented to the Society by Mr. James Stevenson, are specially valuable as showing the most recent results of African travel.

During the session M. Louis Pasteur, Prof. Asa Gray, and Rev. John Kerr, LL.D., were elected honorary members, and Mr. George Anderson, lately M.P. for Glasgow, and now Master of the Mint, Melbourne, was elected a corresponding member. The Graham medal was awarded to Mr. E. C. C. Stanford for his researches on algin. The Society at present has 18 honorary, 11 corresponding, and 691 ordinary members, and in addition to the ordinary meetings, there are sections for architecture, chemistry, biology, sanitation and social economy, and geography and ethnology.

AN EARTHQUAKE INVENTION

WE have been requested to publish the following correspondence:—

Royal Observatory, Edinburgh, June 5, 1885

MY DEAR MR. DAVID STEVENSON,—At p. 248 of the new British Association volume for 1884 there is a section on "Experiments on a Building to Resist Earthquake Motion," which reads amazingly like your paper of twenty years ago; but yet it is not that, for your name does not enter, and they have in a way got round the letter of your invention by employing, in place of your bronze balls in shallow bronze basins, cast iron balls and cast-iron plates, "with saucer-like edges" for the lower basins; and for the upper basins, "cast iron plates slightly concave, but otherwise similar to those below."

Against such men would any patent be safe? though you may not have taken out any patent for your philanthropic invention for saving life in earthquake-persecuted countries; but the whole section is the most indubitable approval of your methods and principles that could well have been proposed by any one. Certainly it transcends anything that could have ever entered the mind of Yours ever very sincerely,

C. PIAZZI SMYTH

Edinburgh, June 11, 1885

DEAR SIR,—Very many thanks for your letter to my father pointing out the report of the British Association on earthquakes for 1884, which I had not seen. My father, from the state of his health, is unfortunately unable to take the matter up himself, but if you will permit me to publish your very interesting and well-put letter in NATURE it will give the honour of the invention to whom the honour is due. My father, who read your letter with great interest, begged to be remembered to "his old friend." In order to save you the trouble of writing again I shall assume, if I do not hear from you in a few days, that you have no objection to your letter being published.

I may mention that the balls for the Japanese aseismatic arrangements for the towers were made of cast iron, and those for the tables in the light-rooms were of gun-metal.

Yours very truly,

D. A. STEVENSON

Professor Piazzi Smyth, &c., &c.

Westford House, Droitwich, June 13, 1885

DEAR MR. D. A. STEVENSON,—Yours of the 11th has reached me here; and, as I left Edinburgh on that day, it was a happy thought of yours to say that, if you did not hear from me soon you would assume my consent to your making some public use of my letter to your worthy father. For, in so far as I wrote it at all, I am ready to stand by it before many or few.

But it was only the beginning of what might have been said; and that I trust you will have perceived, and will supply some of the remaining *notanda*, such as the B.A. man praising up the system for so decidedly relieving the ball-supported building from all the *sharp*, destructive effects of an earthquake-shock, and leaving only a gentle to-and-fro motion on the balls;—because this was so admirably illustrated on your father's experimental model at Milton House—by the ease and safety with which the model lighthouse standing on balls in basins was knocked all about the yard by men with sledge-hammers, when they struck only the lower basins, or what they were fixed on as representing solid, yet earthquake-affected, ground; but the moment they struck the base of the lighthouse taken off the basins and balls and planted on the ground, down toppled lantern and lamps with such a fracture, that no more experiments could be made that day.

Then, again, your father had duly allowed that his system would not defend from vertical earthquake-shocks, but he hoped that they would be far more rare at any one place than horizontal shocks spreading all around and far from the places of vertical action; and exactly so says the B.A. man for himself and his imitation balls and basins.

And then he concludes with that he does hope for so much alleviation to human suffering in earthquake regions from the large amount of safety that balls and basin supports for dwellings must give in a general way that seismic science will be elevated in the eyes of the people, or something to that effect. To all which of course you can perfectly agree, both in your own and your father's name. I can mention that the turning-point with him as to the practicability of the scheme was when he ascertained by rigid and calm scientific measures that the amount of absolute motion which had done the most mischief in some of the worst Italian earthquakes was not more than three inches, so that it came legitimately within the compass of the means *he* first suggested, and R.S.S. Arts duly stamped with its approval ten years ago.

Hereabouts is a different earth effect—viz. the High Street, so called, of Droitwich—going down slowly but surely to fill up the vacancies occasioned below by the ceaseless bringing up of salt-rock dissolved in water pumped by numberless steam-engines, and furnishing, it is said, half the human family with that one necessary mineral condiment, salt; and so much vapour of it is in the air that mere residence here for a time is said to cure rheumatism and other complaints, even without taking the celebrated brine baths, of ten times the saltness of the ocean itself. Yours very truly,

C. PIAZZI SMYTH

P.S.—The spectroscopic salt line D is preternaturally strong in the air here; "D" might stand for Droitwich.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xvii. fasc. 1.—Annual reports of the Society.—On the isomerism of hydrocarbons according to the theory of substitution, by M. Menshutkin (analysed in another column).—On the preparation of hemines, by M. Schalfeyeff.—On its crystalline forms, by A. Lagorion (with plates).—Notes on an apparatus for washing precipitates; on the oxidation of aromatic amines; on the action of alcohol on diazo compounds.—On the isomerism of solutions, by W. Alexeyeff.—On the same, by D. Konovaloff.—Minutes of proceedings of the physico-chemical section of the Moscow Society of amateurs of Natural Sciences.—On the electrolytic figures of Nobili and Gebhard in the magnetic field, by W. Stchegliaeff (with a plate).—On the collision of absolutely rigid bodies, by N. Schiller, being a mathematical inquiry, to show that the invariability of the *vis viva* can be established by the geometrical determination of the absolute invariability of the systems.—On the dilatation of liquids, by K. Jouk. Researches at the University of Kieff proved that common ether, ethylic alcohol, sulphurous anhydride, diethylamine, and chloric ethyl comply with the formula $v = a + b \log (\tau - t)$.—Polemics between MM. Kraewitsch, Stoletoff, and Petroff.

Vol. xvii., fasc. 2.—Thermal data for hydrocarbon compound o bromide of aluminium, by G. Gustavson. The figures found by Berthelot, give for the molecule Al_2Br_6 a heat of dissolution equal to 170,600 units, M. Gustavson has found, from a series of six determinations, an average of 180,237 (from 179,926 to 180,763). When taking $AlBr_3\ 3(C_7H_8)$, the number of calorics received was nearly 168 (from 168,001 to 168,567).—On diallyloxalic acid, and on the preparation of oxalic ether, by E. Schatzky.—On the formation of carbonates of strontium, barium, and calcium, by J. Bevad, being an inquiry into the rapidity of reactions.—On the change of colours of coloured surfaces under artificial light, by Th. Petrushevsky.

Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, Dresden, 1884.—Osteology of *Rana temporaria*, L., and *Rana esculenta*, L., by H. Reibisch.—Note on *Testudinaria elephantipes*, Lindl., and *Welwitschia mirabilis*, Hook, by Prof. O. Drude.—Biographical notices of the late Dr. H. R. Göppert of Breslau, of F. von Hochstetter of Vienna, and of Dr. W. Gonnermann of Coburg, by Dr. Geinitz.—Mineralogical and geological results of a journey to Italy in the year 1884, by A. Purgold.—On a prehistoric necropolis at Trög, near Rosegg, Carinthia, by W. Osborne.—On some metal objects recently discovered at Jessen, near Lommatsch, by Dr. Caro.—On the increase of accidents from lightning in the Kingdom of Saxony, by Johannes Freyberg.—Remarks on some urns and other archæological remains lately discovered at Uebigau, near Dresden, by Dr. J. von Deichmüller.—Memoirs on the phanerogamous flora of the Voigtland district, Saxony, by A. Artzt.—On the granites, gneiss, crystallised limestones, schists, and other primitive rocks occurring in the districts north of the Zittau and Jeschken ranges, by Emil Danzig.

Rendiconti del Reale Istituto Lombardo, May 7.—Results so far obtained from the study of the chief ichthiofauna of the Cretaceous period, by Prof. F. Bassani. This elaborate monograph concludes with a comparative table of the fossil fishes of Pietrarvia, Voirons, Comen, Lesina, Crespano, Monte S. Agata, Grodischtz, Tolfa, and Hakel.—A contribution to the study of etherification by double decomposition: formation of the nitrous ether of allylic alcohol, by Prof. Giacomo Bertoni. —Further remarks on the functions which satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Remarks on the modifications introduced by the present Minister, Pessina, into the Penal Code proposed by Savelli, by E. A. Buccellati.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"Regional Metamorphism," by Joseph Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.

Metamorphic rocks have been divided into two classes—(1) Those in which the change has been caused by contact with heated eruptive rocks; (2) Those extending over wider areas, in which the rocks are in no apparent relation to eruptive or igneous rocks. The first has been termed *Contact Metamorphism*, and the second *Normal* or *Regional Metamorphism*, the latter two terms having been used to express the same phenomena and treated as synonymous.

The author, however, for reasons to be assigned, proposes, while retaining the use of both the latter terms, to apply them differently. Normal metamorphism he would confine, as hitherto, to the changes caused by the heat due to depth, on the supposition of the existence of a heated central nucleus of the earth, while he would use the term *regional metamorphism* to denote changes effected by the agency of the physical causes to which Mr. Mallet referred the fusion of the volcanic rocks, namely, *the heat produced locally within the crust of the earth by transformation into heat of the mechanical work of compression, or of crushing of portions of that crust.*

The primary object of Mr. Mallet's experiments was to ascertain the force required to crush portions of various rocks of given size, and to determine the quantity of heat evolved by the process. For this purpose the work done was measured by the number of cubic feet of water at 32° F. that could be converted into steam of one atmosphere (or at 212° F.) by the estimated heat evolved by the crushing of 1 cubic foot of each class of rock.

With all the harder rocks the heat produced in the metal surroundings by the complete crushing was easily perceptible by the hand, and was so great with some of the granites and porphyries as to necessitate a delay for the apparatus to cool. Both Mr. Mallet and Prof. Rankine were of opinion that in the crushing of a rigid material such as rock *almost the entire* mechanical work (with the exception of a small residue of external work) reappears as heat. It was further shown that, even in the most rigid bodies, crushing begins by compression and yielding, and that at this stage heat begins to be evolved.

Consequently the work thus developed being transformed into heat, that heat will be greatest along those lines or planes at places where the movement and pressure, together constituting the work, is greatest; whence Mallet concluded that along or about such axial lines of concentrated compressive and crushing work the temperature may locally rise to a red heat, or even to that of fusing the rocky materials crushed and of the pressing-together-walls themselver adjacent to them. This was in his opinion the real nature and origin of the volcanic heat as now produced on the globe.

Although the hypothesis fails for various reasons in its application to vulcanicity, especially for the reason that the great lines of disturbances and compression of the Alps, Pyrenees, and other mountain chains are free from either active or extinct volcanoes, there is, nevertheless, reason to believe that this source of heat may have been adequate to produce great molecular changes in the rocks along the lines of disturbance and upheaval, though the extreme results obtained by entire crushing by mallet would rarely or ever occur in nature. It is, however, precisely along such lines that not only are older rocks metamorphosed, but rocks of Cretaceous and Tertiary age—which usually have not been affected by normal metamorphism—coming, in these mountain-chains, under the influence of the disturbing forces, have undergone a change analogous to that produced by normal metamorphism.

Objections have been raised to the explanation offered in some cases of alteration of sedimentary strata in mountain-chains by ordinary normal metamorphism, on the grounds that unaltered strata alternate with altered strata. Sometimes this may be explained by inversion of the strata, or, where that is not the case, it may be due to the circumstance that differences of mineral composition, or in the proportion of the water of imbibition, have caused the metamorphism to affect different beds in different degrees. On the theory of *regional metamorphism*, in the sense the author would use it, another explanation suggests itself by the way in which differences in the resistance of the rocks develop different quantities of heat. Mr. Mallet has shown by experiments on the compressibility of rocks at Holyhead that, although certain slate-rocks were compressed by precisely the same force before their elastic limits were passed, yet, owing to differences in their compressibility, the heat developed in the rocks when released would render the quartz-rock nearly three times as hot as the slate-rock. In this manner, therefore, it seems possible to account for a special and restricted metamorphism of the strata in mountain-chains, and for its frequently localised occurrence.

The remarkable changes which take place in the condition of the coal of Pennsylvania, as it ranges into the Appalachian Mountains, may also be owing more probably to *regional* than to normal metamorphism. This mountain-range consists of a series of great parallel folds increasing in acuteness as the central axis is approached. Eruptive rocks are absent, but, nevertheless, the strata as they approach the central chain become more crystalline, and the coal, which at a distance is ordinary bituminous coal, passes into anthracite and even graphite. The late Prof. H. D. Rogers divided this great coal-field into four basins. The coal in the less-disturbed district near the Ohio River, where the flexures are extremely gentle and wide apart, contains from 40 to 50 per cent. of volatile matter; in the wide basin further east it decreases to 30 or 35 per cent.; in the basins of the Alleghany range, in which, although there are no important dislocations or great flexures, there are some extensive and symmetrical anticlinal axes of the flatter form, the proportion of the volatile matter in the coal varies from 16 to 22 per cent.; while in the most easterly chain of basins which are associated with the boldest flexures and greatest dislocations, with close plications and inversions of strata, the quantity of volatile matter in the coal is reduced to 6 to 14 per cent.

A somewhat analogous instance is presented by the Carboniferous series of Belgium. The excessive squeezing, faulting, and inversion which the Coal-measures have undergone on the flanks of the axis of the Ardennes, is there accompanied by an alteration of the highly bituminous coals into dry coals and into anthracite; while the Carboniferous and Devonian limestones amidst the sharply convoluted and folded strata of the Ardennes are there, as they are also on the line of the same disturbance in the Boulonnais, transformed very generally into crystalline marbles. The few exposures of eruptive rocks are all on a small scale, and affect the adjacent rocks only by contact metamorphism. It is probable that the anthracite of South Wales is the result of similar *regional metamorphism.*

In the case of contact metamorphism the changes were produced by great heat, for the eruptive rocks must have had a temperature of 3000° to 4000° F. or more; while in the case of normal metamorphism it is evident that the changes produced did not depend so much on high temperature as on pressure or the presence of water, and there is reason to believe that a temperature of about 600° to 800° F. would suffice to produce all or almost all the observed hydrothermal effects. For although in many instances of normal metamorphism new minerals are formed, the rocks are not fused, nor are the fossils destroyed. In Brittany, black slates which pass into schists with large crystals of chiastolite still show impressions of *orthis*, *trilobites*, and other Silurian fossils. Devonian strata in the Vosges pass into a rock consisting of pyroxene, garnet, epidote, &c., and yet retain impressions of *corals*.

Of the enormous tangential pressure exercised in the elevation of these chains, some idea may be formed when we consider the amount of compression which those portions of the crust have undergone. Thus, for example, Heim estimates that in the Alps the compression has been to the extent of 72 miles; and in a recent paper by Prof. Claypole he arrives at the conclusion, after a careful investigation of the magnitude and width of each fold, that in the Appalachian Mounta ns "a tract of the earth's surface, measuring originally 153 miles from south-east to north-west, has been so crushed and compressed that its present breadth along the line of section is only 65 miles," and of this, in one part—the Cumberland Valley—"95 miles of country have been compressed into 16 miles."

These vast compressions could not have taken place without the transformation into heat of the equivalent amount of mechanical work, though the degree and centralisation of the heat would depend on the rapidity and completeness with which the crushing has been effected. It is not therefore surprising to find that, in some of the newer mountain-ranges, a small residual portion of the heat thus mechanically evolved may still exist and cause slight aberrations in the position of the underground isothermal lines, and the same cause may possibly account for other exceptional cases.

The only sufficiently complete set of observations on a mountain-chain of this character that have yet been made are those before alluded to by Dr. Stapff in the St. Gothard Tunnel. The author has before given, in his paper on "Underground Temperatures," particulars of these observations, and therefore here only mentions that at the north end of the tunnel in the part where an axis of elevation of late geological age (Pliocene) traverses the range, the thermic gradient, which normally equals about 57 feet for 1° F., is there not more than 38 feet; and for this Dr. Stapff states that there was no obvious explanation.

The author concludes by expressing a belief that there exists, in the compression and motion of the strata which has always accompanied the upheaval of mountain-chains, a *vera causa* for the production of an amount of heat sufficient to produce one form of metamorphic action—a form which can affect only particular regions—and he would, therefore, in order to show its distinctiveness from either *contact* or *normal* metamorphism, designate it by the term of "*Regional Metamorphism*."

Physical Society, June 13.—Prof. Guthrie, President, in the chair.—On the winding of voltmeters, by Profs. W. E. Ayrton and John Perry. As it is most important that voltmeters, ohmmeters, powermeters, and ergmeters should be so constructed that the percentage increase of resistance of their fine wire coils due to the heating effects of the currents passing through them should be as small as possible, the question arises as to whether such coils should be made of German silver wire, or of copper, or partly of German silver and partly of copper wire, and how the diameter of the wire should vary in different parts of the coil. The authors have therefore been led to investigate the conditions that make this heating error a minimum with cylindrical coils of internal and external radii r_0 and r_1. At a place whose distance from the axis is r, let the cross-section of the wire be x_1, ρ the specific resistance of the material; then, assuming that $x = x_0 r^a$, $\rho = \rho_0 r^b$, $\rho r = \rho_0 r_0 r^c$, and that a current, C, in one spire of radius r produces a magnetic effect, KCr^d, on the supended needle, they find that the heating error is proportional to

$$r_0 \rho_0 \frac{p^2}{(r_1^p - r_0^p)^2} \cdot \frac{n}{r_1^n - r_0^n} \cdot \frac{r_1^m - r_0^m}{m},$$

where $p = d - a + 1$, $n = 2 + b - 2a$, $m = 2 + 1·7144 b - 4a$. The conditions that make this expression a minimum are worked out in the paper, the result being that with one of their magnifying spring solenoid instruments, where $d = -1$, the values of a and b giving a minimum value are $a = 0·325$ and $b = -0·5$, and since in practice b cannot be negative, they conclude that $b = 0$ and $a = ·4$ give the best results—*i.e.*, that all the wire employed in the bobbin should be of copper, and the law of increase of cross-section proceeding from the centre should be $x = x_0 r^{0·4}$. The actual waste of energy in the instruments is next considered, and, lastly, the authors show how to pass from a voltmeter with known winding, and whose maximum reading is P_1 to another of the same volume and shape whose maximum reading is to be P_2, and they conclude that, as they have shown that the waste of energy is the same in both for their maximum readings, the resistances of the instruments must be proportional to the squares of P_1 and P_2, or, following the law already arrived at for a minimum error due to heating, the cross-sections of the wires of the two instruments at similar places must be inversely proportional to P_1 and P_2. The employment of outside coils for voltmeters is considered, and it is shown that if we desire the same error in the two instruments due to heating when the outside resistance coils are of the same size and shape, it is necessary to have the same ratio between the resistance of the resistance coil and that of the magnetising coil in the two cases. To have a less or a greater error in the second case it is only necessary to use the equation—

$$e\text{(the error)} = \frac{2 + F.V}{1 + F.V},$$

where F is a constant and V the volume of the German silver resistance coil. From this V may be determined and the ratio $\frac{R_1}{R}$ of the resistances of the resistance coil and the magnetising coil is given by $\frac{R_1}{R} = \frac{F}{D} V$, where D is a constant which, like F, is obtained from experiments on the first instrument. The diminution of the heating error by using much iron in the instrument so as to obtain the same magnetic action with a much smaller current is discussed, and experiments were shown to illustrate how such employment of iron introduced a permanent magnetism error and caused the indications of such an instrument on the lower part of the scale to be uncertain and to depend upon whether measurements were being made with an increasing or a diminishing current.—On the manner in which light affects the resistance of selenium and sulphur cells, by Mr. Shelford Bidwell. In a communication made to the Society at its last meeting, the author had described a sulphur cell which behaved in all respects like a selenium cell when exposed to light. The action of this cell was supposed to be electrolytic, the sulphur containing a small quantity of sulphide of silver. If this were the case the result of a current traversing the cell would be to deposit sulphur upon the anode, and, as sulphur has an enormous resistance, that of the cell would increase unless the sulphur thus deposited combined with the silver. It is this combination that is believed to be much facilitated by light, a supposition the author believed he had confirmed by direct experiment. Mr. Bidwell had also measured the resistance of a piece of selenium that was believed never to have been heated in contact with a metal. The specimen was crystallised by heating for some time in a glass mould, two opposite sides cleaned, and two pieces of tinfoil between which the resistance was measured pressed against them. In this way the specific resistance was found to be 2500 megohms, which is enormously higher than that of the selenium in the "cell," a fact tending to confirm the theory that the conduction in such cells is due to the electrolysis of the selenides of the metals forming the terminal produced in the "cooking," and similar to that of the sulphur cell described above.—On the error involved in Prof. Quinke's method of calculating surface tensions from the dimensions of flat drops and bubbles, by Mr. A. M. Worthington. In a series of well-known papers Prof. Quinke has recorded a large number of measures of flat drops and bubbles, from which he has deduced the values of tensions for the free surface of a liquid and for the common surface of two liquids in contact. The numerical results obtained in this way exceed those obtained from observations upon the rise in capillary tubes, which Prof. Quinke attributes chiefly to the fact that in the latter case the edge angle is not zero. Mr. Worthington, however, shows that the surface tensions obtained by Prof. Quinke with flat drops are too high, this arising from his having assumed that the drops were flat at the vertex. The error thus introduced is very considerable, amounting in most cases to as much as 10 per cent. of the whole value, and upon its being duly corrected, the values obtained do not appreciably exceed those obtained with capillary tubes.—On a comparison between the mercury standards of resistance issued by M. Mascart with those of the British Association, by Mr. R. T. Glazebrook.

Anthropological Institute, June 23.—Francis Galton, F.R.S., President, in the chair.—The election of the following new members was announced.—Prince Roland Bonaparte, Lady Brassey, Miss M. North, Dr. Robert Brown, M.A., Col. Cadell, V.C., C. Heape, H. H. Johnston, D. MacRitchie, Prof. H. N. Moseley, F.R.S., C. Seidler.—Lady Brassey exhibited a collection of objects of ethnological interest from Polynesia.—Several ethnological specimens from New Ireland were exhibited by Miss North.—Mr. Carl Lumholtz exhibited a series of Australian implements.—Mr. H. B. Guppy read a paper on the physical characteristics of the natives of the Solomon Islands. In this paper the author gave the results of observations made during the years 1881-84 on the natives of certain localities in the Solomon group. The typical Solomon Island native (male) is well proportioned, with a height of about 5 feet 3 inches, a weight of 125 to 130 lbs., and a chest-girth between 34 and 35 inches, whilst the colour of his skin is a deep brown, corresponding with colour-type 35 of M. Broca. Considerable variety. however, prevails in the physical characters of these natives, and it was shown, by comparing the inhabitants of the islands of Bougainville Strait with those of St. Christoval and its adjoining islands at the opposite end of the group, that in the former locality there exists a taller, darker, and more brachycephalic race, whilst in the latter mesocephaly prevails, and the average native is rather shorter and of a lighter hue. The colour of the skin varies considerably throughout the group from a very deep brown to a light copperish hue, the range being represented by colour-types 42 and 29 with their intermediate shades. After making 109 measurements of the heads and skulls of natives in order to obtain the ratio of the transverse to the longitudinal diameter, the author arrived at the conclusion that, although mesocephaly and brachycephaly most frequently characterise these people, the form of the skull varies between too wide limits to allow of one particular type being referred to this group. The range of the cephalic indices calculated from these measurements is 69 to 86, and the greater number are gathered in two groups—one around the indices 74 and 75, and the other around the indices 79 and 80.—The following papers were also read:—On the Sakais, by Mr. Abraham Hale.—Notes on the astronomical customs and religious ideas of the Chokitapia or Blackfeet Indians, by M. Jean L'Heureux.—Observations on the Mexican zodiac and astrology, by Mr. Hyde Clarke.—On the primary divisions and geographical distribution of mankind, by Mr. James Dallas.

Entomological Society, June 3.—R. McLachlan, F.R.S., President, in the chair.—Two new members were elected.—Exhibitions: Mr. F. P. Pascoe, aërial roots of an orchid which resemble caterpillars; and a new genus and species of *Colydiidæ* from North Borneo.—Mr. G. T. Porritt, larvæ of *Phycis betulæ* and of *Coleophora currucipennella*.—Mr. R. McLachlan, a specimen of *Deiopeia pulchella* captured on board ship in the Atlantic, many miles from land.—Mr. J. W. Douglas communicated notes on an apple-tree destroyed by *Schizoneura lanigera* and *Mytilaspis pomorum*, and Mr. F. Enock read the completion of his account of the life-history of *Atypus piceus*.

PARIS

Academy of Sciences, June 22.—M. Bouley, President, in the chair.—At the opening of the proceedings the President announced the death of M. Tresca, member of the Section for Mechanics, who died on June 21, and in whom the Academy loses one of its most distinguished and active associates.—Note on Dr. Raphael Dubois' apparatus for applying anæsthetics composed of titrate mixtures of chloroform and air, by M. Paul Bert. This apparatus has been tried with the greatest success in Brussels and Ghent, and especially by Dr. Péan of Paris, who has already tested its efficiency in 400 surgical operations. The anæsthesis in nearly all cases continues perfectly regular and complete, without any interruption, even under severe operations. The pulse remains normal, the respiration easy and undisturbed, the awakening calm and natural.—On the superiority of the new "tubes à ailerons" over the ordinary smooth cylinders at present employed in tubular boilers for generating steam, by M. J. Serve. The author and inventor claims by these cylinders to have solved the problem how to produce the greatest quantity of heat with the least expenditure of fuel.—On an arrangement by which the magnetic potential due to a system of bobbins may be determined without calculation, by M. G. Lippmann.—Note on the influence of thunderstorms on underground telegraphic wires, by M. Blavier. The occasional disturbances, to which even well-protected underground wires are subject, apparently in opposition to the theory of static electricity, the author thinks may be explained either as an effect of electrodynamic induction, or as an effect of electrostatic induction.—On the molecular lowerings which constitute the limits of congelation for bodies dissolved in water, by M. F. M. Raoult.—Description of two new types of hygrometers, by M. Bourbouze.—On the transformation of sulphur: MM. Reicher and Ruys' claims of priority of invention in connection with M. Gernez's recent communications, by M. J. H. Van't Hoff.—Alkaloids produced by the action of ammoniac on glucose, by M. C. Tauret.—Action of the seleniates and selenites, and the alkaloids. A new reaction of codeine, by M. Ph. Lafon.—Note on Aseptol (orthoxyphenylsulphurous acid), by M. E. Terrant.—Contribution to the study of antiseptics. Action of antiseptics on the higher organisms. Thymic acid, by MM. A. Mairet, Pilatte, and Combemale.—On the process of fructification of the genus Callipteris, by M. Ed. Bureau.—On the infusoria by Balbiani named *Anoplophyra circulans*, by M. A. Schneider.

CHRISTIANIA

Society of Science, May 15.—Herr Worw-Müller referred to the meritorious work of the recently-deceased Danish Prof. Panum. as regards physiology as well as pathology. He further presented a paper in which he demonstrated the utility of Robert's method for the determination of sugar in animal substances when above 0·4 per cent. Finally he explained the researches made by Herr J. Otto on the functions of the sugar in the liver. He stated that they proved that the blood contained far more sugar on entering than on leaving the liver, and more than the blood in general. The researches went to support M. Bernard's experiences, viz., that the quantity of sugar formed in the liver in the course of twenty-four hours was much larger than hitherto thought.—Prof. O. Sars presented a paper: "A contribution to the Norwegian invertebrate fauna," by Herr C. A. Hansson.

CONTENTS

THURSDAY, JULY 9, 1885

THE INTERNATIONAL SANITARY CONFERENCE IN ROME

THE late Conference in Rome, which for some unknown reason stands adjourned for the present to reassemble again in November, has arrived at certain results, the details of which are not published yet, and until the full and authenticated report is at hand it would be unjustifiable to subject them to criticism. But as far as the gross results achieved and the methods followed by that Conference have already become known through the reports sent to the daily papers, there is no reason for viewing those results with any peculiar satisfaction. As far as we can follow the proceedings of the Conference, its achievements cannot be considered an advance on those of its predecessors held in Constantinople in 1866 and in Vienna in 1874.

During the present century Europe has been visited six times by cholera, and after the second visitation (1847-50) the first International Sanitary Conference was convened to Paris in 1851, in order to arrive at some common understanding as to quarantine, and to discuss various questions of hygiene, as well as the etiology of the disease.

Between 1852-56 Europe was again visited by cholera (England in 1853-4), and very important knowledge was then gained as to the intimate relations existing between general insanitary conditions and the spread and severity of the disease. After the next visitation of Europe by cholera (in 1865-6) the second International Sanitary Conference met at Constantinople (in 1866). The results of the deliberations of this Conference have been in many respects important. The Conference agreed, with few dissentients, that cholera has for its starting-point India; that its invasion into other countries is effected by human intercourse, including linen and wearing apparel; that its spread depends in a great measure on general insanitary conditions of habitation, air, water, and food. In order to avert and check the invasion of Europe by the disease, the Conference agreed to a certain complicated system of quarantine both by land and sea, which embodied and enlarged on the scheme laid down by the preceding Conference of 1851, but which had been found incapable to avert the introduction of the disease in 1865-6.

Next cholera appeared in Europe in various countries between 1869-73, and after the epidemic came to an end another International Conference assembled in Vienna in 1874. This Conference, while confirming the results of the deliberations of its predecessors, arrived at certain important conclusions as to the value of disinfection and quarantine. As regards the latter the Conference agreed that all measures of quarantine, as far as they are practicable, are fallacious and incapable of averting or checking the introduction and spread of the disease; that all measures of land quarantine are to be condemned; and that maritime quarantine is to be replaced by competent medical inspection. Cholera appeared next in Egypt in 1883, and from here was introduced into Marseilles, where it assumed, in July 1884, alarming proportions; thence it spread into Toulon, the south and north of France, into Italy and Spain, raging everywhere with great severity. If at any time land and maritime quarantine had a fair trial it was in 1884 in France, Italy, and Spain. Every one remembers the dictum of M. Fauvel, then at the head of medical affairs in France, that the disease that broke out in 1884 in Marseilles and spread thence into Toulon and other parts of France could not be Asiatic cholera, because quarantine, after the appearance of cholera in Egypt in 1883, had been very perfect and had been carried out in French maritime ports with great rigour. Every one remembers also that, in spite of all the measures of land quarantine practised in France, Italy, and Spain in 1884—and at the present moment practised in Spain—its lazarettos, fumigations, and military cordons with its attendant troubles, miseries, and cruelties, cholera spread and raged with great severity in France and Italy, and is at the present moment assuming alarming proportions in the eastern and south-eastern parts of Spain; while, on the other hand, this country, without any maritime or land quarantine, but with an efficient and competent medical inspection of all shipping in its maritime ports, has remained free from cholera in 1884 and hitherto, notwithstanding its vast communications with Egypt, Italy, and Spain. Maritime and land quarantine have had a repeated and fair trial, but have been found utterly wanting, and countries like France, Italy, and Spain placing the utmost faith in them have dearly paid for it. Now, what lesson is to be learned from all this, and let us ask at the same time what lesson has the late Conference in Rome learned from this?

The Conference of Constantinople (in 1866) had adopted ten days as the furthest limit of the period of incubation—that is to say, if any ship coming from an infected part had been at sea for ten days and no case of cholera has appeared on board, the ship is to be considered "clean" and is to receive free *pratique*. Now, steamers sailing from Bombay arrive under favourable conditions off Suez on the eleventh day, and therefore if no cholera has appeared during the whole of the voyage, the ship ought, according to the above, receive free *pratique*. But instead of this every ship is detained and kept under "inspection" for at least twenty-four hours at Suez, at the instance of the Egyptian authorities acting under the instructions of the General Board of Health. The majority of the medical members of the late Conference at Rome carried this still further in recommending that all ships coming from India should be detained and kept under inspection at Suez for five days, some delegates even for ten days. Another still more iniquitous recommendation, and one which, if carried into practice, is likely to have serious consequences for Egypt and Europe, is this: that if any "suspected" ship—the decision as to this "suspicion" resting with an Egyptian official of self-estimated competency—arrive off Suez, the passengers and crew are to be turned out into lazarettos, kept there under observation, disinfected, &c. Now, the Conference, in order to establish a permanent focus of cholera from which the disease might, and in all probability would, spread into Egypt and the adjoining countries, the Mediterranean Basin and Europe, could not have recommended any arrangement that is more likely to further such a hazardous and dangerous object. In vain did Dr. Thorne, one of the English delegates, urge at the Conference the iniquity and danger of this recommendation. The French delegates leading the majority turned a deaf ear to any reasonable suggestion; they seem to have learned no lesson from the misery that lazarettos, fumigations, and all other measures of land quarantine, without stopping the introduction and spread of cholera, have in the past inflicted on their country.

If we ask ourselves, What new facts, what new experiences have in the last cholera epidemic in 1884 been gained in order to justify these recommendations of the majority of the Conference? we have to answer—None; and those that have become known point in the opposite direction. The recommendation as to five to ten days' quarantine off Suez for ships coming direct from India seems to imply that the late outbreak of cholera in Egypt owed its origin to importation from India. This view has during 1883-84 been stated and re-stated by French writers with their usual self-confidence, but not a tittle of evidence has been brought forward to support it. Moreover there exists a good deal of evidence showing that that outbreak, which, as is well known, commenced in Damietta, owed its origin to importation from an altogether different direction—viz., overland by pilgrims from Mecca. As Prof. Lewis, another delegate from England, has urged at the Conference, no English ship coming from India has ever been known to have imported cholera into Egypt and Europe; and, considering the enormous number of vessels arriving from Indian ports in Egypt, the Mediterranean countries and Europe, it is certainly a very remarkable fact that importation, if it happened in this manner, should not be of common occurrence.

The real danger from cholera for Egypt, Turkey, and Europe does not lie at Suez and the Suez Canal, but at Mecca and the countries about the Caspian Sea, this being the route in which cholera has hitherto travelled—viz., from Mecca, Mesopotamia, and Persia, into the Red Sea coast, Egypt, Syria, the Levant, Turkey, and Russia—and therefore these are the portals, if any, which the European Powers ought to guard. As England has urged in the past, and as it has also urged on this occasion, every country may, and has a right to protect itself as it thinks best. France and Spain may make their own maritime quarantine as rigorous, their land quarantine as vexatious as they choose; but that these countries should dictate measures to others, which past experience has proved to be fallacious and futile to achieve the end they aim at, is as iniquitous as it is against common sense.

Cholera in Europe being dependent on importation from the East, it is quite clear that absolute prevention of such importation would theoretically be the best safeguard; but then the question arises, and it is one that has been repeatedly asked—viz., can this be practically achieved? To stop unconditionally every and all communication with an infected locality involves, apart from the great practical difficulties in carrying it out, such enormous hardships, material loss and misery, that the remedy would entail greater misfortunes than the evil it tries to cure, even granting, for the sake of argument, that it is capable of so doing.

Prof. von Pettenkofer in his various writings on the subject of quarantine has fully and clearly stated the case, and their perusal would have materially enlightened many of the members of the late Conference. They would also find in those writings what they might have found already in the protocols of the former conferences (in Constantinople and Vienna), viz. that one of the *chief* and *first duties* of the State in order to prevent and check the spread of cholera is a *proper attention to general sanitation*. Make your military cordons as strict as you please, stop and impede all traffic by sea and land as much as you like, fumigate your railway travellers and mails as carefully and rigorously as possible, you will not hereby succeed in stopping all communication with an infected country. On the other hand, give up all those silly and harassing limitations, but keep a good look-out for infected ships coming to any of your ports, detain the infected persons in a specially-fitted hospital, disinfect the ship and articles, but allow the rest of the passengers and crew to depart, keeping their names and addresses, and notify their arrival to the sanitary authorities of the place they are bound to. Further than this, see that your dwellings, your water and air are in sanitary respects looked after, and that filth is properly disposed of, and you will hereby have done what is compatible with all past and present experience in order to check the entrance and dissemination of cholera. It is admitted on all hands that general insanitary conditions of dwellings, water, and air are the most powerful allies of cholera; without them, cholera is as unable to spread as typhoid fever.

The principles just mentioned are practically those on which the sanitary authorities in this country have been acting in the past, and on which they are acting in the present. The danger to this country from importation of cholera from Spain is greater than perhaps to any other, seeing the vast maritime communications existing between this country and the east and south coast of Spain; but there can be little doubt that, if cholera should unfortunately be imported, it can never assume those gigantic proportions that it has assumed in France, Italy, and that it is now assuming in Spain.

If one reads of the unspeakably filthy conditions prevailing in Spain, and reads at the same time of the silly and arbitrary proceedings of the authorities in carrying out quarantine, one is reminded of the General who, in trying to keep out a powerful enemy is putting up on the frontier a few dummy soldiers and toy guns, but who has omitted to provide the interior of the country with a real army and guns. The result is, of course, clear: the enemy cannot be prevented from entering, and, having entered, cannot be kept from overrunning and devastating the country.

A NATURALIST'S WANDERINGS IN THE EASTERN ARCHIPELAGO

A Naturalist's Wanderings in the Eastern Archipelago, a Narrative of Travel and Exploration from 1878 *to* 1883. By Henry O. Forbes, F.R.G.S. With numerous Illustrations. (London: Sampson Low, Marston, Searle, and Rivington, 1885.)

MR. FORBES' Wanderings in the far East extended over about four and a half years, during which time he visited the Keeling Islands, Java, Sumatra, Amboyna, Timor Laut, Buru, and Timor. In Java, Sumatra, Buru, and Timor he made extensive inland journeys through districts rarely or never before visited by European naturalists; and as he everywhere collected assiduously and observed intelligently, the record of his travels is exceedingly interesting. His special studies were botanical and ethnological, and in these departments he has added much to our stores of knowledge. His observations on the manners and customs, the myths and superstitions of the various tribes among whom he resided or travelled will be of great value to anthropologists, owing to the wide range of his observations and the time and trouble he devoted to the inquiry. In zoology he did not collect largely, and indeed it was simply impossible for him to do so, since the continuous labour and attention needed to form a well-preserved herbarium in the damp equatorial climate and while almost constantly moving about, leave the traveller but little leisure to devote to other departments of natural history. To collect effectually in any wild tropical country, the naturalist should settle himself for at least six months at a time in a good central position from which short excursions in various directions can be made; and if these head-quarters are well chosen it is possible to obtain an almost perpetual "fine season," and thus greatly increase both his collecting power and his personal enjoyment.

Mr. Forbes appears to have had rather more than his fair share of accidents to his collections, and in every case what was lost was of especial interest. His insect collection from the Keeling Islands was destroyed on the way back to Java, and we thus lose the opportunity of comparing the list with that made by Mr. Darwin more than forty years before. In Timor Laut a large part of his herbarium was destroyed by fire, while a smaller collection made in the interior of Buru was actually left behind for want of porters to carry it. The Timor Laut collection is especially to be regretted, as it was obtained with great difficulty in perhaps the least known island of the whole archipelago, while it is probable that many years will elapse before any other naturalist will venture to explore so remote and inhospitable a country.

Mr. Forbes' residence for three weeks in the Keeling Islands enabled him to note what changes had occurred since Darwin's visit nearly half a century earlier. These are very slight, and seem incompatible with the theory that any subsidence has taken place, because the inner margin of some of the islands next the lagoon are sometimes half a mile distant from the outer edge, and the greatest cyclones do not carry the coral *débris* nearly so far. It is now generally admitted that the celebrated "subsidence theory" of the formation of atolls and barrier reefs is unsound as a general explanation of the facts; yet it so fully and plausibly explained all the details of coral structure known at the time, as to command universal acceptance and unbounded admiration. We have here a remarkable instance of the danger of founding a general explanation of widespread phenomena on an assumed basis, for the fact of long-continued subsidence, which was the very foundation of the whole theory, was in most cases quite incapable of proof. It is also now apparent that the theory was to some extent inconsistent with the views as to oceanic islands which Darwin himself originated and which are now generally admitted to be sound. His great argument, that no single oceanic island possessed ancient stratified rocks or contained a single indigenous mammal, was equally an argument against the view that the widespread coral archipelagoes of the Pacific and Indian Oceans were due to the subsidence of co-extensive tracts of land, since it is almost impossible that all the higher points of these submerged lands, spread over nearly half the surface of the globe, should be without exception of volcanic origin.

Crabs of two or three species were the most abundant terrestrial inhabitants of the Keeling Islands living in narrow corkscrew burrows, which are so numerous that one hundred and twenty of their holes were counted in an area only two feet aquare. Around these holes little mounds are formed, and the crabs carry into their burrows twigs of trees, pieces of seaweeds, seeds, &c., thus fulfilling in many ways the functions of earthworms in this newly-formed land. Their numbers are enormous, and Mr. Forbes thus describes the curious optical effect produced by them:—

"On placing the foot on the region occupied by them, one perceives an undulation of the surface followed, over a circular area, by a surprising change of the pure white ground into a warm pink colour, which for the moment the stranger puts down to some affection of his eyes from the reflection of the light. He soon perceives that this movement is caused by the simultaneous stampede of the dense crowd of the peopled shore into their dwellings, just within the door of which they halt, with the larger of their two pincer-claws, which is of a rich pink colour, effectually barring the entrance except where one watchful stalked eye is thrust out to take an inquiring look if the alarm is real. As one advances the pink areas again change into white, as the Crustaceans withdraw into their subterranean fastnesses. On traversing a broad field occupied by these crabs, the constant undulations and change of colours produce a curious dazzling effect upon the eyes."

During his long residence in the mountains of Java, Mr. Forbes made many interesting observations on the fertilisation of orchids. He was surprised at the large number of these plants which, though often possessing the combined attractions of showy flowers and fragrant odours, yet never or rarely produce seed-capsules. In one case, for example, out of 360 flowers examined till they withered or dropped off, only six produced capsules. Again, he finds a considerable number of species with showy flowers which are yet specially adapted for self-fertilisation and never seem to be visited by insects. The most extreme and marvellous example of this phenomenon is found in a plant related to *Chrysoglossum*, which fertilises itself without ever opening its flowers at all. Mr. Forbes observed these plants in the forest as well as in numerous specimens grown in a garden, and all were fertilised in the same way; and he adds:—"In opening the locked-up petals, I found the labellum beautifully marked with lines of purple, carmine, and orange, and the column also; but no insect eye could ever be fascinated or allured by its painted whorls."

These observations are of extreme interest, and they certainly prove, as Mr. Forbes remarks, that the rule "that the flowers of orchids are fertilised by the pollen of their flowers," is by no means so universal as has been supposed. Yet the phenomenon does not seem so extraordinary if we look upon it as one of the normal phases in the developmental life-history of species. The overwhelming amount of evidence which has now been obtained of adaptations for cross-fertilisation, not in orchids only, but throughout the whole series of flowering plants, and the almost constant association of conspicuous form, colour, and odour with adaptations for insect fertilisation, force us to the conclusion that in almost all the cases adduced by Mr. Forbes we have species which were once adapted for insect-fertilisation. But in the terrific struggle for existence ever going on in tropical regions, insects are subject perhaps more than any other group of organisms to excessive fluctuations of numbers, sometimes culminating in the complete extermination of species; because they are equally liable to severe injury by physical and organic causes—by adverse seasons which destroy them in some of their earlier stages, or by the excessive attacks of insectivorous animals in both their larval and perfect states. It must therefore often happen that certain species of insects almost disappear in districts where they are usually abundant, and if any particular plant has had its flowers so highly specialised as to be adapted for fertilisation by one of these insects only, it must become extinct unless it occasionally produces varieties which are capable of self-fertilisation. The species of orchids in which a very small percentage of flowers produce seed capsules are evidently those in which the special insects adapted to fertilise them have become either temporarily or permanently scarce, and if that scarcity goes on increasing one of three things must happen—either the flower must become modified so as to be fertilised by some more abundant insect, or it must become capable of self-fertilisation, or it must become extinct. No doubt all these three cases occur, but it is of the second alone that we can obtain any knowledge, because we there find, as in our own bee-orchis, the special attractions of conspicuous form and colour which have yet ceased to be of service to the species. But no naturalist can doubt that these attractions were once serviceable; and we are thus led to conclude that all such instances are forms of functional degeneration which under changed conditions of the environment have afforded the only means of preserving the species.

Mr. Forbes's record of his thirteen months of travel in Sumatra are perhaps the most interesting portions of his book. He here met with some of the most marvellous productions of the vegetable kingdom—strange parasitical Rafflesiaceæ, an eccentric fig which ran underground and there produced its fruit, just showing their tops above the surface, and the giant arum (*Amorphophallus titanum*), some of which were seventeen feet high and with tubers six feet six inches in circumference. In the same forest huge earth-worms raised tubes of mud four and a half inches in circumference and eight inches high; and were so numerous as to render the whole surface of the ground as rough and hummocky as that of a newly-ploughed field. Here too, as well as in Java, he found a wonderful case of mimicry in a spider which deceived him even a second time; and he here obtained the rare *Ornithoptera brookeana*, perhaps the most chastely beautiful of all butterflies. Grand mountains, active volcanoes, glorious forest scenery, strange antique monoliths, and many interesting races of men, combine to render Sumatra one of the finest hunting-grounds yet left for the naturalist, while over the greater part of it there are facilities for travel or for residence rarely to be found in so little known a country.

In his later and more adventurous explorations of Timor Laut and Timor, Mr. Forbes was accompanied by his wife, a lady who seems to have endured all the annoyances, privations, and dangers of such a journey with truly heroic fortitude. Although these islands are far less known to naturalists than almost any other part of the Archipelago, they seem comparatively poor in a natural-history point of view. A considerable proportion of the birds and butterflies of Timor Laut were new species, but the collections were scanty, and there is, no doubt, much still to be done there if a collector could freely explore the country and not be confined, as was Mr. Forbes, to a limited tract owing to tribal warfare. One of the interesting discoveries here was another example of mimicry among birds, in which a new species of oriole mimics a new honeysucker, just as do corresponding species in Ceram, Buru, Gilolo, and Timor. A most interesting case of protective colouration was also observed in the white-headed fruit-pigeon of Timor (*Ptilopus cinctus*). These birds sat motionless during the heat of the day in numbers on well-exposed branches, yet Mr. Forbes states that it was with the greatest difficulty that either he or his sharp-eyed native servant could detect them, even in trees where they knew they were sitting. The strongly-contrasted white and dark colours of this species are such that any person looking at a specimen in a museum might take it as an example of a defenceless bird with very conspicuous plumage, and might ask triumphantly how our theory of protective colouration can be applied here. Yet it turns out that these strongly-marked colours so exactly harmonise with the colours of the branches of the trees on which it sits, exposed to the glare of the tropical sun, as to be completely protective; and we thus have another illustration of the impossibility of forming any correct judgment on this question unless we are able to observe each species in its native country and among the exact surroundings to which it has become adapted.

The hasty journey through the interior of Timor, among strange scenery and strange people, is full of interest. Most of the mountain tops, where alone a rich and interesting vegetation was to be found, were strictly taboed, and it was often only by stratagem that specimens were collected; while the difficulties of travel in a country absolutely without roads and consisting almost wholly of an endless series of rugged mountains and deep valleys were exceptionally great.

The book is on the whole very well written, and will give the reader an excellent idea of some of the less known parts of the Malay Archipelago. The weakest part of it are the illustrations, which, though numerous, appear to be for the most part reproductions of rough sketches by some unsatisfactory process of photo-zincography. For this the author was probably not responsible, but his readers will regret that the strange and beautiful scenery he has so graphically described is not more effectively presented to the eye. The portraits of many of the natives are, however, very well done, while several good maps and a full index greatly add to the value of the book as a useful work of reference.

ALFRED R. WALLACE

FIVE ELEMENTARY TEXT-BOOKS OF HYGIENE

A Manual of Health Science. Adapted for Use in Schools and Colleges and suited to the Requirements of Students preparing for the Examinations in Hygiene of the Science and Art Department, &c. By Andrew Wilson, F.R.S.E., F.L.S. (London: Longmans, Green, and Co., 1885.)

The Laws of Health. By W. H. Corfield, M.A., M.D. (Oxon.). (London: Longmans, Green, and Co., 1880.)

Principles of Hygiene. Expressly Adapted to the Requirements of the Syllabus of the Science and Art Department, South Kensington. By Albert Carey, F.R.G.S. (London: Thomas Murby.)

Hygiene. Its Principles as Applied to Public Health. Adapted to the Requirements of the Elementary and Advanced Stages of the Science and Art Department, the Sanitary Examinations at the Universities, &c. By Edward F. Willoughby, M.B. Lond., San. Sci. Cert. Lond. & Camb. (London and Glasgow: W. Collins, Sons, and Co.)

Hygiene: a Manual of Personal and Public Health. By Arthur Newsholme, M.D. Lond. (London: Geo. Gill and Sons, 1884.)

THESE works are partly if not principally intended for the use of students of the Science and Art Department, South Kensington. It is very essential, therefore, that not only should the matter be put in a pleasant and readable form, but that there should be no serious errors, as students of elementary works cannot be expected to recognise errors as such, from any knowledge they may possess on allied subjects. In fact they, and many others besides, find a difficulty in conceiving that what is printed in a book need not necessarily be correct. It is also necessary that the chapters should be well arranged, with the matter well assorted under headings, and that nothing of importance should be omitted.

"A Manual of Health Science," by Andrew Wilson, F.R.S.E., F.L.S., cannot be said to be in agreement with the above principles. Many of the chapters are ill-arranged, and important points are omitted, especially in the chapter on Removal of Waste. It is not by any means free from errors, of which we may cite a few as specimens: thus on p. 20 it is stated that "the solids" of the gastric juice "amount to over 990 parts per 1000, the remainder being water;" if such were really the case, the juice instead of being a liquid like water, would be a solid of a very dense character. Again, on p. 80, "the cistern" for drinking water "becomes a necessary article of furniture in our houses on any system," whereas the chief advantage of a constant supply is that cisterns for drinking water are unnecessary. Again, at p. 91, it is stated that "each individual exhales about ·6 cubic foot CO_2 per 24 hours" instead of per hour. At p. 112 we find that "propulsion draws foul air out, and aspiration drives fresh air in." There are several other misstatements, but the above will suffice. An unnecessary amount of space is devoted to soaps and hair-washes. The notice of a soap of a particular manufacturer in a work of this class is, we think, undesirable as having somewhat the character of an advertisement. The illustrations, which are numerous, are very good.

"The Laws of Health," by Prof. Corfield, M.D., is a very valuable little work, and although not originally intended to form a class-book for the Science and Art Department, is admirably adapted for this purpose. It contains nearly all that it is necessary to know in a very small compass, and bears throughout the impress of the high scientific attainments and practical knowledge of the author. The chapter on Small-Pox and Vaccination is especially good, and its arguments very convincing.

"The Principles of Hygiene," by Albert Carey, F.R.G.S., is only of use for the first or elementary stage in Hygiene of the Department, although it is not so stated in the preface. The book is without illustrations, a great drawback to elementary students; and a good deal of space is devoted to matters of only secondary importance. It is therefore but moderately suited for the class of readers for whom it was written.

"The Principles of Hygiene," by E. F. Willoughby, M.B., S.Sc.C. Lond. & Camb., is intended for the use of students of all three stages of the Science and Art Department. It is also very well suited for the preparation of candidates for the University Examinations in Public Health. We can speak highly of this work, which contains sound and useful information on every subject necessary for the above courses, and is well up to the latest improvements and most generally received opinions in the science of which it treats. In our opinion it is perhaps better adapted for the advanced and honours students than for the elementary, as some parts intended for the latter are somewhat needlessly complex. The chapter on Vital Statistics is likely to be extremely useful to the University candidates, this somewhat difficult subject being here ably and intelligently treated.

"Hygiene, a Manual of Personal and Public Health," by A. Newsholme, M.D. Lond., is very well suited for students in the elementary and advanced stages. They will find here all that they require to know in an easily assimilable form. We do not, however, agree with Dr. Newsholme in thinking the "Banner" system of drainage one to be recommended, and our opinion coincides with that of several practical sanitarians. In every other respect the subject is ably treated by the author, and his work deserves a wide circulation amongst the science teachers of the country.

OUR BOOK SHELF

Euclid, Book I.; with Notes and Exercises for the Use of Preparatory Schools and Candidates preparing for Naval Cadetship and Sandhurst Preliminary Examinations. By Braithwaite Arnett, M.A. (Cambridge: Deighton, 1885.)

As the examinations for which this work is intended to prepare pupils rigidly require what are called Euclid's proofs we have here merely an edition mainly on the lines of Simson's text. This text is so presented that the pupil may see how to write out his "props" in such a way as shall please the examiner. Everything is done that can be done by another to secure success. That the pupil may not be physically incommoded more than is absolutely necessary the text is so printed as to involve the minimum of exertion.

On the sinister page of the open volume behold the text printed as the dreaded examiner desires to see it broken up, each new step in the reasoning claiming a fresh line, the figure correctly drawn (a really important matter), and to every page its own private "prop." These are merits which the editor can rightly appropriate to himself (which he does in his Preface).

On the dexter page, *in ordine longo*, come the "references," saving the pupil the horrid nuisance of turning back (as he lies prone on the ground) to see what "def. 15" is, and this kind (?) action is carried on to Prop. 48. So that if this one definition had obtruded itself into each proposition, it would have been printed forty-eight times and ever would it have greeted the student with a cheery "Here we are again!"

But this is a fault—unless all the first book could be printed on one side of a not too unwieldy page—which Mr. Arnett's book must be content to share with our "Revised Bible" references to such words as "slave" for the A.V. "servant."

Below the "references" come a very copious collection of riders. We have looked at the ludicrous side of matters, but it would be doing Mr. Arnett a very great injustice if we confined our attention to all the conveniences he has got together to ease the work of this class of students, of whom (*horres cimus referentes*) we have had experience in time past, in getting up this particular subject.

Throughout there is plenty of judicious explanation and illustration: the theorems are grouped in sections of subject-matter, as direct and converse theorems, so are the problems in sections, and there is a genealogical chart for the first twenty-six propositions. In fact nothing is scamped.

To return to the dexter page, the riders are exceedingly varied and well-grouped, and are calculated to draw out the intelligence of a thoughtful pupil if such an one uses the book.

If the first book of the glorious "Elements" must be edited at such length, we commend Mr. Arnett's edition to those who require such "props" as are here supplied, feeling convinced that if they cannot master the "props" with them, then the study of geometry is not their proper work.

Botany. A Specific Subject of Instruction in Public Elementary Schools. By Vincent T. Murché. (London: Blackie and Son, 1885.)

THE preface to this little volume states that "the three books which form this series are emphatically children's books, and not text-books for South Kensington students." As long as the author confines himself to that part of the science which is, in our opinion, best adapted to the mind of a child, his "chatty, experimental method" may very probably gain the attention of youthful readers. The first forty-eight pages, which he devotes to external morphology, are unpretentious and successful. We may well wish that the author had confined himself to external morphology; but he launches out into anatomy and physiology—branches of the science which are ill-adapted at best to the mind of a child: in this middle section of the book his success leaves him when he states that "the epidermis of the orange consists . . . of a thick peel;" that "there is in every plant . . . a peculiar vital fluid which is the source of all its solid parts;" this, we are told, is found in spring "in an active state between the bark and the wood. In this condition it is called *cambium!*" It is also stated (p. 58) that the cells of the pith "form the channel by which all the fluids absorbed by the roots are carried upwards towards the leaves and flowers," while the part played in the transfer of fluids by the lignified walls is systematically ignored, and it is expressly stated on p. 78 that "there can be no passage of fluids up or down, except by the process of osmosis." When the author leaves this part of the subject, on which he is, to say the least, not very sound, his success again returns: he describes simply and clearly the chief characters of the flower and fruit; but concludes with a condensed and not very satisfactory treatment of some of the lower forms of vegetable life.

It is unfortunate that a book, parts of which might prove so useful, should be disfigured by serious blunders; why should not the proof-sheets, in cases like the present, be submitted to some competent authority, who would easily sift out the grosser errors? F. O. B.

Journal of the Royal Agricultural Society of England. Second Series. Vol. 21, Part I. (London: John Murray, 1885.)

THIS journal fully maintains the high character it has acquired under the able editorship of Mr. H. M. Jenkins. The part under notice is a bulky volume of nearly five hundred pages, and includes some eight or ten original papers by well-known agricultural writers, besides the always valuable annual reports of the entomologist, chemist, and botanist to the Society. Prof. Wortley Axe reports on a recent outbreak of abortion in Lincolnshire ewe-flocks, and Prof. Robertson on anæmia in sheep. Mr. S. B. S. Druce, Barrister-at-Law, has a significant paper on the alteration in the distribution of the agricultural population of England and Wales between the returns of the census of 1871 and 1881. Dr. J. H. Gilbert, F.R.S., contributes a sympathetic memoir of the late Dr. Augustus Voelcker, the paper being accompanied by a graphic portrait. Sir J. B. Lawes, F.R.S., writing on sugar as a food for stock, concludes that even at its present low price, sugar does not appear to be an economical substance to use when brought into comparison with other foods which are available to the farmer. Mr. H. Ling Roth writes on Franco-Swiss dairy farming, and Mr. W. Little on the agriculture of Glamorganshire, while the longest contribution to the current part is the first instalment of a report on Canadian agriculture, by Prof. Fream. The author confines his remarks chiefly to the prairie region of British North America, and after discussing the physical and geological features of this vast region, the character of its soils, the composition and value of its native herbage, and the peculiarities of its climate, he proceeds to give an exhaustive description of the agriculture of Manitoba and the North-West Territories, and concludes with an expression of his opinions as to the probable future of prairie farming. The moderate and impartial spirit in which this paper is written will enhance its value to readers on both sides of the Atlantic, and lead them to look forward to the publication of the second part, in which it is proposed to deal with the agriculture of the Eastern Provinces of the Dominion. In the course of his inquiries, Prof. Fream appears to have discovered in "goose wheat" a novelty both of botanical and agricultural interest. This part of the *Journal* also contains a report on the field and feeding experiments at Woburn, by Dr. J. Augustus Voelcker, in which the author gives evidence of the same attention to accuracy and matters of detail as were so eminently characteristic of his late father, to whose vacant post as consulting chemist to the Society he was recently elected by the Council.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

"An Earthquake Invention"

WITH reference to the correspondence on this subject in this week's NATURE (vol. xxxii. p. 213), will you permit me to state that the gentleman to whose paper in the British Association Report for 1884 Prof. Piazzi Smyth refers has long been a resident of Japan, that he is now on a voyage from that country to Australia and New Zealand, and that it must, therefore, in the ordinary course of things, be some months before he can see and reply to the correspondence in question. In the mean time, it may not be amiss to point out that the capital of Japan is about 12,000 miles from the learned societies of Europe and their *Proceedings*, and that there, as described, a man must be content to work with what he finds at his hand; there are no great public libraries in which we can find out readily what has been done before in any particular field. Mr. Stevenson's paper appears to have been published twenty years ago, and the chances are that it never, from that time to the present, reached the East. That it never came to the knowledge of "the B.A. man" will be readily believed by the many readers of NATURE who know what a careful and conscientious worker that man is. Besides, unless it be presumptuous in an unscientific person to say so, the learned Professor's solitary premiss does not at all support his amiable conclusion. If he will again examine the letters, to the publication of which he appears to have given his consent without a clear notion of what he was doing, he will doubtless perceive that one man may carry out experiments in Japan in 1884 without knowing that similar experiments had been carried out by another man in England in 1864; and when Prof. Piazzi Smyth has reached this point, it may occur to him that the tone and expressions of his letters, so far as they refer to the gentleman in Japan, require more consideration than they received when they were penned.

It should also be added that these experiments with regard to buildings in earthquake countries form only one of a long series of investigations which the gentleman in question has for years past been pursuing over the whole domain of seismology. Most of his numerous papers on this subject have been noticed from time to time in NATURE. M.

Gray's Inn, July 3

On the Occurrence of Lumpenus lampetriformis and Gadiculus argenteus off Aberdeen

I RECORDED and figured in the *Proceedings* of the Zoological Society for 1884 the first species of *Lumpenus lampetriformis* obtained in Great Britain. It was a male 10.7 inches long, captured trawling by Prof. McIntosh, fifteen miles off St. Abb's Head. On June 20 I received a letter from Mr. Sim, of Aberdeen, inclosing a sketch of a fish which had become entangled in the net of a steam trawler, and which specimen he was good enough to forward for my inspection. It is a female of the same species 8·6 inches in length, in which the caudal fin differs from that of the male example in that its form is lanceolate. The second specimen, which I received at the same time from Mr. Sim, was that of a *Gadiculus argenteus*, Guichenot, which was cast up on the beach after a slight storm on April 13, 1885. To this latter fish a considerable amount of interest attaches itself. Pertaining to a genus whose habitat is considered intermediate between the littoral and deep-sea zones, I have been in doubt whether it has or has not been previously obtained off our shores. Couch labelled a fish of this species from the *Porcupine* Expedition as *Macrourus linearis*, and which is in the British Museum collection. Of it he wrote as follows:—"Much resembling a whiting, but shorter in proportion to its depth and with a much larger eye. Caught from a depth of 183 fathoms, muddy ground, 54° 10' N. and 10° 59' W. Length about 6 inches; no barb; the head short, eye large, mouth capacious, teeth small, dorsal fins three, anal two, tail a little concave, colour in spirit pale yellow. If we can suppose that a whiting can live at such a depth, we can suppose also that the eye might become larger and the body rather shorter, proportionally, but otherwise it is a distinct species and yet nearly alike; but from the latitude, and especially the longitude, it is scarcely a British fish."

I should have deemed a fish from such a spot undoubtedly British, but as I was not quite sure whether Mr. Laughrin, who had been in charge of the fish collection in the *Porcupine* Expedition, might not have inadvertently mixed up Mediterranean forms with those from higher latitudes, and as *Gadiculus argenteus* originally was obtained from the coast of Algiers, I wrote to him on the subject. However, he would only reply that "I do not think he [Mr. Couch] had any of the Mediterranean fish; I cannot remember, it is so long ago." It is very interesting being able, after so many years' interval, to adduce corroborative evidence as to this fish being entitled to a position in the British fish fauna, the *Porcupine* specimen having been obtained on the west coast of Ireland, Mr. Sim's on the east coast of Scotland. The specimen is 3·3 inches in length, D. 11/13/15, A. 16/16, L. l. 56. There is a dark spot at the base of the anterior rays of the first and second dorsal fins.

Cheltenham, July 4 FRANCIS DAY

Swallows

If "E. H." will take down a swallow's nest (*Hirundo urbica*) directly after the young brood has left it, he will find the lining swarming with two species of active insects altogether out of proportion as to size of the swallow on which they are parasitic. At the same time also the nest contains numerous ovate *pupæ* as black as jet, evidently the offsprings of the insects which, if kept during the winter following, will develop into wonderfully active wingless *imago*, which, when liberated, are difficult to capture and kill. These are the gnats, &c., to which "E. H.'s" informant alluded, but they approach in size nearer to sheep lice. Under the microscope they are interesting objects. Circulation can be watched, and in addition to a peculiarly-formed head, pointed rudimentary wings can be seen in shape much like the swallows. It appears to me that swallows do not hatch their parasites on their bodies, but incubate them in the lining of their nests; but a high degree of heat is not necessary to develop the pupa. In my opinion there is no design or intention on the part of the swallow to breed or cultivate parasites for consumption during migration. The life of the parasite depends on the existence of the swallow, and not the swallow upon the parasite. At the present time I have nests in the corners of my windows, and when the migratory season arrives I can safely rely upon a collection of insects and pupa from them which I would gladly send to any of your readers who care to write for them about the middle of autumn. WM. WATTS

Piethorn, Rochdale, July 4

SWALLOWS are infested by at least three genera of parasitic two-winged insects, *Ornithomyia*, *Stenopteryx*, and *Oxypterum*. Figures of these flies may be found in F. Walker's "Insecta Britannica Diptera," vol. ii. Tab. xx. O. S.

Heidelberg, Germany, July 4

"The Evolution of Vegetation"

As the science of botany is interesting to many people according as it throws light on biological questions, perhaps just now, while the Darwin Memorial is still fresh in your mind, you will allow one of the many to make known a want by inserting this letter in your paper.

Prof. Bower, in his article, NATURE, vol. xxxi. p. 460, seems to tell the young botanist to go to the other side of the globe in order to find fresh fields of labour. This sort of work, I should think, is very much needed; but if Prof. Bower or some other master in the science would publish his views relating to the evolution of vegetation, perhaps another motive would be added for the enterprise. I hope I am not asking too largely, though aware that men who have won good reputations may hesitate to print their theories. Yet a Parker has given us "Mammalian Descent," and, what he has done to teach us in one direction, surely some one else will in another.

On pp. 4 and 5, "Mammalian Descent," we are told that there are three groups of workers all labouring to build up the truth as it is in Darwin—the zoologists, the palæontologists, and the embryologists. Now there are some botanists who would gladly make a fourth group if a teacher would arise to direct them where and how to work, even if that work was with the zoologists in the land of the Monotremes or at home with the embryologists watching the development of plants, though the plants were of cellular tissue only.

I do hope that I have not written to you in vain.

Bradford, June 23 J. CLAYTON

Foul Water

ALLOW me to call attention to the fact every year—generally some time in May—the sea-water on this coast becomes in a condition that fishermen call "foul." It is due to the presence of enormous quantities of gelatinous masses of small size and spherical, cylindrical and irregular forms, in which nucleated granules are imbedded. After immersion, even for a few seconds, ropes, nets, &c., feel as if they had been dipped in thin glue.

The men allege that this "foul water" has an injurious effect upon their tackle, and also lessens their take of some kinds of fish. It continues for about a month and then disappears. This year I have had and still have some of the organisms under microscopic observation, and I am very anxious to know if they have already been the subject of scientific inquiry, or not; and also information as to the geographical extent of their diffusion.

Sheerness-on-Sea W. H. SHRUBSOLE

Composite Portraits

IT is most unfortunate, but an obvious fact, that in the sheet of composite portraits of American notabilities in NATURE of June 25, Figs. 2 and 3 are impressions from one and the same negative. Not only are they alike, but they present the same peculiarities, even the same defects. If it were not so, they would serve to blow to shivers the whole edifice founded upon such averages; for if 16 naturalists and 31 academicians present two composites which are indistinguishable, to what purpose is the average? C. M. INGLEBY

Athenæum Club

IRIDESCENT CRYSTALS OF CHLORATE OF POTASH

THE appearance of Mr. Madan's paper in NATURE, vol. xxxii. p. 102, induces me to offer some additional remarks on this subject.

In the discussion that followed the reading of my paper Mr. Crookes referred to the closely analogous spectra exhibited by opals, as described in his paper (*Proc. Roy. Soc.*, vol. xvii.). This paper, though it came before me at the time when it was read, was not in my mind when I wrote my own. I called shortly afterwards at Mr. Crookes' house, and saw the spectra of his opals. Supposing that there were sufficient grounds for the commonly received idea that the colours of the opal are due to fine tubes in the mineral, we did not at the time conceive that the phenomena could be the same; were it not for this, I should certainly have added to my paper a reference to that of Mr. Crookes.

Mr. Crookes was so good as to lend me his opals for more leisurely study. The further examination has so impressed me with the similarity of character of the spectra, that I am strongly disposed to think that the colours of the opal and those of the chlorate crystals may be due to the same cause. This does not, however, lead me to attribute tubes or striæ to the chlorate crystals, the structure of which can comparatively easily be made out, but to doubt very greatly the theory which attributes the colours of opal to fine tubes.

Mr. Madan does not profess to have actually seen in the chlorate crystals such tubes as he supposes to exist, nor could I see anything of the kind on examining some of the crystals I have got after the appearance of his paper. On the other hand, I notice that Brewster did not state that he had actually seen the supposed tubes, but merely inferred their existence from a comparison of the appearance under the microscope of the precious opal with that of hydrophane. And Mr. Crookes tells me that an opal is not spoiled or affected by being immersed in water or even oil. The fact is that it is extremely difficult to make out what the actual structure is with which we have to deal in the case of the opal, whereas in the case of the chlorate crystals it is unmistakable. Moreover, in the case of the chlorate crystals there is a wonderful uniformity in the phenomena presented by the same crystal, extending, it may be, over nearly the whole of even a large crystal, whereas in the opal the colour extends over comparatively small patches; and even a single patch is seen under the microscope to present differences of structure in different parts. Hence if the colours in opal and those in the chlorate crystals are really due to a similar cause, it seems much more likely that a study of the phenomena of the chlorate crystals will throw light on those of the opal, than that the phenomena of the opal should furnish the key to the explanation of the colours of the chlorate crystals.

In truth, I do not see how the presence of tubes, if such there be in the opal, would account for the phenomena, and especially for the very peculiar spectrum exhibited. The supposition of the existence of rows of tubes leads one to look in the direction of diffraction. But I do not see how monochromatic light, or, at least, light almost monochromatic, can be obtained by diffraction. And even independently of this consideration there is one feature of the production of colour in the chlorate crystals which shows, at once and decisively, that at least in *their* case the colour cannot be due to diffraction. If an iridescent crystal be chosen with an even surface, and the flame of a candle in a dark room be viewed by reflection in it, it is found that the colour is seen in the direction of the regularly-reflected light. In fact, the coloured light forms a well-defined image of the flame of the candle, coinciding with, or overlapping, the colourless image due to reflection from the first surface. This differs altogether from what we get in the case of a grating, or in that of mother-of-pearl or Labrador spar. It agrees so far with the colours of thin plates, or the colours shown by reflection by certain quasi-metallic substances, such as several of the aniline dyes, though the production of colour in these three cases is due to three totally different causes.

It has been conclusively proved that the seat of the colour in the chlorate of potash crystals is in a very thin twin stratum; and I entertain myself little or no doubt that the colour depends in some way on the different orientation of the planes of polarisation in the two components of a twin, and on the difference of retardation of the two polarised pencils which traverse the thin stratum. But anything beyond this is at present only a matter of speculation. I see only two directions in one or other of which to look for a possible explanation; but as these could only be propounded at considerable length, and the matter has not at present advanced further, I refrained from saying anything about it in my former paper, nor will I further mention it here.

In conclusion, I would mention an interesting paper on "The Spectrum of the Noble Opal," by Prof. H. Behrens, a copy of which I have just received by the kindness of the author. In this paper, which is printed in the *Neues Jahrbuch für Mineralogie*, &c., 1873, the author, who was evidently unacquainted with Mr. Crookes's paper when he wrote his own, has described and figured the peculiar spectra of several opals. G. G. STOKES

EXPERIMENTAL FARMING

ENGLISH farmers are not readers. They do not know, apparently, that there is much to unlearn in the practice of their art, old as it may be. But although they will not allow themselves to be enlightened by books or newspapers, they are not incapable of imitation, and for that reason experimental farming, carried out in any particular district in a practical manner, has always proved useful. Up to the present time the history of experimental farms in England is, so far as their number is concerned, a meagre one. In the whole of Europe there are 160 experimental farm stations, of which number the United Kingdom can boast of about half a dozen, including Rothamsted; Woburn, which, by the Duke of Bedford's munificence, has become a field of experiments for the Royal Agricultural Society; the stations of the Highland and Agricultural Society, of the National Board of Education in Ireland, and of the Agricultural Association of Sussex. It is a characteristic feature of our English system that the State lends no assistance to either of these establishments, while that of Sir John B. Lawes, at Rothamsted, has been conducted for many years on a princely scale by the owner at his sole cost.

The Rothamsted station, founded in 1843, has become the most prominent teaching establishment in the world. There is not a single point of interest connected with the cropping and manuring of the land, the forming and treatment of pastures, and the feeding of animals, which has not been made the subject of exhaustive experiment at Rothamsted, while the silo experiments which have been lately undertaken for the purpose of testing the value of ensilage, will probably do more for the instruction of those land-proprietors and large farmers who are watching them than all else which has been said or done in regard to this much-praised cattle food. It would be strange indeed if agriculturists refused to listen to Sir John Lawes, but although certain facts of prime importance in the long catalogue of useful lessons from Rothamsted have been widely distributed, the voluminous writings of the great experimenter, trusted as he is, are not read by one per cent. of those on whose behalf they were undertaken. Some of the more important teachings of Rothamsted have become so familiar that they have passed into agricultural axioms, such as "phosphorus for turnips, nitrogen for corn." We have ourselves known farmers who have travelled a hundred miles—a long flight for such men—for the purpose of seeing for themselves at Rothamsted how corn might be grown continuously by means of small dressings of nitrogenous manures, and thus they have solved a problem of vital importance to themselves and their families. But comparatively few farmers will trust themselves so far from home, even on a matter of life and death, and it has become a business of grave importance to the rent-receiving portion of the landed interest to convey to the rank and file of tenant farmers the necessary knowledge which they are too inert and ignorant to acquire for themselves.

In the hope of teaching farmers, the Royal Agricultural Society, the Bath and West of England Society, some landlords in Sussex, and others, are endeavouring to increase the number of experimental farms. Minds that are entirely untrained or ignorant can only be taught orally or by imitation. Put an attractive story into the hands of an ill-instructed boy, and he will soon lay the book aside; but, read or relate the story to him, and he will probably be found a fascinated listener. It is the same with farmers and scientific farming. They cannot learn from books, but they will listen to the story by word of mouth. The leading agricultural societies are therefore making a timely move in considering the best methods of teaching farmers by example—that is, by the multiplication of experimental farms. Lectures delivered by professors, and listened to with stubborn incredulity, are of little use compared with experiments tried by the roadside and discussed at the market tables of the neighbourhood. It is gratifying to notice, therefore, that at a recent Council meeting of the Royal Agricultural Society a new departure was announced in the appointment of a committee to consider how the National Society could best co-operate with local societies in carrying out investigations into subjects of practical utility in agriculture. An additional reason for multiplying stations is that, in consequence of the variation of climate and other causes, farming is conducted under different conditions in the several districts. In one locality, for example, the special problem to be solved may concern the management of grasses, in another that of corn. In all alike the object of the teachers of agriculture must be to substitute, so far as may be possible, the rule of three for the rule of thumb at present in vogue.

At Rothamsted the experiments of the past forty years have related to the growth of continuous crops year after year on the same land, to the growth of crops under rotation, to the use of every kind of artificial manure, or of farm-yard dung, in varying quantities on every kind of crop, and, for the sake of comparison, to the omission of all manure on some of the land, to the manuring of permanent pasture, fallowing, the use of various feeding stuffs, town sewage, the question whether plants assimilate free nitrogen, ensilage, rainfall, and the waste of nitrogen in land-drainage water. It has been stated that some of the elaborate investigations which have been conducted at Rothamsted are too "scientific" for humbler establishments. If by science we mean a complete knowledge of facts the phrase is hardly accurate, but no doubt some of the Rothamsted experiments were accompanied by the analyses of animals, plants, and soils, and could not therefore be repeated at ordinary stations. On the other hand, the most useful experiments for the instruction of farmers are those which relate to the effects of the different foods employed for plants and animals, and in these cases farmers can themselves form estimates of the results which will prove sufficiently accurate for practical purposes and may lead to the saving of millions which are now annually wasted through the ignorant use of manures and improper feeding of animals. H. E.

ELECTRICITY AT THE INVENTIONS EXHIBITION

The Secondary Generators of Messrs. Gaulard and Gibbs

HITHERTO there have been two means employed for electric illumination and the electric transmission of energy—viz. supplying the electricity required for the lamps or other receivers (1) direct from the dynamo machines, and (2) from secondary batteries charged by means of dynamos. A third method has been recently introduced, by means of secondary generators, of which a small installation has been made at the Inventions Exhibition, to which we propose to refer in this article.

The object of this invention is to supply a current which may be varied at will both as regards electromotive force and quantity, and thus be made applicable to work at the same time arc lamps, incandescent lamps, and motors. The means by which this result has been effected is by interposing between the dynamo machine and the lamp or other receiver of electricity a supplementary apparatus, by the use of which an induced current is produced proper to the particular receiver which it is desired to work.

The National Company for the Distribution of Electricity by Secondary Generators, which works the patents of Messrs. Gaulard and Gibbs, originally used secondary generators of the following construction. They were composed of a thick insulated copper wire, surrounded by smaller coils formed of a number of thin insulated copper wires; the thick central wire receiving the current from the dynamo, which was distributed through the secondary wires. This method of construction has been replaced by one of exceeding simplicity, in which the difficulty of insulation and complication of manufacture of the original form are done away with.

The conductor for the primary current and the conductor in which the induced current is produced consist of a series of annular disks of sheet copper $\frac{1}{2}$ millimetre in thickness and $3\frac{1}{2}$ centimetres in width, slit across at one part and furnished with projecting pieces extending outwards on either side of the slit. The conductor for the primary circuit is made up of a series of these annular disks, and the conductor for the induced current is made up of a second similar series, the two series being so interlaced that the convolutions of the helix formed by the disks for the primary circuit alternate with the convolutions of the helix formed by the disks of the induced circuit. An annular disk of insulating material, such as paraffined cardboard, is placed between each convolution of the double helix thus formed, so as to prevent short circuiting between the helices and the several convolutions thereof, and the projecting pieces of all the disks for the primary current are soldered or electrically connected together, and the projecting pieces of all the disks for the induced current are similarly electrically connected. In constructing the secondary coils, they are fixed together between two insulating surfaces by bolts and nuts, the projections by which the several conducting disks are connected projecting helically or spirally around the coil (the projections of the primary alternating with those of the secondary coil), and form convenient means for connecting up any number of convolutions as required.

The end disks of one of the helices thus formed are connected to the leads of the primary circuit by binding-screws, and the end disks of the other helix are similarly connected to the leads for the induced or secondary current. In the centre of the disks is a hollow cylinder of paraffined cardboard or other suitable insulating material, around which the helices are arranged, and in this cylinder is a core of soft iron, or of soft iron wires, which is capable of being automatically raised and lowered in the cylinder, so as to regulate as required the current passing through the coil.

The main wire from the dynamo is connected up in series to the primary helices of a group of secondary generators, and, in passing through the primary helices, induces a current in the secondaries, the tension of which, according to the experimental investigations of the inventors, increases first with the intensity or quantity of the primary current, and, secondly, with the rapidity of the interruptions or alternations, or the variations of its potential. Each secondary generator forms a complete installation, and can be put in or out of circuit at pleasure. The secondaries may be connected up in series, in multiple arc, or in multiple series, as desired, the connections being readily altered by means of a switch-board; tension or quantity is thus obtained according to the nature of the current required. The lamps or other receivers fed from the secondary generator can be connected at will to their respective circuits, and are also independent of one another.

These generators are made to work in connection with alternate-current machines, because the latter can be constructed up to almost any power, as no two parts of the machine having great difference of potential need be in close proximity, and the alternation of current may be made as quickly as desired. The generating dynamo is so constructed and operated that the quantity of current is preserved constant, and the tension is varied to carry this current through the primary conductor against the varying counter electromotive force due to variations in the work done in the secondary circuits of a number of secondary generators. If W represents work, C current, E electromotive force, and R resistance, and if either of these factors be changed, the others must be altered in the same ratio, according to the formula—

$$W = CE = C^2R = \frac{E^2}{R},$$

if uniform effects in the secondary circuits are to be desired.

One of the chief characteristics of this system is that if the primary current be kept constant the loss due to resistance remains fixed, no matter what energy is transmitted—so that if an increase of energy is desired, the only factor that has to be increased is the electromotive force, which bears no ratio to the loss in the conductor. This circumstance is of importance in any house-to-house lighting scheme, where a conductor may be laid down to supply a certain area, and if the lights are not taken up at once, the necessary current can be supplied later within the limits of the dynamo, by increasing the electromotive force, without increasing the size of the conductor, the strength of the current, or the loss in the line.

As regards the very high potential required upon the secondary generator system, the danger is limited to the supply station, as between the two poles of the main dynamo there is an unbroken metallic circuit, which maintains the continuity of the flow of current; and as regards each secondary circuit the work done is represented by a secondary generator, and the only danger would be in grasping both primary terminals at once, which may be made impossible of performance. It will be necessary as regards the dynamo that it shall be insulated from the earth, and also that such parts of the circuit as carry high tension electricity shall be so protected that it shall be impossible to make contact between them and the earth.

In comparing this system, in which there is a loss in the transformation of the energy by the secondary generator, with the direct system, this loss will have to be balanced against that caused by resistance due to distance, whilst as regards the regulation of the supply of energy, this is effected by means of a regulator working the exciting machine of the dynamo at the station; by its means, when a secondary generator is cut out of circuit, a proportionate amount of power is saved. The secondary generators also regulate the energy absorbed, so that a perfect control of power is obtained, which is especially important for domestic supplies of electricity, as, when a suitable current measurer has been designed, consumers will be able to pay simply according to the amount consumed.

At present the extreme northern end only of the East Arcade at the Exhibition is being lighted on this system; it is proposed, however, to extend it to the full length of the East Arcade and to the concert-room.

THE AFGHAN DELIMITATION COMMISSION

WE are indebted to the courtesy of the Kew authorities for the opportunity of publishing the accompanying letter from Surgeon-Major Aitchison, C.I.E., F.R.S., which gives the most recent account of his work as naturalist to the Expedition:—

Camp Tir-Phul, Northern Afghanistan,
6 miles from Khusan

DEAR SIR JOSEPH HOOKER,—

I am now able to write to you with some pleasure, as I have been able to put together this year some 300 species in all. The last 100 I obtained on a ten days' trip that I made from this camp. I left this on April 25 under very bad auspices, as it had blown all night and was blowing a terrible gale with every chance of a heavy fall of rain from the north. But I started and got as far as Khusan, in the vicinity of which, beside the ruins of an old "serai," I halted. I picked up a few odds and ends, the chief attraction was the *Rosa margerita* (if a new sp.) *mihi*. It covers the whole country in localised patches, and being very dwarf in habit, not above 2 feet, the flowers are seen to perfection; they open out expanding almost flat, when the brilliant eyes, formed by the claret colour of the bases of the petals, gives it quite a character. Amongst my rose hips sent to you last year this was one of the species. I hope to be able to supply you with a lot more, it would make a lovely flower border.

I marched next to a place on the right bank of the Hari-rúd River opposite Tomăn-ághá, fifteen miles. Our route lay over a plain that had once been the bed of the river where the river had made a great bend; the river, after silting up this bend, had left it. The most characteristic plant here was a Rhubarb, usually with 3-root leaves of immense proportion for the size of the flowering stem; these leaves are so pressed flat to the ground that it reminds one more of the *Victoria regia* leaves (without the margin), and this is the habit of the plant; the plant was fruiting, having large winged fruit of a most brilliant scarlet; it will make a grand thing in gardens. The beautiful colour of the fruit is much helped out by the splendid green of the leaf background. There are, one may almost say, no leaves on the flowering stem—one or two most minute. I measured one of the largest on the ground: it was 4 feet from the base to apex and 5 feet across; the other two with this one were a little smaller; the three together gave it a very curious look. I hope soon to get the seeds home. I have collected a good deal of the root; it is called "Fool's Rhubarb" owing to its purgative qualities, and curiously enough the fruit is employed in preference to the root as a purgative, given as a decoction. With the exception of an occasional woody shrub that may rise to five feet, the place was covered with a species of Artemisia (probably several) about 2 feet high, and occasional Umbelliferæ. There were no trees of any sort: these are only to be found in the river bed —viz. *Populus euphratica*, and two species of Tamarisk and a Lycium. At Tomăn-ághá, in the bed of the river, was a woody salsolaceous shrub which I do not know. I got good specimens of the wood and flowering branches.

I left Tomăn-ághá on the 28th, passing the remains of some old ruins two miles from my encampment, and turned east by north towards "Galicha" (a carpet). As we marched along, fancy crossing the markings of two pairs of carriage wheels! These had been made some months ago by the carriage of a Persian Prince who had come to our camp at Gulran to be doctored. The route lay now across towards the base of the Paropamissus range over a most extensive plain on which the attraction was a miniature forest of a species of Umbelliferæ, excessively like, but not the, Assafœtida. This was in full bloom, the stem and flowers being at first all of a light orange yellow; as the fruit ripens, the whole colour changes to a russet brown. Each flowering stem is from 3 to 5 feet high, and there are usually 50 plants to 100 yards square, the interspaces being altogether filled up by a grass of a foot in height. On the 29th, left Galicha for the Kambao Pass to enable me to cross through the range. Our march lay over a plain the continuation of that of yesterday, and which from its extent is lost to the sight. This is celebrated as the plain of the wild donkey, and here I counted sixteen herds of at least 10,000 in each. The nearest was a mile off, and their presence was recognised by a cloud of dust rising in a swirl on their galloping—like the smoke from the chimney of a steamer. It was a most extraordinary sight, watching these clumps moving from place to place. They are occasionally shot and eaten. I forgot to tell you that, except my own party, there was probably not a human being within thirty miles of us. The country has *no* inhabitants, and until the nomads turn up with their flocks from the lower regions it is a desolation. The last part of our march was for six miles within the ridges of the base of the hills, and here in the stream beds Tamarisk was the only (woody) shrub. I halted some five miles to the west of the pass, hoping to make a great haul on the 30th. From the moment of entering these valleys they seem a mass of colour—one from buttercups (one species only), another from a poppy; the bed of the stream purple with a tall onion, and the interstices green with one grass. I had previously got most of the things so promising here, but saw signs of getting into a very fine new lot. On the morning of the 30th a regular hurricane of wind blew from the north, so that I thought the best plan would be to move my camp across the pass, and get a better and more sheltered locality. I just managed to get to the north-east side, when it *did* come down—such a torrent! but as all preparations had been made we were comfortable; had I remained on we must have been swept out of our old camp.

May 1 proved a most superb morning, so I was up and out at 6 a.m., went straight back to my old encampment on the west side, and from there collected back. I got some thirty-five species—a second Arum; a Prunus; an Elæagnus, of which I sent you the fruit last year; one Pistachia bush, a large number of Astragali, which I feel sure will stump Baker; a curious Rubiaceous shrub, a fine Orobanche, only five grasses, and a most lovely everlasting pea, like the ordinary English cultivated one, only dwarf. I believe everything here is dwarfed by exposure to the winds. You cannot understand the difficulty I have with it in collecting. To save my plants at all, I have to put them *at once* into paper. It takes three of us to do this, and not allow paper or plants to blow away. I must say it does not improve one's temper.

I got one or two species of a very nice Gentian like *Gentiana Kurroo* of Royle, the altitude of Hari-rúd River, 2000 feet; Kambao Pass, west side, 2900 feet; pass itself, 3550 feet; Kambao on north-east, 3250 feet. Not a fern of any sort, not even Ophioglossum, which I looked upon as a certain find. I spent my second day—viz. May 2—at the camp on the north-east side of pass; here there is a fine hawthorn, from which I collected flowers in bud on the 1st. Along the whole of this range, well within it, where the water is sweet and the air cool, the hawthorn, a common plum, and *Amygdalus eburnea*, are more or less plentiful. I picked up an Oxygraphis, and a very pretty geranium with a most curious potato-like root, only the tubers are heaped up on each other when there is more than one to a plant. You know they made me naturalist, so, in addition to collecting plants, I have to shoot poor little birds, and I hate it. I got two bee-eaters, the one more lovely than the other, and a nightingale.

On the 3rd I marched to a place 8 miles nearer our first Gulran encampment. I had picked up most of the cream, and there was not much, except additions in the way of fruiting species, to be made. This I did, and got a venomous snake which may be a cobra—all but walked on to him—5 feet long and 6 inches at his thickest, fangs three-quarters of an inch; a most unpleasant fellow to meet. I shot him, and after fancying I had killed him, cut off his head and neck to keep (I could not keep his whole body), when lo! his body, minus his head, walked off searching for escape, the head trying to fang its own neck.

On the 4th I moved still east-by-north some 12 miles to our first encampment at Gulran. I got some nice things *en route*, and had just ticketed and arranged them preparatory to great work for the morrow, when in came a letter from Sir Peter Lumsden telling me to return at once. Alas for my great expectations! I packed up, and we moved camp at 2 a.m. on the 5th, marched up the valley, passing our second Gulran encampment, and on south to the east-by-north side of the Chashma-sabz Pass. I had no time to halt and collect. I passed a Gladiolus and an immense number of things. On the pass I collected the "Siah-chot," which is to me, in all probability, *Cotoneaster nummularia*. I had collected its fruit and sent it to you from these very bushes. I got it in this pass last year. It is from this shrub that "Shir-Khist," the manna of these parts, is collected. I have sent you a bottle of it packed amongst some other things. They have two other kinds—one from a Tamarisk and the other from Alhagi. I myself collected it from a Salsola. I got across the pass by 2 p.m.; halted until 8 p.m. and got into Tir-Phul at 8 a.m., the camels at 10 a.m. of the 6th; did 60 miles in 34 hours—good going for camels, and men more or less on foot.

I am glad I am in, because my plants had to be looked to. I got, as I said before, 100 species in this tour, not less than 1200 specimens. It is much harder work than Kurram; the fact is, I am not younger, and my back wants a good deal of oiling.

Yours very truly,

J. E. T. AITCHISON

AN OLD DRAWING OF A MAMMOTH[1]

As an addendum to the historical review of the mammoth discoveries in Siberia and the traditions to which they have given rise, which I have rendered in the "Voyage of the *Vega*," I have the pleasure of presenting a curious drawing of the animal, discovered among the Benzelian MSS. in the Linköping library. My attention was directed to the original by the president, Herr Hans Forssell, who, in his memoir of Erik Benzelius the younger, has given an account of the proceedings which it occasioned in the Upsala Scientific Society.[2]

The drawing bears the following inscription:—

"The length of this animal, called Behemot, is 50 Russian ells; the height is not known, but a rib being 5 arsin long, it may be estimated. The greatest diameter of the horn is half of an arsin, the length slightly above four; the tusks like a square brick; the foreleg from the shoulder to the knee 1¾ arsin long, and at the narrowest part a quarter in diameter. The hole in which the marrow lies is so big that a fist may be inserted, otherwise the legs bear no proportion to the body, being rather short. The heathens living by the River Obi state that they have seen them floating in this river as big as a 'struus,' *i.e.* a vessel which the Russians use. This animal lives in the earth, and dies as soon as it comes into the air."

On the reverse of the drawing we read:—

"This drawing and description is given by Baron Kagg, who has just returned from captivity in Russia and Siberia,[1] 1722, in Decembri."

This drawing was exhibited by Benzelius at the meeting of the Upsala Scientific Society, December 14, 1722. The statement referring thereto in the *Journal* of the Society is as follows:—

"Herr Benzelius exhibited a good drawing of an animal, transmitted by Baron Kagg, who has just returned from captivity in Russia and Siberia, which the

Siberiaks call Mehemoth or Mammont, which has caused many to believe that it was identical with Behemoth of Job. Herr Prof. Rudbeck and Dr. Martin maintained that it was a sea animal, moreover as Herr Kagg stated that it was found at the River Obi. To this was added that Capt. Lundius had said that its bones were mostly found in the earth by the river. With regard to the animal being drawn with claws, Prof. Rudbeck pointed out that as yet no animal *cornigerum* had been found also to be *unguiculatum*, without being *palmipes* or having skin between the toes like geese, &c. It was decided to write to Herr Kagg, requesting some information about the figure, and asking how he had obtained it, so that it might be ascertained whether it was reliable. There is a description about this Mehemot in Capt. Müller's account of the Ostiaks."[2]

At a later meeting, January 11, 1723, Dr. Martin stated that he had carefully examined works of zoology, whether there existed any sea animal like that shown at the last conference, but had found nothing like it, although the head—excepting the horns—and probably also the feet and the tail, were like those of the hippopotamus of the River Nile. At the same meeting Benzelius announced that Lieut.-Col. Schönström had promised to forward a whole tusk of this remarkable animal.

On later occasions too the animal was discussed by the Society. Thus on January 18, 1723, a letter was read from the learned linguist, Sparfvenfelt, wherein he explains the derivation of the words Behemoth and

[1] Published in *Ymer* (Journal of the Swedish Anthropological and Geographical Society), 1884, Parts 7 and 8. (Translation communicated by the Author.)

[2] "Svenska Akademiens handlingar" (*Proceedings* of the Swedish Academy), Part 58. Stockholm, 1883, p. 315.

[1] Major L. Kagg was taken prisoner at the River Dnieper in 1709, and brought to Tobolsk, whence he returned in 1722.

[2] J. B. Müller's "Leben und Gewonheiten der Ostiaken unter dem Polo Arctico wohnende," &c. Berlin, 1720.

Mammont; on February 15 a letter was read from Benzelius, stating that Kagg had received the drawing from a Capt. Tabbert, and that he could give no information as to its correctness. Again, on October 3, Benzelius exhibited a large bone, almost petrified, which was the jaw of a Mammont, or as it was called Behemoth, received from Tobolsk in Siberia, through Capt. Clodt von Jürgensburg, and, on November 22, Benzelius exhibited "part of the tusk of a Behemoth, which was exactly like ivory." Finally, Benzelius communicated with the Russian Chief of Mines, Tatischew, who, in a letter dated May 12, 1725, had given long and important information of the history of the mammoth. This letter is printed in "Acta Literaria Sueciæ" (vol. ii. p. 36, 1725).

A. E. NORDENSKIÖLD

NIAGARA FALLS: THE RATE AT WHICH THEY RECEDE SOUTHWARDS

THE diagrams are from the map issued by the New York Commission for the establishing a State reservation at the Falls, based on surveys made in August and September, 1883, by Thomas Evershed, under direction of Silas Seymour, State Engineer and Surveyor. The scale of the diagrams is one half that of

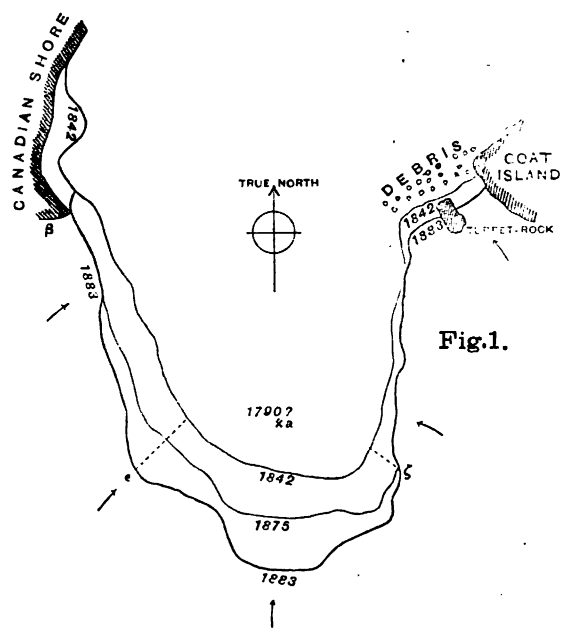


Fig. 1.

the map, which is on a scale of four chains to the inch. To have given all on one diagram with the intervening Goat Island would take up nearly an entire page of NATURE, and if the scale were smaller it would fail to show clearly the distinctive features of the changes in progress. Fig. 1 shows the Canadian or Horse-Shoe Fall, Fig. 2 the Eastern or so-called "American" Fall—a misnomer too deeply rooted in usage to be now supplanted by some more fitting name.

The rate at which the Falls are receding has been a matter of interest to geologists for over fifty years, but the results so far reached have been conflicting and inconclusive. The manner in which the Falls work backward, undermining their brink, is so well known from Lyell's clear description, that I shall not repeat it.

In 1830, Bakewell, on the basis of such information as he could gather from old inhabitants and from his own observations, concluded that during the previous forty years the Falls had receded at the rate of three feet per annum.

Lyell, from such materials as he could obtain during his own visit in 1841 and 1842, estimated the annual retrograde motion at only a foot. It is sufficient to recite such discordant results arrived at by two careful investigators to show how imperfect were the materials at their disposal, nor will any one who has been on the spot wonder at their differing so greatly. It would be possible to roughly compute the southward movement of the innermost recess of the Canadian Fall by referring its position from time to time to some fixed points on the adjoining shore, but any conclusive determination of the movement of the entire Fall could not be obtained in this way. The map referred to gives the outline of the Falls as determined by three surveys: the New York Geological Survey of 1842, the U.S. Lake Survey of 1875, and Evershed's Survey of 1883. The contours of the brink as established by these enable us to measure the total movement.

I divide the contour from β to Goat Island into thirty-three sections, disregarding for obvious reasons the overflow north of β, on the Canadian shore. From β to ϵ are eleven sections, from ϵ to ζ are twelve sections, from ζ to Goat Island are ten sections. It is obvious that much the greater work has been done between β and ζ, and that the innermost recess has kept in the same relative position.

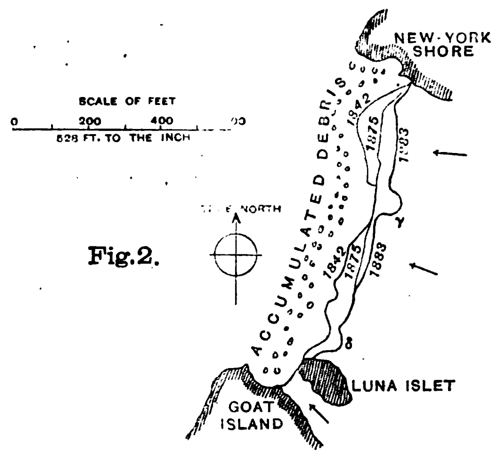


Fig. 2.

The means of the measurements on the sections, along perpendiculars from the contour at the date of each survey, measured on a tracing of the published map, give the following results for the Canadian Fall:—

	33 years ending in 1875 ft.	8 years ending in 1883 ft.	41 years ending in 1883 ft.
Mean aggregate recession along contour of 2000 feet, from β to Goat Island =	80	—	114
Mean aggregate recession along contour of 1200 feet, β to ζ =	—	60	—
Mean annual rate of regression along the whole contour where a visible change was effected =	$2\frac{1}{2}$	$7\frac{1}{2}$	$2\frac{3}{4}$
Total maximum regression at the innermost recess =	118	135	253
Annual rate of maximum regression =	$3\frac{3}{5}$	$16\frac{1}{4}$	$6\frac{1}{8}$

The "American" Fall, measured in ten sections, gave a total mean recession of $37\frac{1}{2}$ feet in the 41 years ending in 1883, which is at the rate of about 10 inches per annum.

I do not know that I have seen any estimate attempted of the relative volumes of water passing over the two falls. From such imperfect data as I have, referring to depth and swiftness, I should think that the rate of erosion for each fall gave some approximation to the volume of water discharged over each; that is to say, $2\frac{3}{4}$ feet per annum for the Canadian Fall, $\frac{5}{8}$ foot per annum for the "American" Fall, would signify that the former pours over its brink three times as much water as the latter.

At the rates of recession above shown it is evident that at no very remote age the two falls were united in one when abreast of the point in Fig. 2 marked "New York Shore," and the entire width was about the same as that of the present Canadian Fall alone. Moreover, the mean width of the fall, from the time it commenced its work at the "heights," seven miles below its present position, according to Lyell's statement as to the gorge of Niagara River, was not greater than the present Canadian Fall. Adding together the present work done by both falls, we should have about $3\frac{1}{2}$ feet per annum as the backward work performed when the entire volume poured over a single fall of the width of the present Canadian Fall.

At this rate 10,000 years would seem sufficient time for the cutting out of the present gorge terminating at the "heights" towards Lake Ontario, instead of Lyell's estimate of 35,000 years. All attempts to calculate the rate of movement proceed on the assumption that the hardness of the lime-rock and shale, the volume of water, and the height of the fall, were, for the whole distance, much the same that they now are; I merely use these same assumptions. It in no wise reflects on Lyell's judgment that he should have erred so greatly in attempting to estimate the rate of regression, while yet the contour of the fall at different periods had not been fixed by triangulation. He was ever the first to lay aside a conjecture when he could lay hold of something more solid in its stead, and it was by his candour and sound judgment in discussing natural phenomena that my interest in such matters was chiefly awakened.

The statement made by him that Hooker, his guide in 1841, reported that an indentation of 40 feet had been made in the "American" Fall since 1815 seems to contain the basis on which he estimated the rate of regression for both falls, as this amounts to a little over one foot per annum. A reference to the results given by me show this to have been approximately correct for the mean rate at the "American" Fall, but wholly inapplicable when applied to the much more important Canadian Fall.

A consideration of his section of the Niagara River leads me to suppose that the falls in the earlier part of their history worked even more rapidly than now in undermining the brink, but I will not venture further upon your space at present.

EDWARD WESSON

Providence, R.I., U.S.A., June 1

NOTES

THE Hon. William Macleay, one of the members of the Senate of Sydney University, has undertaken to give four fellowships, of 400*l.* a year each, for natural science, and to bequeath a sum sufficient to endow them permanently. In order to prevent any sleepy Fellows, we are told, from being quartered on this foundation, he stipulates that they must all have taken the degree of B.A. in the University, must be actively engaged in original study and research, and must not hold any other lucrative appointment, and the appointments are to be renewed every year, so as to give an opportunity for correcting any abuse.

THE Darwin Medal—founded by the Midland Union of Scientific Societies in honour of the great naturalist, and for the encouragement of original research—has been awarded for the current year to Mr. W. J. Harrison, F.G.S., of Birmingham.

THE long excursion of the Geologists' Association this year will be to Belgium (the Meuse and the Ardennes, Brussels, Dinant, Namur, Liége, Maestricht), under the direction of M. Ed. Dupont (Director of the Museum, Brussels, and of the Belgian Geological Survey), Prof. A. Renard, Dr. E. Purves, and Prof. J. Gosselet. The party will meet in Brussels on Monday, August 10, and will proceed the same evening to Charleroi. Further particulars as to fares, routes, &c., will be given in a special circular, which will also contain full particulars of the geology, with illustrations and references. The total expense during the five days of the excursion (Tuesday to Saturday) will vary from 15*s.* to 20*s.* per day for each person. This will include conveyances; also a special steamer on the Meuse, stopping at the various points of interest. By this arrangement much can be seen in a short time. The papers on the geology of Belgium read at the July meeting will be printed, with map and illustrations, for the use of the members during the excursion. Those proposing to join this excursion are requested to give early notice to the Secretary, who will supply further information if required.

A MONUMENT was unveiled last week at the École Normale, Paris, to Dr. Thuillier, the member of the French scientific mission to Egypt who died of cholera at Alexandria in 1883.

THE anniversary meeting of the Sanitary Institute is held today at the Royal Institution at 3 p.m. The chair will be taken by Sir John Lubbock, Bart., D.C.L., F.R.S. An address will be delivered by Prof. W. H. Corfield, M.A., M.D., entitled "The Water Supply of Ancient Roman Cities."

THE new buildings which have been erected in Chancery Lane and Fetter Lane for the purposes of the Birkbeck Literary and Scientific Institution were opened on Saturday afternoon by the Prince of Wales. The building, of which the foundation-stone was laid by the late Duke of Albany, contains accommodation for 6000 students. On the first floor are the library, reading and coffee rooms, and on the three floors above are the class rooms. A sum of over 20,000*l.* has been expended on the premises, which appear to be admirably adapted to the purposes for which they are intended.

THE Swedish Government have despatched Capt. R. Nissen to Kiel and Hamburg for the study of the chronometer observatories there and matters relating thereto. A sum of 250*l.* has been further awarded to Capt. Nissen for his valuable meteorological, astronomical, and magnetic observations during the recent cruise of the *Vanadis* around the world. A sum of money has also been granted to Dr. G. Tiselius, for the study during the summer of the attempts in progress in certain parts of Sweden of forest-cultivation from seeds; and a similar sum to Herr L. Baltzer for the drawing of the Runic inscriptions in the province of Bohus. It has further been decided to appoint an agent in London for one year to study and report on the fresh fish trade between Sweden and England, and the means to be adopted for its advancement.

THE Swedish Government have granted Dr. A. W. Liungman a sum of 350*l.*, in addition to his yearly salary, for the study of the herring and herring-fisheries of the west and south coast of Sweden, and the publication of the material collected.

AN unusually bright meteor was observed at Södertelje, near Stockholm, on the night of June 5, at 11.5 p.m. It came from the south, and went in a straight line west-east at about the height of Orion above the horizon. It could be followed with the eye in its course between Sirius and Algol, where it disappeared. The apparent size was one-fifth of that of the moon, and the colour brilliant white.

ADVICES received from Iceland by the last mail are ot a very disquieting character. Of the bodies of those killed by the avalanche in February last, twenty-four have been recovered, and the authorities have prohibited rebuilding in the valley. The weather during the spring has been exceedingly bad, snow falling incessantly from May 18 till June 5, and although the sea is open the fishing has in consequence been very bad. Agriculture and cattle-grazing are also very backward in consequence of cold winds and night-frost. In many places cattle have died from starvation, and if things do not soon mend there will probably be famine in the island next winter. In some valleys the snow was 30 feet in depth in the middle of June.

WE have received the report of the Liverpool Naturalists' Field Club for the year 1884-85. Steady, quiet prosperity appears to be the order of the day in this and similar associations in this country and in America. An elaborate system of prizes has been carefully organised, and the society appears exceptional in this respect. The report of the committee draws attention to the fact that in botany alone has much work been done; in the wide fields of zoology, geology, and microscopy little has been done. The presidential address is very interesting; it is called "Ornithopolis; bird-life under the shrubs, and what may be seen from my study chair." For the rest, there are the usual reports of excursions and of the evening meetings, and a list of books and scientific apparatus useful in the pursuit of natural history.

A SHARP shock of earthquake, accompanied by a loud rumbling noise, was felt at Kopreinitz in Styria on the night of June 28, which was followed by two others the following morning. Several houses were thrown down, and other damage done.

A NEW theory as to the origin and cause of earthquakes has been propounded by the Viceroy of the Chinese provinces of Shensi and Kansu. In a recent memorial to the throne, published in the *Peking Gazette*, this high official describes an earthquake which occurred on January 15 in various parts of Kansu, and summarises briefly the various reports which he has received on the subject relating to the motion, the damage done (which in some places was extensive), and the measures taken for the relief of the sufferers. He then proceeds to say that for years past earthquake shocks have been so frequent in these regions that people have grown quite accustomed to them; indeed, one officer informs him that in certain villages there were indications of a movement of the earth every night during the fourth watch, but these always ceased after a heavy fall of snow. The memorialist concludes by attributing the earthquake to the mildness of the winter, which caused an excess of the *yang*, or male element of Nature; "but it was due in a measure also to the perfunctory performance of their public duties by the local officials, who thereby failed to call down the harmonising influence of Heaven, and the memorialist can only endeavour to remedy this fault by encouraging his subordinates to cultivate habits of introspection and examination of their own shortcomings, himself setting the example."

ON the morning of June 15 a lovely mirage was seen at sea from Oxelösund, in Sweden, representing two islands, covered with trees, on one of which there was a building. Two monitors were seen steaming off the islands. It may be of interest to add that two Swedish monitors are at present cruising in the Baltic, and were about that time several degrees further north.

THE second annual issue of the "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland" (Griffith and Co.) has appeared. We must still express surprise at finding the Royal Institution placed alongside of the Royal Society as a scientific society, while the London Institution is omitted entirely. A list of the papers read at the various societies is given this year; but it is difficult to see what purpose the publication serves in its present form.

HERR J. MENGES describes, in a recent number of *Globus*, the language of signs employed in trade in Arabia and Eastern Africa. This appears to have been invented to enable sellers and buyers to arrange their business undisturbed by the host of loafers who interfere in transactions carried on in open markets in Eastern towns, and it enables people to conclude their business without the bystanders knowing the prices wanted or offered. It is especially in use in the Red Sea, and its characteristic is that beneath a cloth, or more generally part of the unfolded turban, the hands of the parties meet, and by an arrangement of the fingers the price is understood. If one seizes the outstretched forefinger of the other it means 1, 10, or 100; the two first fingers together mean 2, 20, or 200; the three first, 3, 30, or 300; the four, 4, 40, or 400; the whole hand, 5, 50, or 500; the little finger alone, 6, 60, 600; the third finger alone, 7, 70, 700; the middle finger alone, 8, 80, 800; the first finger alone and bent, 9, 90, 900, while the thumb signifies 1000. If the forefinger of one of the parties be touched in the middle joint with the thumb of the other, it signifies ½, and if the same finger is rubbed with the thumb from the joint to the knuckle it is ¼ more, but if the movement of the thumb be upward to the top instead of downward to the knuckle it means ¼ less. An eighth more is marked by catching the whole nail of the forefinger with the thumb and finger, while the symbol for an eighth less is catching the flesh above the nail—*i.e.* the extreme tip of the finger in the same way. It will thus be seen that, by combinations of the fingers of the seller and buyer, a large range of figures can be represented. It is, of course, understood that average market value of the article is roughly known and that there can be no confusion between, for example, 1, 10, 100, and 1000. This language of symbols is in universal use amongst European, Indian, Arab, and Persian traders on the Red Sea coasts, as well as among tribes coming from the interior, such as Abyssinians, Gallas, Somalis, Bedouins, &c. It is acquired very rapidly, and is more speedy than verbal bargaining; but its main advantages are secrecy and that it protects the parties from the interruption of meddlesome bystanders, who in the East are always ready to give their advice.

THE additions to the Zoological Society's Gardens during the past week include a Collared Peccary (*Dicotyles tajaçu* ♂) from South America, presented by Mr. R. Forrester Daly; a Common Peafowl (*Pavo cristatus* ♂) from India, presented by Mrs. Courage; two Black-bellied Sand-Grouse (*Pterocles arenarius* ♀ ♀), two Bonham's Partridges (*Ammoperdix bonhami* ♂ ♂) from Asia, presented by Mr. W. E. R. Dickson; a Siamese Blue Pie (*Urocissa magnirostris*) from Siam, a Hunting Crow (*Cissa venatoria*) from India, presented by Mr. C. Clifton, F.Z.S.; two Rooks (*Corvus frugilegus*), British, presented by Mr. C. A. Marriott; a Lion (*Felis leo* ♀) from Africa, a Great Kangaroo (*Macropus giganteus*) from Australia, a Grand Eclectus (*Eclectus roratus*) from Moluccas, a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; a Striated Coly (*Colius striatus*) from South Africa, purchased; a Mule Deer (*Cariacus macrotis* ♂), a Mesopotamian Fallow Deer (*Dama mesopotamica*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1472.—M. Celoria of Milan has discussed the elements of the last comet observed by Toscanelli, which is the celebrated one of 1472, also observed by Regiomontanus, whose description of its path in the heavens enabled Halley to make a rough approximation to its orbit, as he states in his "Synopsis of Cometary Astronomy." The Chinese account of the Comet's track contained in the supplement to the great collection of Ma Twan Lin, of which Edouard Biot published a translation in the appendix to the "Connaissance des Temps" for 1846, enabled Langier to make a further calculation of the orbit, though the somewhat full description of the comet's course amongst the stars is unfortunately very deficient in dates.

M. Celoria remarks that possibly from the advanced age which Toscanelli had attained, and the inclement season at which the comet was visible, the Florentine astronomer has not left for the comet of 1472 a representation of its track relatively to the stars as he has done for those of 1433, 1449, and 1457, nor an ephemeris of positions as in the case of the comet of Halley at its appearance in 1456; but two pretty definite places are assigned in Toscanelli's manuscript for January 9 and 17, and with the help of provisional elements a third position for January 22 is deducible. Still, in determining the most probable orbit, M. Celoria has found it desirable to utilise the one definite observation on January 20 which has been left by Regiomontanus. The principal available data are:—

Paris Mean Time	Comet's Longitude	Comet's Latitude
	° ′	° ′
January 9·6326	193 0	+13 0
17·6007	190 20	26 30
20·4021	185 12	46 3
22·2347	110 30	+80 32

Two orbits result from the discussion of these positions, and M. Celoria concludes that it is difficult to decide which is preferable. These orbits are as follows:—

	Orbit II.	Orbit III.
Perihelion passage Paris mean time	1472, Feb. 29·89097	Feb. 29.94555
	° ′ ″	° ′ ″
Longitude of perihelion	39 14 56	39 46 27
,, ascending node	296 7 49	285 53 25
Inclination	14 11 46	9 9 54
Log. perihelion distance	9·68072	9·68654

Motion—Retrograde.

Both sets of elements have the degree of precision compatible with the nature and number of the observations, and beyond doubt afford a closer approximation to the true orbit than either of the previous computations. Perhaps we may attach a slightly greater weight to M. Celoria's orbit II., from which it appears that the nearest approach to the earth took place at midnight on January 22, when the comet in right ascension 293°·5 and declination +76°·6 was distant 0·0652, with an apparent motion of 40° of a great circle daily. On this day Toscanelli refers to the interference of moonlight, and it appears certain that the presence of the moon must have greatly diminished the imposing aspect of such a comet while in the earth's vicinity. In fact we find that the moon was at the first quarter on January 18, and consequently at full soon after the nearest approach of the comet, when the theoretical intensity of light was one hundred times greater than at the end of the first week in January.

One of the European chronicles dates the first appearance of the comet on December 25, 1471, when it will be found from elements (II.) that it was in right ascension 194°·4, declination + 5°·5 at 6 a.m. in London; intensity of light, 0·38. In a quaint description of the comet's track by John Warkworth, Master of St. Peter's College, Cambridge, and a contemporary, which was published in the *Philos. Mag. and Journal of Science*, vol. xiv. (1839), we read: "And some men saide that this sterre was seen ii or iii oures afore the Sunne rysynge in Decembre iijj days before Chrystynmasse in the Southwest . . .;" calculating for 6 a.m. on December 21 we find the comet was in right ascension 193°·8, declination + 5°·2: it would consequently be near the meridian two hours or so before sun-rise, instead of the western quarter of the sky. It is clear that as regards position it might have been found three weeks earlier than Toscanelli's first observation. Warkworth says the comet disappeared on February 22. The Chinese saw it on February 17 approaching one of their constellations composed of α, δ, &c., in Pisces, and it is added in Biot's translation "elle fut longtemps à s'effacer;" calculation gives the place in right ascension 11°·9, declination +0°·7, intensity of light 3·3, in the early evening at Pekin on that date.

M. Celoria's notice contains the geocentric track of the comet, according to both sets of elements, from January 9 to February 27. There is some reference in Pingré to a comet at the beginning of May, 1472, when the comet of Regiomontanus and Toscanelli would rise in Central Europe before 2 a.m., with an intensity of light about equal to that it possessed at the previous Christmas.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JULY* 12–18

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 12

Sun rises, 3h. 59m.; souths, 12h. 5m. 20·7s.; sets, 20h. 11m.; decl. on meridian, 21° 56′ N.: Sidereal Time at Sunset, 15h. 35m.

Moon (New on July 12) rises, 4h. 31m.; souths, 12h. 20m.; sets, 20h. 2m.; decl. on meridian, 16° 47′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	5 18	13 14	21 10	20 23 N.
Venus	5 35	13 25	21 15	19 30 N.
Mars	1 28	9 40	17 52	22 54 N.
Jupiter	8 5	15 4	22 3	10 52 N.
Saturn	2 32	10 42	18 52	22 32 N.

Occultation of Star by the Moon

July	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
18	*m* Virginis	6	10 10	10 27	184 215

Phenomena of Jupiter's Satellites

July	h. m.		July	h. m.	
13	20 50	II. occ. disap.	15	21 15	I. tr. egr.
14	21 38	I. occ. disap.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

July	h.	
13	12	Mercury in conjunction with and 5° 39′ north of the Moon.
13	15	Venus in conjunction with and 5° 22 north of the Moon.
15	7	Jupiter in conjunction with and 3° 7′ north of the Moon.
17	14	Mercury in conjunction with and 0° 11′ south of Venus.

GEOGRAPHICAL NOTES

Dr. Gottsche, formerly a professor in the University of Tokio, has, as we have already intimated, returned to Europe after a long journey in Korea, during which he acquired much information with regard to that country. The length of his journey was over two thousand miles, and he visited all the eight provinces of Korea, as well as 84 out of the 350 districts. The main object of Dr. Gottsche's explorations was to ascertain whether coal and other useful minerals existed in the country; but, on account of influential support which he received he was able to obtain from the native authorities information with regard to the population, taxation, harvests, trade, &c. He has also collected much statistical information which is wholly new and which it is expected will show that the recent English consular reports are quite incorrect. Amongst others the population of the peninsula has been greatly underrated. It has generally been put down at nine millions, whereas it really is over twelve millions, for the official census from which the former estimate is taken only takes into account adults. Dr. Gottsche's principal stations on the journey were Söul, Ichhön, Kwisan, Mangyöng, Kyöngyn, Pusan, Changwön, Cwangyn, Chinsan, &c. He was 138 days *en route*, and, although this was not rapid, he was compelled to neglect some branches of investigation, such as botany and zoology, for his main business was with geology. In this respect Korea appears to belong to the bordering Manchuria. He found but few traces of the high development which the art and science of the country reached in early ages, and which made it the instructress of Japan. Dr. Gottsche, it is said, intends publishing an account of his journey.

Prof. Blumentritt, in an article in *Globus* on the Negritos of the Philippines, points out that the notion which was general at one time that these aborigines of the Archipelago were almost extinct, or absorbed into the Malay population, is an error. It may be said with certainty that they no longer exist in the Babiuyanes, Batanes, and other groups lying to the north of Luzon: but we know too little of the interior of Sámar and

Leyte, as well as of the great island of Mindoro, to say this. We know from Montano's explorations that they live in great numbers in Mindanao and elsewhere; but nevertheless, the *Negrito puro* sooner or later adopts the dress and customs of his Malay conqueror. All the efforts of the Spanish Government and of the Catholic missionaries tend to efface the peculiarities of the Negrito; and the Professor therefore states that, before it is too late, some scientific traveller should visit Mindanao to study the Atás and Mamanuas thoroughly; likewise an investigation of the Negritos of Panay and Negros is much to be desired.

M. LE MONNIER contributes to the last number of the *Deutsche Rundschau für Geographie*, &c., an article on the Island of Hainan, off the coast of China, to which some attention was recently directed on account of the rumoured occupation of it by the French. It has been known to the Chinese since 110 B.C., but it was not till the 13th century that it received its present name. From the earliest times to the present the aborigines, the Li, who inhabit the mountains in the centre, have maintained a struggle against the Chinese. It is even less known than Formosa, for no Europeans have travelled in it. One port, Kiungchow, has recently been opened to foreign trade, the north and south coasts have been surveyed, but there is no survey of the east coast. As to size, it is a little smaller than Formosa, and is larger than either Sicily or Sardinia. The centre is exceedingly mountainous, and from it rivers radiate in all directions to the sea. It is so near the mainland that its flora and fauna are in all respects continental. The direction of the mountain system is from south-west to north-east. Volcanoes have been examined there, but they appear to be now extinct. Earthquakes are frequent. As in Formosa, the population consists of three elements—the Chinese, the subjugated and the independent natives. Amongst the former are the Miaotsze, who have crossed over the narrow strait from time to time from Kwangsi and We tern Kwangtung, and have taken possession of some of the smaller hills. Their language is said to be similar to that of the Li; they are good husbandmen, and are on friendly terms with both the Li and the Chinese. The independent Li appear to be an aboriginal race which has been driven back to the hills by the Chinese immigrants. Information with regard to them is very scanty, but they appear to have a reddish skin and to be of small stature; their language resembles that of the Miaotsze of the mainland. The women are tattooed after their marriage, and they paint their faces with indigo. The Li are expert hunters and shots; the weapons are bamboo bows and arrows and a short sword in a sheath. The main sources of information with regard to Hainan are a paper by the late Mr. Mayers in the *Journal* of the North China Asiatic Society (No. vii., 1873); one by Mr. Swinhoe, entitled "Narrative of an Exploring Visit to Hainan," in the same periodical (No. vii., 1871-2); and a map of the Kwangtung Province, and other publications by Dr. F. Hirth.

HERR GLASER, the Arabian traveller, has returned to Arabia to resume his explorations. This second journey is to be mainly geographical, but archæology will also receive attention. Besides visits to Marib and Nejdran, Herr Glaser contemplates a long journey through the interior from Hadramant to Omaun, and a second across South Arabia.

M. BAUX, member of the Geographical Society of Paris, has been despatched on an ethnographical mission to China; and M. Guerné proceeds to Kiel to take part in the labours of the commission for the scientific examination of the German coasts. These missions are undertaken by direction of the Minister of Public Instruction of France.

PROF. SEELSTRANG, of the University of Cordoba, has been appointed by the Argentine Government to superintend the publication of an atlas of the Republic, and a considerable sum has been appropriated for the work. It is to consist of twenty-seven parts, and four of these are already in hand.

AT the last meeting of the Geographical Society of Paris, M. Alphonse Milne-Edwards in the chair, M. de Saint-Pol-Lias, who is now in Cochin China, presented a map of the upper course of the Red River, prepared by the Annamites. Another map of importance is that of the navigable water-ways of southern Indo-China, prepared by M. Rueff, who has established a company for navigating these waters. A letter was read from Jeddah stating that the collections of the unfortunate M. Huber, including his remarkable examples of Semitic epigraphy, were safe in the hands of the French Consul, and that the explorer's remains were buried in Jeddah on May 27.

THE last number (Band viii. Heft 2) of the *Geographische Blätter*, published by the Bremen Geographical Society, contains a study on the Congo region by Dr. Oppel, dealing with the scientific and economieal importance of this district. The paper is divided into two main sections: (1) The discovery and investigation of the Congo (*a*) between 1484 and 1872, (*b*) the systematic exploration since 1872; (2) The extent and boundaries, geology, &c., of the Congo region. Prof. Seelstrang writes on the Argentine province of Buenos Ayres, its geography, fauna, flora, climate, inhabitants, trade, industry, &c., in short, a kind of encyclopædic article on the province. Another paper on South American geography, or rather geology, is that by Dr. von Thering on the Lagoa dos Patos, in the province of Rio Grande do Sul, the largest lake in Brazil This is accompanied by a map of the extent of the sea in the province at the beginning of the alluvial epoch. Herr Zöller writes on the Batanga River; the number also contains a report of the late *Geographen-tag* at Hamburg.

ON A RADIANT ENERGY RECORDER

SUNSHINE-RECORDERS may be divided into two classes, viz., those which roughly measure solar energy by the burning of card and wood, and those which, by means of some photographic process, yield a record of the relative intensity of some more or less definite ray. The principle of the instrument which I am about to describe differs from those referred to in this respect—that it depends upon the evaporation of water *in vacuo*, and its indications are therefore readily expressible in heat-units.

The form of instrument with which I have sought to test the applicability of the method consists of a Wollaston's cryophorus (of the form pictured in Ganot's "Physics," p. 272, edition 1872), in which the vertical tube and lower bulb are replaced by a simple glass tube graduated in cubic centimetres. The bulb containing the water to be evaporated is blackened by holding it in the smoke of burning camphor, and is then exposed to the sun, the rest of the apparatus being silvered or properly protected by bright sheets of tin. At sunset the quantity of water which has distilled over can be read off on the graduated tube.

An experiment on June 6 showed 1·8 cc. to have passed over from a bulb of about 2 inches in diameter, and to have condensed in a narrow measuring tube between the hours of 10.40 and 3.20. The instrument seems very sensitive, and may well find many applications. In a suitable form of instrument the total nett solar energy gained by the blackened absorbing surface will be almost exactly represented in heat-units by multiplying the number of cubic centimetres of water distilled by the latent heat of steam. To measure the loss of the earth's radiation at night a similar instrument containing alcohol or some other liquid of low freezing-point might be employed. In either case, when a continuous time record is required, the graduated tube might be used as a cylindrical lens to condense light on photographic paper.

The following are the more important conditions which the apparatus in a future form should probably fulfil:—

(1) To present a constant and known absorbing surface to the sun.

(2) To preserve a constant surface for evaporation which should be the same in the condenser, so that a reversal of the direction of distillation can take place under the same conditions when the black bulb is losing energy.

(3) To give rise to the minimum of reflection and convection currents on the absorbing surface.

(4) The apparatus should be so screened as to be at the temperature of the air apart from the gain of energy at the blackened surface.

Some of these conditions seem likely to be more or less fulfilled in an apparatus consisting of two glass bulbs of equal diameter connected together by a tube bent through an angle of about 150°, to bring the bulbs near together, and thus keep them in air of the same temperature. In the bulb containing the water to be evaporated, a black bulb might be fixed to absorb the solar radiation, whilst to the upper part of the second bulb should be sealed a graduated tube in which the distilled water might be measured by inclining the instrument. If metal globes were employed the connecting tube might be made to form the beam of a balance.

The completion of other work will prevent my return to this subject at present—perhaps altogether—but I have ventured to publish this incomplete account of an apparently promising method for the measurement of solar radiation, in the hope that it may be of use and interest to others.

University College, Liverpool. J. W. CLARK

P.S.—It may perhaps be found advantageous to use an apparatus like an inverted cryophorus, in which the absorbed radiant energy generates a vapour-pressure, and is made to lift a column of water in the tube—the height of the column and the time being registered photographically.

THE GROWTH OF CEREALS

PERHAPS nowhere is the influence of the different climatic factors on the rapidity of growth so well illustrated as on the plains of Russia. Therefore W. Kowalewski's careful researches into this subject, summarised in the *Memoirs* of the St. Petersburgh Society of Naturalists (xv. 1), are especially worthy of attention. The author has gathered all necessary information for showing the periods of growth of various cereals on the soil of Russia, from the far north of Arkhangelsk, to the southern province of Kherson, and he has arrived at most interesting results, of which the following is a summary. If the periods of growth of the same cereal be taken throughout Russia, it appears that, altogether, it is in the higher latitudes that it ripens fastest. Oats and spring wheat take 123 days and barley 110 days to ripen about Kherson, and only 98, 88, and 98 days at Arkhangelsk, the difference in favour of the north being respectively thus: 25, 35, and 12 days. The intermediate regions show also intermediate differences, while for each latitude the growth of cereals proceeds faster in the eastern parts of Russia than in the western. It is obvious that if the rapidity of growth were due to temperature, the phenomena would be the reverse of what they are. Moreover, the want of moisture in the southern steppes is also a condition in favour of the rapidity of growth: so that it is in the insolation that we must seek for the cause of the above-stated difference. In fact, oats being usually sown about May 17 at Arkhangelsk, and the harvest usually occurring about Sept. 1, the insolation continues there for 2000 hours in 98 days, not to speak of the 240 hours of bright nights; while at Kherson, during 123 days (from April 1 to Aug. 1) the insolation lasts only for 1850 hours. The difference in favour of Arkhangelsk is thus equal to 150 hours (to 400 hours, if the bright nights be added), and it compensates for the influence of temperature. It is useless to add, moreover, that the cereals cultivated in the north have already undergone a certain accommodation to their conditions. As to the intensity of light, Prof. Famintzin's work on the subject, corroborated by ulterior researches, shows that the great intensity of light in Southern Russia, combined with the great transparency of the atmosphere, is rather a condition against the rapidity of growth, the intensity of light exceeding the limits of the maximum of decomposition of carbonic acid. Winter rye shows the same differences as the spring cereals. It appears from M. Kowalewski's tables that in the Arkhangelsk district winter rye takes 375 days to arrive at ripeness, of which there are 202 days of winter rest, 68 days of autumn growth, and 105 days of spring and summer growth, making thus a total of 173 days of growth. At Kherson the total growth lasts for 290 days, of which only 101 days of winter rest and 189 days of productive growth (63 during the autumn and 126 during the summer). The difference reaches thus 16 days in favour of the north, and it would rise to 20 or 25 days if only spring and summer be taken into account. The graphical representation of all these data is most interesting. Thus the lines of simultaneous sowing of winter rye from north-west to south-east correspond to the isochimenes, while the lines of simultaneous ripening of the spring cereals—oats, barley, sarrazin, wheat—run from south-west to north-east, corresponding to the lines of equal summer temperatures. The retarding influence of rain comes out also pretty well.

THE ROYAL SOCIETY OF NEW SOUTH WALES

THE annual general meeting of the members of the Royal Society of New South Wales was held on May 7. The president, Mr. H. C. Russell, B.A., F.R.A.S., occupied the chair, and delivered an address, from which we give the following extracts:—

"There is a very general impression, borne out by the evidence which geology has furnished, that at least the east coast, if not all Australia, is rising in relation to the mean level of the sea. The late Rev. W. B. Clarke, in a report to the Port Jackson Harbour Commission, said 'that the coast has risen in former geological epochs, and that it has risen during the present epoch is capable of distinct proof.' 'Raised beaches of shells, which are not kitchen middens, may be seen about twenty-five feet above the sea, near Ryde, on the Paramatta estuary, and at Mossman's Bay, in Port Jackson, at a height of 132 feet above high-water.' Again, 'regarding the whole coast from Broken Bay to Botany Bay as mere peninsulatic fragments, united only by low isthmuses, bare or covered with sand, as they actually are, one may still see that there must have been oscillations of level, and finally elevation.' Speaking of other portions of the coast, Mr. Clarke says:—'At Adelaide in 1855 the railway between the city and the port was being constructed, and Mr. Babbage has since shown that in four years a difference of four inches of rise between the levels of those places has taken place.' And again, 'according to Mr. Ellery, the accomplished and accurate Williamstown observer, the self-registering tide-gauge at that place indicated a rise of the bottom of Hobson's Bay of four inches in twelve months, and a deposit of recent shells and imbedded bones of sheep and bullocks which had been thrown into the bay is now seen at a level above the reach of the sides.' Again, quoting from a letter by the late Mr. John Kent, of Brisbane:—'A survey was made of a shelf of rocks in Brisbane River in 1842 by Captain Gilmore, Mr. Petrie, and myself, and in making a re-survey in 1858 Mr. Roberts found the relative depths were singularly correct, but that the general depth of water over the shelf of rock had decreased eighteen inches in sixteen years since the first survey was made.' Sir Roderick Murchison, in the *Proceedings* of the Royal Geographical Society of London (vol. vii. p. 42) quotes from a letter he had received from the late Mr. Kent, of Brisbane:—'I have lately drawn the attention of the Rev. W. B. Clarke to the fact that the eastern coast of New Holland is rising at the rate of (say) one inch per annum, as ascertained by the height of rocks in the river Brisbane above tide levels, through a period of twenty years, and he assures me that to the south the same result has been inferred, though the observations have not extended over so long a period. At what rate the rise is now going on there are no data to establish. Till a series of mean tidal levels are marked on the rocks of the harbour, and the alteration made as distinct as that in Hobson's Bay, any deduction as to the rate of rise must be conjectural and unreliable.' I have but taken a few extracts from a great mass of evidence which Mr. Clarke brought forward in proof of the rapid elevation of the coast of Australia. I was deeply interested in this report when it was published in 1866, and as soon as I had opportunity determined to make such observations with a self-registering tide-gauge as would determine the rate of rise, if any, and in collecting information bearing upon this subject during the past thirteen years. I wrote to Mr. Ellery and asked him for further particulars of the rise going on in Victoria, and in reply he said that Mr. Clarke had in some way misunderstood his remarks, which had reference to the silting up of the harbour, not the elevation of the land; and he at the same time sent me a copy of his paper on 'The Tidal datum of Hobson's Bay,' read before the Royal Society of Victoria, August 14, 1879. After giving the history of the tide-gauge, which was started in 1858 under the Harbour Department, and was not under his control till 1874, Mr. Ellery says:—'It is to be regretted that no precise references to mean tide level in the earlier days can be found. Where measurements do exist in Hobson's Bay they are lacking in accurate information as to the state of the tides, and I find nothing trustworthy upon which to base any statements as to change of sea level since surveys have been made. I think it desirable that permanent bench marks on the natural faces of the rock *in situ* should be established around our bay, carefully connected by accurate levelling with one another and with the tide-gauge, for it is very doubtful if bench marks on buildings can be assumed to afford a permanent datum.' The first self-registering tide-gauge in Sydney was erected on Fort Denison by the late Mr. Smalley in 1867. Unfortunately the design was so faulty that all the records of the heights of tides made by it are of no value, although the times of high and low water are correct. The reason for this fault in its records was that an ordinary hempen cord was used to connect the float and the pencil, and this gradually got longer by use, and also varied with the weather. Finding it impossible to remedy this fault satisfactorily in view of the necessity for exact records of the heights of the tides, in 1872 I had a new gauge made, which, without losing the accuracy of the time record, which the old one possessed, insured the correct record of the height of the tides. This instrument is figured and described in the 'Sydney Meteorological volume for 1878,' and to that work I must refer you for particulars. The record by the new gauge was begun on June 27, 1872, and at that time the precaution was taken of measuring the length of the chain connecting the float and the wheel, so that should any change take place its exact amount could be ascertained. The wisdom of this has been evident on several occasions when the chain was broken by accident, and the exact length restored. The well made for the tide gauge is in part cut in the solid rock, and from the rock to the surface of the ground the sides of the well are built up (round) with solid masonry, so that the top ring of the well is practically part of the solid rock, and cannot move unless the rock does so. On this ring the frame of the tide gauge stands, and the instrument, therefore, has a permanent relation to the rock, and there can be no change in its parts which might be mistaken for a change in sea level. I have been particular in detailing the conditions under which the tide measurements have been made, to show you that sufficient precautions to ensure accuracy have been taken. In each year the mean of all the tides is taken as the mean sea level for that year, and when these results for the past twelve years are placed side by side, it is at first sight rather puzzling, for although the greatest departure from the mean of all is only one inch, yet within this small range the land seems to rise and fall in an erratic way. The cause of these variations, however, was found in the varying relative positions of sun, moon, and earth, and perhaps, to some extent, in the effects of heavy gales. Taken as a whole, these results seem to prove conclusively that no change whatever has taken place in the relation of land and sea during the past twelve years. Of course the question is not settled—a slow change that would be visible in centuries might be altogether hidden in the results before us; but so far as they go these results will be interesting to scientific men, for they are the first that have been taken with such accuracy as the investigation demands. Mean Sea Levels: 1873, 2 feet 5·9 inches; 1874, 2 feet 7 inches; 1875, 2 feet 6·3 inches; 1876, 2 feet 5·5 inches; 1877, 2 feet 6·7 inches; 1878, 2 feet 6 inches; 1879, 2 feet 5·5 inches; 1880, 2 feet 6·2 inches; 1881, 2 feet 5·2 inches; 1882, 2 feet 6·1 inches; 1883, 2 feet 6·8 inches; 1884, 2 feet 6·95 inches—2 feet 6·11 inches. In examining this question I looked for some mark of old surveys which might show what the evidence of a longer period would be, but I have failed to find any mark put in with such care as the investigation demands. There is, however, one mark on the north-east face of the round tower on Fort Denison which was put in by H.M.S. *Herald* during her survey of Sydney harbour. It is cut in the stone three feet above mean sea level, and is marked with the broad arrow under it. I have been at some trouble to find out on what observations this mark was based; but although I have learned that the survey was made in 1857, and that the *Herald* was in port from February 26 to December 21, 1857, I cannot learn how long the tide observations were continued, but I hope still to do so. The time and method of taking mean sea level might account for a difference from the true mean of four or five inches, as is shown by the different monthly means from the recording tide gauge, and until I can learn on what observations the *Herald's* mark depends, it cannot be used as evidence of change of level of the land. I have, however, connected it carefully with the zero of the tide gauge, and if it exactly represents mean sea level in 1857, it proved that the land has risen five inches in twenty-seven years; but, since the tide gauge shows no change whatever during twelve of these years, I think the evidence of the mark cannot be taken without full particulars of the observations on which it depends. In the course of conversation with the late Rev. W. B. Clarke on the question of the elevation of the coast, he pointed out to me evidence not only of the elevation of this coast, but also of its subsidence, and expressed his conviction that Port Jackson, Hawkesbury River, and other places on the coast had been cut out by the action of fresh water, when the coast was much higher than it is at present—in fact, that these inlets had been at one time gullies exactly similar in character to those which now exist in the Blue Mountains, and which have been so obviously cut out by fresh water. Since that time many bridges have been made along the coast, and the borings made for foundations for these bridges have special significance in connection with Mr. Clarke's opinion; and by the kindness of the Engineer-in-chief for Railways and the Engineer-in-chief for Roads and Bridges I am able to quote here some of these measures, which prove conclusively that the sea was at one time much lower than it is at present. The soundings taken for the Parramatta Railway bridge show 26 feet water, 32 feet mud and silt, 8 feet loose sand, 12 feet hard sand, 10 feet loose sand: total, 88 feet. George's River bridge—8 feet water, 87 feet mud and sand, 9 feet black clay, 16 feet sand, 4 feet hard sand: total, 121 feet. Hawkesbury River bridge—44 feet water, 31 feet light mud, 87 feet black mud, 8 feet very hard sand: total, 170 feet. In the road-bridge over the Parramatta River—41 feet water, 16 feet shells and mud, 15 feet sand, 9 feet blue clay, 6 feet clays and shells: total, 87 feet. Ironstone Cove road-bridge—26 feet water, 7 feet stiff blue clay, 36 feet very stiff blue clay, 15 feet yellow clay, 5 feet stiff black clay, 11 feet sand and clay, 2 feet clean sand, 3 feet gravel and wood: total, 105 feet. Shoalhaven River road-bridge—14 feet water, 103 feet mud and silt: total, 117 feet. The bottom of the Hawkesbury, therefore, where the railway-bridge is to be, is 170 feet below the level of the sea to-day; and when the rocks were washed away to form the river-bed to that depth, the sea must have been at least 170 feet below its present level, and the bearings in Sydney Harbour and George's River indicate a similar fact, if not to the same extent. Without going further into this question, which is foreign to my present purpose, I think I have said enough to show that the evidence for elevation and subsidence of the land are about equal, the question before us being, In which direction is the change going on now? In estimating the value of the evidence quoted as to the rate of rise in Queensland and South Australia, we must not forget that when engineers adopt the usual rule as to mean sea level—that is, as to the mean of high and low water at any time of the year—they assume that all such means are equal or represent a constant level, when in point of fact two such determinations of sea level may differ by 8 inches or even more, and in the absence of a self-registering tide-gauge, or constant observations extending over a year, no levelling referred to the sea in the usual way is of any value whatever in such an investigation as that required to determine whether the relative level of land and water varies. I have already shown that Mr. Ellery thinks there is no evidence of present rising in Hobson's Bay, and the fact that at the time the engineering levels referred to were taken in South Australia and Queensland there were no self-registering tide-gauges to determine accurately mean sea level, is sufficient to warrant us in hesitating before we receive the evidence as to the rate of elevation furnished from these colonies, which I quoted from Mr. Clarke's report. Some few months since it occurred to me that it would be desirable to put a self-recording gauge on Lake George, with a view of keeping a continuous record of evaporation and other changes of level in it; and as soon as the instrument could be got ready I put it up on the west side of the lake, in front of Douglas House, which is about a mile from the present southern end. The work of erecting the instrument was completed on the afternoon of February 18, and the pencil was put down on the paper to begin its curious record at 7 p.m. on that day. At the time the lake seemed calm as a millpond, and, looking at its smooth surface, no one would have dreamed that such changes were going on in it as began to reveal themselves so soon as the pencil touched the paper, and in two hours the pencil had recorded a rise and fall of about 2 inches. This is not a motion like the ordinary wind-made waves, which pass by in two or three seconds, but a slow and gradual rise, occupying an hour, and then a corresponding fall in about the same time, to do which a current must first have set from north to south for an hour, and then reversed; and if we consider for a moment the force necessary to put a body of water 18 miles long, 5 wide, and 15 or 20 feet deep, in such motion, we shall get some idea of the magnitude of the forces at work. The record had not been going 24 hours when it became obvious that these periodic motions in the level of the water had a period of about two hours, and on the afternoon of the second day a heavy thunderstorm passed over the south end of the lake, and threw a little light on the cause of the pulsations. The storm rain was very heavy and much of it must have run into the lake, tending to raise the waters there. With the storm there came a violent squall of wind from the south, on to the south end of the lake; in a few minutes great foam-crested waves could be seen in the middle, and the recording gauge at once showed what was the matter; the wind had blown the water away from the south end and reduced the general level 3 inches. In 10 minutes the squall was over, and the water began to recover its level, in doing which the current set towards the south end of the lake, and could be seen running past the jetty at the rate of about two miles per hour. But it did not stop when the old level was reached, the momentum carried it beyond that point, and raised the water up at the south end of the lake. Then it turned and ran back again, repeating this process time after time at intervals of about two hours, the rise and fall getting gradually less until in about eight hours the water was almost still, when suddenly, at 11.30 p.m., the water began to rise faster than ever, and in 30 minutes had risen 4 inches; it then turned and fell nearly as fast as it had risen, and reached its lowest point in 1 hour 41 minutes, having fallen exactly 6 inches. At Douglas House the night was fine and calm, without the sign of a storm. Yet it seems probable that a storm passed over the north end of the lake, and started the motion, which kept on at intervals of about two hours for 14 hours, the rise and fall gradually getting less. I was fortunate enough to be present and see so much of the record and the corresponding weather. You have no doubt noticed that one set of pulsations was started by a sudden fall, and the other by a sudden rise, in the lake, and that the impulse which caused the water to rise was greater than the other. Similar impulses have kept the lake in almost constant motion ever since, and when once under way, they will go on throughout a gale of wind with just as much regularity as in a calm. Ordinarily such a set of motions lasts 10 or 12 hours, decreasing gradually as if the friction of the water stopped it; but on several occasions they have kept on for days together. The most remarkable impulse yet recorded was on the 14th of April, when the water was remarkably still, and had been so during the 11th, 12th, and 13th. At 11 a.m. on that day Mr. Glover, who has charge of the gauge, saw a thunderstorm coming down from the north, and went into the recording-house to see its effect. The lake was rising fast, and in 30 minutes rose 4 inches; as the storm passed overhead the rising ceased, and the lake at once began to fall, getting back to its previous level in 15 minutes; passing this point it fell 2 inches more– in all 6 inches—and then began to rise again, so starting a series of pulsations that lasted five days. Rain came with this storm, and on the 14th and 15th measured by gauges at each end of the lake 1·10 inch rain fell, and this caused a rise of 1½ inches in the lake, which can be distinctly seen in the record as something independent of the pulsations. With the rain there was a strong breeze of wind, and by the third day after the water had returned to its old level, all the rain having evaporated in three days. In each of the cases I have mentioned so far the impulses seem to have been given by a sudden storm breaking over the lake, but there are other instances in which the impulse was of a totally different character, and it seems as if a small force properly managed was made to do duty for a large one, just as we should set a heavy weight suspended by a string in motion by giving it first a little push, and then adding impulse at each swing. So the force, whatever it be, which in these cases acts on the water in the lake, gives it a little start and gradually gets it in motion. The best instance of this occurred on the afternoon of April 5, at the time the lake was very quiet, and suddenly the water rose an inch, and fell again within 30 minutes; next time it rose an inch and a half, and fell 2 inches in three-quarters of an hour; the next time it rose 2 inches, and fell 3½ inches in an hour; it then rose 3¾ inches in 40 minutes, and so started a series of pulsations which settled down to two-hour intervals, and lasted twenty hours. Usually, the rise and fall take about equal times, but now and then the whole fall will take place in 14 or 15 minutes, and the corresponding rise takes 116 minutes, and it is not very unusual to find one in a set of twice the period of the others, as if one had been left out. In fact the variations in the conditions of vibration are very puzzling. With a view of finding out the most common period I have measured 54 of the best defined amongst those already recorded. Of these 33 have a period of 2 hours 11 minutes, five a period of 2 hours 5 minutes, six a period of 2 hours 17 minutes, and ten a period of 1 hour 12 minutes. The periods of those on the Lake of Geneva are 72 minutes and 35 minutes. Of those in Lake George which have a period of 2 hours 11 minutes, some are the largest yet recorded, and others only a half or a quarter of an inch rise and fall; so that there must be something which makes or tends to make the period 2 hours 11 minutes. It is noteworthy that at Lake George as well as the Lake of Geneva, the short seich is not half the long one; but they bear about the same proportion one to the other in each case. As to the cause of these motions in the lake I am not prepared to say much at present. Further investigation is needed, and I hope, by the aid of a recording aneroid already there, and a recording anemometer to be erected shortly, to be able to compare the changes of wind and pressure with the changes in the lake; but I do not expect to find everything. Changes of level, &c., are going on in the earth surface, which, from an astronomical point of view, are intensely interesting, because they affect the instruments, and therefore the measures. They are very minute, and we have no means of keeping a continuous record of them; but it is possible that if such changes affect the lake they will be so magnified by its comparatively enormous extent as to show themselves on the recording instruments there. The baragraph at Sydney has shown long since that thunderstorms come on with a sudden rise of the barometer, which at times amounts to a tenth of an inch. If such a change could affect one end of the lake for a few minutes it would be equivalent to putting suddenly on to it an inch of water, which would make itself known at once by a rush to the other end; but although such changes must have some effect, I do not think it can be considerable, because, as I have elsewhere shown, these storms move at the rate of about 60 miles per hour, and are often 70 miles wide, so that such a storm coming on to the lake would spread all over it too rapidly to cause much motion in the water. I am here assuming that the storms there are of the same character as those which pass over Sydney, but they may be smaller when passing the lake, and travel more slowly. Certainly the storm which I saw coming down the lake did not traval with anything like such velocity. M. Vaucher, who studied for years the motions of the same kind which take place in the Lake of Geneva, considered himself justified in saying: "The lake is disturbed when the barometer is unsteady, and because of the varying pressure." From what I have seen so far, the first part of this is true of Lake George, but it is not because the barometer is unsteady, but because at such times the wind is puffy and variable, and imparts to the water its own peculiarity. Of the power of the wind to set the water in motion I have mentioned several instances to-night, which I need not repeat, but I may add that the large impulses come from the north, because, as it seems to me, the wind from that direction acting on the water, the whole length of the lake has greater power than when blowing from the south over a short stretch of water, the gauge is fixed about a mile from the south end. But, although the wind is such an obvious cause of the phenomena under discussion, I think the barometric changes have some share in it, and there are some changes recorded which, so far, I am unable to refer to any cause. Mr. Russell then entered into details of the surroundings of Lake George, which, he stated, are of very great interest, viewed in the light of discussions as to the possible change in the amount of rainfall in the colony during long periods. The persistence of level in Lake George, he pointed out, is very strong evidence in favour of the view that there has been no great change in the rainfall there for thousands of years, and probably the same may be said of Australia. The rainfall on the lake in 1870, Mr. Russell said, was 50 inches, double the average rainfall, which is 25 inches, and it is not to be wondered at that the lake rose at an unusual rate. Still this rain, heavy as it was, only served to cut little gutters in the older deposits which had been brought down the gullies. The primary object in placing the recording gauge on Lake George was to ascertain the rate of evaporation from such a large body of water, the conditions at the lake being very favourable for such an investigation. The record began on February 18, and the time since is too short to justify any assumption of the rate of evaporation there; but I may mention some of the facts that have been recorded bearing upon this question. In 68 days the level of the lake has fallen 7 inches by evaporation; in this interval, according to the records of rain-gauges at each end of the lake, 3·55 inches of rain has fallen, so that, ignoring the water which may have run from the hills during these rains, the lake has lost all the rain falling into it and 7 inches more, that is, 10½ inches. During the past 14 years the lake has lost by evaporation 12 feet; and in May, 1878, the railway survey carried down the western side showed that the lake was then

6 feet below its 1871 level, or 2225 feet above the sea. It appears, therefore, that in 7 years, 1871 to 1878, the lake lost 6 feet; and again, from May, 1878, to February, 1885, say seven years, the lake again lost 6 feet by evaporation, and this of course in addition to all the rain which fell during that period. Taking the records at Goulburn and Gungahleen, near the lake, the average rainfall for the first 7 years was 27·95 inches, and during the next 7 years 23·68 inches. One would expect to find more evaporation during the drier years, but this is not borne out by observations. From the rainfall and recorded evaporation the lake, therefore, lost by evaporation at least 3 feet per annum. I say at least, because some rain water must have run into the lake in addition to that which fell into it directly, but its amount cannot be determined. In future the recording gauge will determine this, and perhaps then we may apply the experience gained to estimating how much ran in during the past fourteen years. Lake George is called a fresh-water lake, and some have even gone so far as to propose to use it as a reservoir for the supply of towns. When there I ascertained that no one could use the water on account of its purgative properties, one glass full being quite enough to satisfy those who made use of it; and it is there said that the water running into the lake from the Currawang copper mine had poisoned all the fish. This is not literally true, for there are still fish in the lake; but very many were killed some years [since, presumably by the cause mentioned. I obtained some of the water, and am indebted to Mr. Dixon, of the Technical College Laboratory, for the following interesting information as to what the water contains:—It is quite evident that with 187·5 grains of mineral matter per gallon the water cannot be used for domestic purposes, and from the fact that this matter is constantly being added to, it cannot improve, unless it were possible to withdraw large quantities of the water, and supply its place with rain-water; but during by far the greater number of years during which the lake has been known, viz., 64 years, the supply of rain-water going into it annually has not been equal to the evaporation, and there is no other outlet. After the great flood of 1870 the lake, during the last 14 years, has gradually decreased by nearly a foot per annum, and similar conditions existed before; and it is therefore obvious that it would not be possible to wash out the salts with rain-water and artificial drainage except in wet years—perhape once in 20 years. Extract Mining Department's report, 1880:—'Three samples of water from the Currawang Copper mines were sent for analysis, with special reference to their poisonous action on the fish in Lake George, and were therefore only examined with regard to the metals in solution. The metals were present as sulphates, and are stated below:—Water from the creek contains: Sulphate of copper, 1·12 grains per gallon; sulphate of zinc, 16·78 grains per gallon; sulphate of iron, 0·43 grains per gallon. Water from the working shaft: Sulphate of copper, 17·67 grains per gallon; sulphate of zinc, 53·54 grains per gallon; sulphate of iron, 1·42 grains per gallon. Water from the old shaft: Sulphate of copper, 6·42 grains per gallon; sulphate of zinc, 7·20 grains per gallon; sulphate of iron, 0·98 grains per gallon.' This water would necessarily be poisonous to fish, and flowing into a lake without outlet, would ultimately render the whole water poisonous. 'Technical College Laboratory, Sydney, 2nd May, 1885. My dear Mr. Russell,—The water from Lake George contains 187·5 grains per gallon of solid matter dried at 212° F. The residue has a strongly alkaline reaction, effervesces with acid, blackens much on ignition, but does not show the presence of nitrates in doing so. The metals present are aluminium, calcium, and magnesium; the acids chlorine, carbonic acid, sulphuric acid, and phosphoric acid, the last two in small quantity. The salts are probably arranged as chloride of sodium, sulphate of sodium, phosphate of sodium, carbonate of sodium, and carbonates of calcium and magnesium. The purgative properties of the water are probably due to the salts as a whole, and especially the carbonate of magnesia. It should be borne in mind, however, that waters containing much organic matter frequently have a purgative effect.—Signed, W. A. DIXON. P.S.—Zinc and copper are entirely absent.'"

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

SCIENCE AND ART DEPARTMENT.—The following Prizes, Scholarships, Associateships, &c., have been awarded in connection with the Normal School of Science and Royal School of Mines, South Kensington.

First Year's Scholarships: — James Rodger, Andrew McWilliam, Tom. H. Denning, John Richards.

Second Year's Scholarships:—Arthur E. Sutton, Thomas Rose.

The following Prizes were also awarded:—Alfred V. Jennings, the "Edward Forbes" Medal and Prize of Books for Biology; Arthur E. Sutton, the "Murchison Medal" and Prize of Books for Geology; and the "Tyndall Prize" of Books for Physics, Course I.; Henry G. Graves, the "De la Beche" Medal for Mining; John C. Little and James Allen, "Bessemer" Medals with Prizes of Books from Prof. W. Chandler Roberts for Metallurgy; Arthur W. Bishop and Peter S. Buik, the "Hodgkinson" Prizes for Chemistry.

Associateships, Normal School of Science:—Isaac T. Walls (Chemistry, 2nd Class); Alfred Fowler (Mechanics, 1st Class); George H. Wyatt (Physics, 2nd Class); Martin F. Woodward (Biology, 1st Class).

Associateships, Royal School of Mines:—John C. Little (Metallurgy, 1st Class); Thomas A. Rickard (Metallurgy, 1st Class); Percy E. O. Carr (Metallurgy, 1st Class); Walter A. A. Dowden (Metallurgy, 2nd Class); Henry G. Graves (Mining, 1st Class); Ernest Woakes (Mining, 1st Class).

DR. REDWOOD has retired as Emeritus Professor from the Chair of Chemistry at the Pharmaceutical Society. The vacancy has been filled by the appointment of Mr. Wyndham Dunstan, Demonstrator of Chemistry in the University Museum of Oxford.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, May 21.—A science of criminal legislation in connection with the projected Italian Penal Code, by E. A. Buccellati.—Note on the inscribed Etruscan arms and mirrors in the Fol Museum, Geneva, by Prof. E. Lattes.—The system of projected homogeneous co-ordinates for the elements of ordinary space, by Prof. F. Aschieri.—On the separation of cream from milk, and the conditions tending to accelerate the process, by Prof. G. Morosini.—Further researches on the functions that satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—Remarks on the Mexican skulls deposited in the Civic Museum, Milan, by E. A. Verga.—Meteorological observations made at the Brera Observatory, Milan, during the month of May.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"A Memoir introductory to a General Theory of Mathematical Form." By A. B. Kempe, M.A., F.R.S.

The object of the memoir is the treatment of the "necessary matter" of exact or mathematical thought as a connected whole; the separation of its essential elements from the accidental clothing—algebraical, geometrical, logical, &c.—in which they are usually presented for consideration; and the indication of that to which the infinite variety which those elements exhibit is due.

The memoir opens with the statement of certain fundamental principles, viz.:—Whatever may be the true nature of things and of the conceptions which we have of them (as to which points we are not concerned in the memoir to inquire) in the operations of reasoning they are dealt with as a number of distinct entities or *units*.

These units come under consideration in a variety of guises—as points, lines, statements, relationships, arrangements, intervals or periods of time, algebraical expressions, &c., &c.—occupy various positions, and are otherwise variously circumstanced. Thus, while some units are undistinguished from each other, others are by these] peculiarities rendered distinguishable. For example, the angular points of a square are distinguishable from the sides, but are not distinguishable from each other. In some instances where distinctions exist they are ignored as not material. Both cases are included in the general statement that some units are distinguished from each other and some are not.

In like manner some *pairs* of units are distinguished from each other while others are not. Pairs may be distinguished even though the units composing them are not. Thus the angular points of a square are undistinguishable from each other, and a pair of such points lying at the extremities of a side are undistinguishable from the three other like pairs, but are distinguishable from the two pairs formed by taking angular points at the extremities of a diagonal, which pairs again are undistinguishable from each other. Further, a pair, *ab*, may sometimes be distinguished from a pair, *ba*, though the units *a* and *b* are undistinguished. Thus if *a*, *b*, *c* be the angular points of an equilateral triangle, and barbs be drawn on the sides pointing from *a* to *b*, from *b* to *c*, and from *c* to *a* respectively, the angular points *a*, *b*, *c* will be undistinguished from each other; each has an arrow proceeding from it and to it, but the pair *ab* is distinguished from the pair *ba*, for an arrow proceeds from *a* to *b*, but none from *b* to *a*.

In the same way we have distinguished and undistinguished triads, tetrads, &c.

Every collection of units has a definite *form*, due—(1) to the number of its component units, and (2) to the way in which the distinguished and undistinguished units, pairs, triads, &c., are distributed through the collection. Two collections of the same number of units, but having different *distributions*, will be of different forms. The angular points of a cube and of a regular plane octagon furnish examples of two systems of eight units, having different distributions. In the former case there are three sorts of pairs, in the latter four.

Each of the forms which a system of *n* units can assume owing to varieties of distribution is one of a definite number of possible forms, and the peculiarities and properties of the collection depend, as far as the processes of reasoning are concerned, upon the particular form it assumes, and are independent of the dress—geometrical, logical, algebraical, &c.—in which it is presented; so that two systems which are of the same form have precisely the same properties, although the garbs in which they are severally clothed may by their dissimilarity lead us to place the systems under very different categories, and even to regard them as belonging to "different branches of science."

It may seem in some cases that other considerations are involved besides "form," but it will be found on investigation that the introduction of such considerations involves also the introduction of fresh units, and then we have merely to consider the form of the enlarged collection.

Taking these principles as a basis, the memoir, which is a lengthy one of 426 sections arranged under 42 heads, discusses the various forms which systems can assume, and gives some general modes, graphical and literal, of representing them. The genesis of algebras is considered, and the nature of the particular forms dealt with in geometry, ordinary algebra, formal logic, and other cases, is specified.

Zoological Society, June 16.—Prof. W. H. Flower, President, in the chair.—The Secretary read some extracts from a letter addressed to him by Mr. J. Buttikofer, of the Leyden Museum, calling attention to a paper published in 1857 by the late Dr. Bernstein, concerning the material of which the edible birds' nests of *Collocalia esculenta* are composed.—A letter was read from Major-General Sir Peter Lumsden, K.C.B., giving details of the place and time of capture of two young Snow-Leopards sent down from the Afghan frontier to Quettah, and intended for the Society's collection.—Mr. Oldfield Thomas exhibited and remarked on a specimen of a rare burrowing Rodent (*Heterocephalus glaber*) procured by Mr. E. Lort Phillips during his recent expedition in Somaliland, remarkable for having an almost completely naked skin, and for its extraordinary habits.—Dr. Guillemard exhibited a series of eight skulls of the Kamtschatkan Wild Sheep (*Ovis nivicola*), pointing out the difference existing between it and *O. canadensis*.—Mr. W. T. Blanford exhibited the skull and an imperfect skin of a supposed new species of *Paradoxurus* from the Pulnai Hills, Southern India.—A communication was read from Dr. G. Hartlaub, F.M.Z.S., giving an account of a new species of Parrot of the genus *Psittacula* recently received from Barranquilla, U.S. of Colombia, which he proposed to describe as *Psittacula spengeli*.—Dr. Guillemard, F.Z.S., read the sixth part of his report on the collection of birds formed during the voyage of the yacht *Marchesa*. The present communication treated of the birds collected in New Guinea and the Papuan Islands.—Dr. Guillemard also exhibited a very fine series of Paradiseidæ obtained during the yacht's voyage.—Mr. G. A. Boulenger read a paper containing a description of the German River-Frog (*Rana esculenta*, var. *ridibunda*, Pallas).—Mr. P. L. Sclater read the description of a new species of *Icterus*, obtained by Mr. Hauxwell on the Upper Amazons, which he proposed to name *I. hauxwelli*.—A second paper by Mr. Sclater contained notes on the way in which *Lemur macaco* carries its young, as observed in a specimen living in the Society's Gardens.—Mr. A. D. Bartlett read some notes on the female Chimpanzee now living in the Society's Gardens, which he showed to be different from the ordinary Chimpanzee, and to be probably the *Troglodytes calvus* of Du Chaillu.—Dr. Gadow, C.M.Z.S., communicated a memoir by Miss Beatrice Lindsay, of Girton College, Cambridge, upon the Avian Sternum. The different theories held as to the origin of the sternum having been reviewed, the author proceeded, after an explanation of the various types of structure examined, to give an account of her own views. Miss Lindsay came to the conclusion that the keel is an apophysis of the two halves of the sternum, and is not produced by the clavicles or any other parts belonging to the shoulder-girdle; also that the part of the sternum whereof the keel is an outgrowth is itself of secondary origin, and that the various processes of the sternum are produced by addition and not by resorption of bony matter.—Col. J. Biddulph read a paper on the Rocky Mountain Sheep, in reference to the new geographical race lately named by Mr. Nelson *Ovis montana dalli*, and confirming the view that there are two distinct types or races of this sheep in North America.

Geological Society, June 10.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Dr. A. G. Nathorst, of Stockholm, was proposed as a Foreign Correspondent of this Society.—The following communications were read:—Note on the sternal apparatus in *Iguanodon*, by J. W. Hulke, F.R.S., V.P.G.S.—The Lower Palæozoic rocks of the neighbourhood of Haverfordwest, by J. E. Marr, F.G.S., and T. Roberts, F.G.S.—On certain fossiliferous nodules and fragments of hæmatite (sometimes magnetite) from the (so-called) Permian breccias of Leicestershire and South Derbyshire, by W. S. Gresley, F.G.S.

SYDNEY

Linnean Society of New South Wales, April 29.—Dr. James C. Cox, F.L.S., Vice-President, in the chair.—The following papers were read:—Revision of the genus *Lamprima*, with descriptions of new species, by William Macleay, F.L.S.—Notes on the zoology of the Maclay Coast, New Guinea, by N. de Miklouho-Maclay. This paper consists of a carefully detailed account and description of a rare species of *Macropus*, to which the Baron gives the specific name of *Tibol*, the native name for the animal. A plate accompanies the paper.—On two new species of *Dorcopsis* from the south coast of New Guinea, by N. de Miklouho-Maclay. This contains descriptions and illustrations of *Dorcopsis macleayi* and *D beccari*, two new species in the Macleay Museum. This brings the number of known species of the genus up to five.—The Australian sponges recently described by Carter, by R. von Lendenfeld, Ph.D.—On the fertilisation of *Goodenia hederacea*, by Alex. G. Hamilton.—Notes on the habits of *Falco subniger* and *Glareola grallaria*, by K. H. Bennett.—The geology of Dubbo, by the Rev. J. Milne Curran.—Dr. J. C. Cox exhibited a sandstone nodule, the outer crust of which to a considerable depth was stained with iron, the original colour, as shown by the central portion, having been white. Also a large *Cephalopod*, belonging to the family *Sepiidæ* and genus *Sepia*, which had been recently presented to the Australian Museum by the Hon. William Macleay. This unique specimen is about three feet long from the hinder part to the apex of the arms; the body is about eighteen inches long, and eighteen inches broad, deeply notched at the lower margin, and peaked in the centre at the neck, and arched on each side; the head is about eighteen inches from the body to the apex of the arms. It is of a dark brown olive colour, quite smooth, the tentacles are about two feet long, the cups on the arms do not correspond with any known species, nor do the cups on the tentacles; it is very like *Sepia tuberculata* of Lamarck, but no tubercles exist on the surface, and it is much longer. *Sepia vermiculata* of Quoy and Gaim. is very like it, but is only fifteen inches long; most of the species, however, of the genus have been described from the shell.

PARIS

Academy of Sciences, June 29.—M. Bouley, President, in the chair—Remarks on Poinsot's theory, and on two movements corresponding to the same polhodie, by M. G. Darboux.—On Palmieri's experiments relative to atmospheric electricity, by M. Faye.—Remarks on the same subject by M. Mascart.—Researches on isomery in the aromatic series. Heat of neutralisation of the oxybenzoic acids, by MM. Berthelot and Werner.

—Note on the monument to be erected to the memory of Nicolas Leblanc, inventor of artificial soda, by M. Eug. Peligot. For various reasons it has been decided to place in the Conservatoire des Arts et Métiers the statue raised by international subscription to Leblanc. In the report of the Committee it is stated that the illustrious savant was born, not at Issoudun, as is generally supposed, but at Yvry-le-Pré, Department of the Cher, on December 6, 1742.—Note on the peculiar properties of Poinsot's "herpolhodie" curve, by M. J. N. Franke.—Remarks on the same subject, by M. Darboux.—On the reduction of the problem of the brachistochrones to canonical equations, by M. Andoyer. —On the secular variation of the magnetic declination at Rio de Janeiro, by M. Cruls.—On the crepuscular light, by M. P. J. Denza. These after-glows, which seem to have become nearly extinct during the past winter, have again begun to appear about the beginning of this summer. At Moncalieri, and in other parts of Italy and Sicily, they became very intense towards the end of May, and their brilliancy was even increased during the first days of the month of June. On the 13th especially the effects were most surprising, rivalling those witnessed during the winter of 1883. The phases of the phenomenon have also closely resembled those so often described during the periods of its greatest intensity. The author considers that all this tends more and more to confirm his own theory, that the crepuscular lights are due, not to the Krakatoa eruption, but mainly to the vapour of water disseminated throughout the higher regions of the atmosphere.—On the reappearance of the crepuscular glows, by M. A. Boillot. The author describes the effects seen at Paris on June 12 and subsequently, and also considers that their reappearance can scarcely be brought into connection with the Krakatoa eruption of August, 1883.—On the nacreous crystals of sulphur, by M. D. Gernez.—On the properties of the persulphuret of hydrogen, by M. P. Sabatier.—On the nitrate of anhydrous ammoniacal ammonia on iron, zinc, and some other metals, by M. G. Arth.—Note on the reduction of the hexatomic alcohols, by MM. J. A. Le Bel and M. Wassermann. —On a new method of preparing pyrocatechine, by M. J. Meunier.—On the action of chlorine and iodine on pilocarpine, by M. Chastaing.—Note on the quantitative analysis of the phosphoric acid present in the natural and mineral phosphates employed for manuring the soil, by M. E. Aubin.—On the development of the vascular glands in the embryo, by M. Retterer.—On a new type of Sarcosporidies, by M. R. Blanchard.—Calorimetric observations on children, by M. Ch. Richet.—New researches on the regeneration of the nerves in the periphery of animal organisms, by M. C. Vanlair.—A note on the influence of the attraction of the moon on the creation of the Gulf Stream was submitted, by M. Ch. Dufour.

Berlin

Meteorological Society, June 2.—Dr. Neuhauss communicated meteorological observations instituted by him during a voyage around the world from April to December last year. During the whole passage through the Mediterranean Sea, the Suez Canal, the Red Sea, the Indian and Pacific Ocean, he had regularly every day made observations with a compared thermometer, aneroid barometer, and psychrometer, of the temperature and the atmospheric pressure every two hours from 6 a.m. till 8 p.m., and three times a day determinations of the humidity. His attention was specially directed to determine these meteorological conditions within the tropics and more particularly in the neighbourhood of the equator. Among the more noteworthy results of these observations he showed that the daily range of temperature over the Suez Canal amounted to 29°·2 F., from a maximum of about 86°·0 to a minimum of 56°·8, while the range of temperature on the Red Sea was only about 6°·8 to 9°·0, and that on the Indian Ocean in the neighbourhood of the equator was still less. The maximum temperature under the equator amounted nearly to 99°·5, and always coincided with the culminating point of the sun. The opinion that the maximum temperature in the tropics occurred at 10 a.m. was not confirmed by the observations. What was observed on this point was simply that the maximum temperature frequently began in the region of the tropics at 10 a.m., and lasted two hours, when, from some secondary cause or other, a small abatement of only a few tenths of a degree might be observed just at 12 noon. Squalls and rain-showers were always accompanied by a sinking of temperature which occasionally showed a range of 4°·5. On his voyage from New Zealand to Hawaii in June and July Dr. Neuhauss daily observed within the tropics a constant rising of the temperature till evening, reaching the maximum between 6 and 8 p.m. On the open sea he nowhere found higher temperatures than those he had observed on first crossing the equator. The registrations of the barometer within the tropics exhibited the well-known daily oscillation of the atmospheric pressure with two maxima and two minima. The first maximum showed itself at 10 a.m., the second at 6 p.m. It was remarkable that the squalls and rain-showers did not affect the regular march of the barometer. The hygrometric observations in the tropics on the Indian Ocean yielded considerably less daily amplitudes than on the Mediterranean Sea and on the Suez Canal. The phenomena of the twilight on the Indian Ocean, whose magnificence of colour was described, were particularly beautiful. Very noteworthy were the observations on the duration of the twilight, but a regular difference between the evening and the morning twilight was not established. Their respective durations on particular days were, on the other hand, very unequal. The astronomical twilight—*i.e.* the time from sunset till the last evanescence of light in the western sky—usually lasted from an hour to an hour and a quarter. The end of the twilight at sea could be precisely determined to a second. A great charm was afforded in the observations of the zodiacal light, which Dr. Neuhauss was able to watch every morning before sunrise on the Indian Ocean. In the evening with fatigued eyes the observation of the zodiacal light was not successful. In the morning, on the other hand, the bluish-white light pyramid could be followed by the eye to the zenith. Its brightness excelled that of the brightest parts of the Milky Way; its light was quite steady without any quiverings, and thus showed no polarisation. This phenomenon, still so little understood, was recommended as an object of observation to marine officers.—Prof. Spörer described a whirlwind observed at Potsdam on April 15 at 12 noon. The air was quite still, the sky perfectly clear, when, from a grassy sward begirt by bush, an eye-witness observed the whirlwind arise. He first heard a rustling in the leaves of the shrubs, and then observed a column of dust, of about the height of the surrounding inclosures, which, on its continued movement, split into two vortices. One of these, or perhaps only a branch of one, moving onward, without leaving any traces on its way, arrived at a neighbouring garden, where, at a particular spot, it tore up and carried aloft in a whirling manner to a considerable height the windows of several hot-beds, rending them in pieces. The weight of each of these windows was about 30 lbs. Thence the whirlwind advanced towards a neighbouring garden and tore off the windows, which were open in the direction from which the whirlwind was coming. On its further course, which was marked out by a powerful rushing noise and by a very high dust-column, the whirlwind inflicted no more destruction. Prof. Spörer was of opinion that the whirlwind originated and grew in intensity over ground which was greatly heated, just as happens in volcanic outbursts and high protuberances of the sun, when in the one case ashes and in the other hydrogen are swept aloft over highly heated surfaces.

Physiological Society, June 5.—Prof. Brieger, following up his communications of a year ago, reported on his further investigations into the ptomaïnes. In his former communications the speaker had described five well-characterised bases —neurine, muscarine, neuridine, and two other diamines—extracted from the ptomaïnes, which were developed in putrefying nitrogenous substances, and in the form of beautiful crystallised salts, and had subjected them to precise chemical and physiological analysis. As the result of this analysis, neurine, muscarine, and a base similar to, but not identical with, trimethyldiamine had were found to be very violent poisons, while the two others showed themselves to be less poisonous. Seeing that the ptomaïnes must here be regarded as products o the putrefactive bacteria, Prof. Brieger set himself the task o studying the products of pathogenic bacteria. He proceeded, however, beforehand to investigate the ptomaïnes which developed under natural putrefaction in the case of human corpses, and found that here quite different bases came to light than those which appeared under artificial putrefaction. Immediately after death lecithin decomposed itself, and large quantities of choline became developed, and, along with this base, neuridine appeared on the third day of putrefaction, increasing in quantity with the progress of putrefaction. From the seventh day after death there came to view an entirely new base, which, with hydrochlorate of platinum, yielded very beautiful crystals, and, both in this connection as also in the form of hydrochlorate of gold and in its conjunction with hydrochloric acid, had been searchingly examined. This base, altogether different both in its quantities and in its composition from the bases hitherto known, was named "cadaverine." It increased in quantity with time while choline and neuridine diminished. Later on there appeared another new base which was also characterised by its hydrochlorates of platinum and gold, as likewise by its chemical composition, which the speaker called "putrescine" and was able to show in the form of beautiful crystals, both in a pure state and in the hydrochlorates of platinum and gold. Both these new bases, cadaverine as well as putrescine, acted but weakly on the animal organism. The first possessed the well-known smell of coniine, which former observers had already noticed in putrefying bodies. Besides these weakly acting nitrogenous bases, there were found in the later stages of putrefaction two diamines of very powerfully poisonous effect, which, injected even in small doses in animals experimented on, produced death under paralysis. These two were presented in distinct crystals and isolated. A survey of the whole series of isolated ptomaïnes taken from corrupting nitrogenous substances showed that, contrary to the former assumption, they were all simply compound, that they were all diamines belonging to the series of fats. Their great resemblance to vegetable alkaloids rendered it necessary that in the case of chemical investigations only such alkaloids and bases should be deemed demonstrated to exist in a dead body which had been isolated and had been presented in their characteristic salt-crystals. In the endeavour to study the bases produced by pathogenic bacilli Prof. Brieger had examined artificial cultures of bacilli, and first the typhoid bacillus on peptone. This led to no positive result. It was the culture of the typhoid bacillus on meat infusion and meat jelly which first led to the isolation of two new intensely poisonous bases, one of which, being injected in small quantities into animals, acted similarly to neurine, producing death under a strong flow of saliva, paralysis and diarrhœa, while the other produced only violent exhausting diarrhœa. The small quantities of these poisons did not yet, however, allow them to be sufficiently characterised chemically. They appeared to be triamines, and should be further investigated. The method adopted in the course of this investigation promised additional important results.—Dr. H. Virchow communicated the observations he had made on the cells of the vitreous humour, regarding which the opinion had hitherto been entertained that they were lymph cells which had emigrated from the blood vessels, and which, by reason of their amœboid movements, presented the most various forms either on the surface or in the interior of the vitreous body. Dr. Virchow had first examined the vitreous body of very different species of fish, and in the case of these animals, which were provided with vessels of the vitreous humour, he had established that the cells were perfectly fixed, invariable formations, which manifested themselves so characteristically that it was possible to distinguish the particular species by the particular form of the cells of the vitreous humour. This conclusion determined the speaker to examine the vitreous humour of other cold-blooded animals, and he chose frogs for this purpose, and had, besides, examined the vitreous body in an Alpaca sheep and in the fowl. After a description of the methods of examination he had adopted, he described minutely the forms of the cells of the vitreous body he had found in these different animals. In the case of the sheep he found them ranged only on the surface in perfectly definite order; they here consisted of small, round nuclei surrounded by large masses of protoplasm manifoldly sinuated and branched. In the case of the fowl the cells likewise lay on the surface of the vitreous body in regular arrangement. The protoplasm surrounding the nuclei was, however, in part drawn out lengthwise and branched at the ends, in part stellate, divided into thin rays, in part irregularly arranged. In the case of the frogs the greatest multiplicity of forms was met with. The cells lay either between the blood-capillaries or on them, and in this case were to be recognised only with great difficulty. The nuclei were mostly longish, and around these nuclei extended the delicate protoplasm, often spun out in fine lines of fibres between the vessels, or covering them. In the case of a few cells long processes extended from the protoplasm, of which single pieces had detached themselves. In the case of others the protoplasm had spread itself out into a very wide, uncommonly delicate film covering the vitreous body. Other cells, again, had granular protoplasm, and were either round, with a large round nucleus, or were more or less lengthened to the degree even of a filiform shape. To relate these different forms of the cells of the vitreous humour each to an integral characteristic difference in the species to which it belonged, was more than the speaker had been able to accomplish. Towards the solution of this problem further investigations would be required.—Herr Aronsohn communicated the further experiences which, in conjunction with Herr Sachs, he had collected relative to the heat-centre in the cerebrum, discovered by him last year. When on a perfectly definite part of the cerebrum he pricked with a needle so deeply as to touch the parts lying under the cortex, then he observed a rise of temperature in the rectum, in the muscles, and in the skin of from about 1° to 2° C. The prick had to touch the corpus striatum in order to produce a rise of temperature, and in point of fact it was only the median part of the corpus striatum which, on being touched, gave rise to this result. No other part, however nearly situated to this spot, could, on being touched, produce this rise of temperature. The increase of temperature continued for about three hours after the prick, and affected the two sides even when the wounding of the brain was only one-sided. Electrical stimulation of the same limited spot produced a similar result. Whether there were ganglions lying on the spot in question, which influenced the production of warmth, or whether only definite nerve-tracts were touched, was a question which could not be decided. In order to ascertain the immediate cause of the increase of temperature, experiments regarding the respiration, and determinations of the urea were simultaneously carried out. These experiments showed that immediately after the corpus striatum was pricked the inhalation of oxygen and the exhalation of carbonic acid were increased, and that the secretion of urea was augmented. It was therefore clear that an increase in the metabolism generally followed the prick, an increase which, in the opinion of the speaker, was due to the heightened innervation of the muscular system caused by the prick or the electrical stimulation.

CONTENTS

THURSDAY, JULY 16, 1885

THE BIRDS OF LANCASHIRE

The Birds of Lancashire. By F. S. Mitchell, M.B.O.U. Illustrated by J. G. Keulemans, Victor Prout, &c. Pp. xviii. 224. (London: Van Voorst, 1885.)

IMPORTANT as are the services which the writers of county faunas have rendered to the study of British ornithology every one knows, or ought to know, that such works have a very variable value. In some cases the geographical position of the county concerned is such as to invest its avifauna with high interest quite apart from the manner of its treatment, which may be, and in a few instances that we could but will not name, has been of a slovenly character. Or again, local considerations may be comparatively insignificant, and yet the book, from the combined knowledge and skill of the author, will be a great and positive gain to zoological literature. Thus it follows that the most pretentious works not unfrequently fall short of even a moderate standard of excellence, while that is attained or even surpassed by others put forward with unpresuming modesty. It gives us great pleasure to express our opinion that the little book now before us, "The Birds of Lancashire," falls well within the latter category. Its author, Mr. Frederick Shaw Mitchell, is known to have been engaged in its preparation for several years, and that he has used those years of preparation to good purpose almost every page in the book testifies. We have especially to commend his introductory remarks, which prove that he has taken the proper and philosophical view of the duties of a faunistic monographer, while the rest of the book shows how efficiently he has discharged them according to that view.

In these days the county of Lancaster, or at least its southern half, with its swarming population, its tall chimneys expelling tons upon tons of soot, and, still worse, volumes of noxious vapours, its once limpid streams drunk up by countless manufactories and returned to their channels befouled with deleterious compounds, presents almost as poor a field for the outdoor naturalist as can well be found in the United Kingdom. Nor does its geographical situation offer the ornithologist much promise for the pursuit of his study. Its coast-line, though extensive as that of English counties goes, is formed by the recess of a land-locked sea; and notwithstanding that as yet we really know little of the routes taken by birds in their migrations, there is nothing to induce the belief that any much-frequented route will be found to skirt Morecambe Bay, the sand-hills of Blackpool, or the estuaries of the Ribble and the Mersey. Nor do the hills of its interior, though rising to the height of nearly 2000 feet, and even exceeding that in the northern detached district of Furness, which contains the much admired Coniston Water and Windermere, add greatly to the attractiveness of a county which has the disadvantage of lying on the wrong side of our island—for we take it to be undeniable that in England birds, both as individuals and as species, decrease in number as we pass from the eastern to the western coast.

"The vast increase of population, and the scientific farming which drains every marsh, substitutes for every bosky nook a rigid bank and paling mathematically drawn, are the chief causes of the decrease both in species and individuals which has taken place in the manufacturing districts; but it is astonishing how many still flourish among the teeming millions which dwell there, and should it be possible for air and water to become more pure, there is no doubt that, except in the immediate vicinity of buildings, little further diminution would occur.

"The way in which birds are driven away by the extension of buildings, and by the conversion of a rural into an urban locality, may well be instanced by the case of Peel Park, Salford, which is one in point. Mr. John Plant has kindly permitted me to use his notes, which have been carefully kept since 1850, and which show the following results:—

	Personally observed.	Breeding.
1850–60	71 species	34 species
1860–70	42 ,,	— ,,
1870–75	19 ,,	8 ,,
1876–80	15 ,,	— ,,
1881	13 ,,	— ,,
1882	5 ,,	2[1] ,,

Mr. Plant considers that the main causes are not so much simply the presence of more people and greater disturbance by them, as the destruction of natural food, and loss of protective foliage, from the vitiated atmosphere, and makes the melancholy prophecy that, if the same thing goes on for another ten years, there will not be a large tree alive in the park."—*Introductory*, p. iii.

Yet Mr. Mitchell does not think that on the whole birds in Lancashire are decreasing, and remarks that "the greater scarcity of the Goldfinch, for instance, which feeds on the thistles of waste lands, is balanced by the greater plentifulness of the Hawfinch, which prefers a more cultivated country." The extensive range and increasing numbers of the species last mentioned of late years throughout the whole of England is indeed a matter that is at present quite unaccountable. But Mr. Mitchell goes on to say that "if the game-preserver will lay aside some of his truculence in respect of species which occasionally diminish his stock, if the denizens of towns will discourage the bird-catching fraternity, and be content to only hear the Linnet and the Bullfinch in their natural haunts, and if the specimen hunter will try to be content with skins which are not *local*, there is no reason to expect any approach to extinction of species which are now on the list." Here we would remark that not much harm comes from bird-catching if the law now existing be obeyed, and that without it few "denizens of towns" would ever hear the song of any bird; but we quite agree with what our author says as to the game-preserver and skin-collector. From the results of somewhat extensive observation in many parts of England it is clear that the absolute extermination of both Kestrel and Sparrow-Hawk—the last of the birds-of-prey which can be said to inhabit this country generally—will be accomplished in a very few years, and even our three species of Owl—in spite of the Act which nominally protects them—are likely to suffer the same fate. Mr. Mitchell no doubt recognises the fact, as every impartial observer must do, that, birds-of-prey excepted, the system of strict game-preserving affords an incalculable amount of protection to all other birds; but the "local specimen-hunter" is usually a pestilent character indeed—one who without any counterbalancing merit simply flatters his own vanity, degrades an interesting not

[1] Starling and House Sparrow.

to say instructive study, and induces his fellow-subjects to break the law by the price he offers for his "rarities."

Passing to another part of our theme we wish to mention our author's remarks on the valueless nature of nearly all the ordinary records with regard to the migrations of birds. Many we are sure must have felt the truth of the following statements; but we do not recollect having before seen it so explicitly put forth, and congratulate Mr. Mitchell on perceiving its importance. He says:—

"The fact is, that very few of the observations, now so numerously made, as to the movements of summer migrants, are worth anything at all; and if data are to be collected on land of value commensurate with those now being collected on information from lighthouses, &c., by the committee appointed by the British Association, it will be necessary for the observer to fulfil something like the following conditions: firstly, that he should be continuously engaged out of doors; secondly, that he should be entirely familiar, not only with the plumage of the birds, but that he should be able to recognise most of them when flying, and be thoroughly acquainted with their song, their call and alarm notes; and thirdly, that he should have a knowledge of the food requirements of each species, and be able, for instance, to infer, from the plentifulness of such and such an insect, that such and such a bird may be expected to feed on it. Such a conjunction can only be found in few individuals; but if every man in his leisure field-walks would, and especially in connection with meteorological conditions, note the other natural circumstances at the time of his first seeing a spring arrival, a mass of information would be got together, invaluable for the discovery of the laws of geographical distribution; and until something of the sort is done, and such information sifted and compared, I believe those laws will remain, as they are now, dubious and conjectural."—*Introductory*, pp. ix. x.

In the bibliographical portion of his work Mr. Mitchell shows himself to be well read, and the selections he makes from the writings of his predecessors seem to be exceedingly judicious. If he errs at all, which we do not say is the case, it is on the side of conciseness, and we can imagine that many readers who have not access to a good library would be better pleased had his extracts occasionally been longer, so that, should his little book reach a second edition, as it well deserves to do, this point might be borne in mind by the author; though we cannot find it in ourselves to blame him on this account, knowing the tendency to superfluity which prevails among the ornithological writers of the present day. One unquestionable merit Mr. Mitchell possesses. He is free from the wish to exaggerate the importance of his subject, and is certainly not bent on making out a numerous list of the birds of his county, as so many compilers of local faunas have done, by giving fresh life to the most doubtful reports which profess to record impossibilities. In one case, indeed, he seems to us to have transgressed; but he may be pardoned for not being aware of the profound mistrust that was entertained nearly five-and-twenty years since by well-informed persons in regard to some statements that were then made in a certain auction-catalogue. The Swallow-tailed Kite should disappear from his list. Lancashire, however, indubitably boasts the possession of the only existing "British-killed" specimens of the Black-throated Wheatear and the Wall-Creeper—though an example of the latter is known to have been obtained in Norfolk nearly one hundred years ago—and accordingly a coloured figure (by Mr. Keulemans) of each of these species is introduced. Some carefully drawn illustrations of decoys, as well as several other ingenious modes of netting or snaring wild birds, are also given, and these add not a little to the interest of the book; for, with the exception of the plates in Rowley's not very accessible "Ornithological Miscellany," we are not aware of any representation of the mode of capture by "fly-nets," while we think neither the "douker-net" nor the "snipe-pantle" has ever been figured before; and with respect to this last term, which Mr. Mitchell derives "from the Anglo-Norman 'panter = a net or snare,'" we may observe that Olina in 1622, and Willughby after him, calls a certain kind of net used in taking starlings, woodcocks, and other birds *pantiera*—a word which seems to exist now in Italian as *pantera*.[1] Of course a work on the birds of Lancashire could not be complete without a reference to Gerarde and the Pile of Foulders, whereon bernacles turned to geese; but we are glad to see that Mr. Mitchell abstains from sneering at the old herbalist's credulity, as so many modern writers have done, though we must point out to him that in these days to speak of a bernacle as "a species of multivalve" is to use a somewhat vague if not inaccurate expression. Let us add that a map of the county and, so far as we have tested it, an excellent index are among the merits of this satisfactory little book.

A CATALOGUE OF CANADIAN PLANTS

Geological and Natural History Survey of Canada. Alfred R. C. Selwyn, LL.D., F.R.S., F.G.S., Director. "Catalogue of Canadian Plants. Part II. Gamopetalæ." By John Macoun, M.A., F.L.S., F.R.S.C. 8vo, 200 pp. (Montreal: Dawson Brothers, 1884.)

ALTHOUGH this is only a catalogue of names and localities, it is a work of much interest and one that has been greatly needed by European botanists and botanical geographers. The flora of the north temperate zone in both hemispheres is so very similar in general character that nearly half of the genera of the Canadian area and a large number of the species reach to it all the way from Britain across Europe and through Siberia, and the remarkable longitudinal differentiation of the flora of the United States renders it a matter of much interest to be able to trace out the dispersion of the species through the more northern areas of the Continent. The "Flora Boreali-Americana" of Sir Wm. Hooker is now forty years old, and all that has since been worked out about the Canadian species and their distribution has never been put together and published so that it was available for general use. The first portion of the present Catalogue, which was issued in 1883, contained the Polypetalous natural orders; including naturalisations the number of Polypetalous genera was 243, and of species 907. The present part contains the Gamopetalæ, and carries up the number of genera to 498, and of species to 1811. So that the total number of flowering plants now known in British North America may be estimated at about 3000 species against 10,000 or 12,000 now known in the United States. One of the most remarkable points

[1] See also Prof. Skeat's "Etymological Dictionary" (p. 415) *sub voce* "Painter," for instances of its use by Chaucer and others.

about the Canadian flora is how extremely few species enter into it that are not found in the United States. The general question of the characteristics of the North American flora was fully discussed by Dr. Asa Gray in an address to the biological section of the British Association at Montreal, which was published in the issue for November, 1884, of the *American Journal of Science*. Two of its leading characteristics as compared with Europe are the abundant development of peculiar types of Compositæ and Ericaceæ. It is to this present catalogue that we must turn for full details on such matters as these in application to the northern area. One of the most curious instances of a locality for a well-marked plant widely distant from its main area is furnished by the occurrence of *Calluna vulgaris* in very small quantity in Newfoundland, Cape Breton Island, and Nova Scotia. It is not known on the American continent, and the genus *Erica* is entirely absent. A large number of common European plants, such as *Bellis perennis*, *Chrysanthemum Leucanthemum*, *Tussilago Farfara*, *Hyoscyamus niger*, and *Anagallis arvensis* are fully naturalised in Canada. Some British species, such as *Gentiana Amarella* and *Hieracium umbellatum* are represented in Canada by varieties mostly readily distinguishable from the European type. Of plants alpine in their European range which are widely spread in British North America we have instances in *Loiseleuria procumbens*, *Arctostaphyllos alpina*, *Linnæa borealis*, *Lobelia Dortmanna*, *Vaccinium uliginosum*, and *V. Vitis-idæa;* and of plants of wide European and British dispersion at a lower level in *Campanula rotundifolia*, *Achillea Millefolium*, *Viburnum Opulus*, *Pyrola minor*, and *Andromeda polifolia*. Mr. Macoun has consulted Dr. Asa Gray and Dr. Sereno Watson on all points of doubtful identification, and used the same nomenclature and standard of specific limitation.

J. G. 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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Zoology of Dr. Riebeck's "Chittagong Hill Tribes." —The Gayal and Gaur

In NATURE for June 25 (*ante*, p. 169) there appeared a review of the late Dr. Emil Riebeck's "Chittagong Hill Tribes." The contributions of the specialists who are entitled "the foremost naturalists of Germany" are mentioned as "separate monographs of great value."

This is no stinted praise, and as one of the separate monographs, that on the zoology, by Dr. Julius Kuhn, is especially noticed, I took the earliest opportunity of reading what I anticipated would prove a very interesting essay on the fauna of a rather imperfectly-known region.

I will only say that I was disappointed. The zoological "monograph" consists of four pages, two and a half of which are taken up by Dr. Kuhn's remarks on the gayal and gaur. These are the only portions deserving notice; the remaining page and a half contain notes, all trivial, and some seriously incorrect, on skulls of a rhinoceros, a bear, and a monkey, of only one of which a specific determination is attempted, and in that instance the name given is, I believe, wrong. Perhaps these notes are not by Dr. Kuhn, for his observations on the gayal (*Bos frontalis*, var. *gavæus*) and the gaur (*B. gaurus*, var. *cavifrons*) show some acquaintance, though an imperfect one, with the literature of the subject. Your reviewer credits Dr. Kuhn with the discovery that "the gayal or wild ox of Bengal, Assam, and Further India does not differ specifically from the gaur of India proper," and Dr. Kuhn writes apparently under the impression that the occurrence of the gaur east of the Bay of Bengal is not known. The range of the gaur throughout Assam, Tipporah, Chittagong, Burmah, and the Malay peninsula has, however, been well known for thirty years at least, and has been repeatedly described by Cantor, Blyth, Jordon, and other naturalists, whilst the head of a Tenasserim gaur was well figured nearly fifty years ago in the *Journal* of the Royal Asiatic Society (vol. iii., 1836, p. 50). The fact that the wild gaur is called gayal by the natives of some parts of India is also not new. The name by which the tame gayal, *Bos frontalis*, is generally known in the country is not *gayal*, but *mithan*.

Dr. Kuhn's principal object is to show that the gayal may be a domesticated race of the gaur. It would be impossible to do justice to the subject without going into considerable detail, but the first stage in the inquiry is one to which no reference is made by Dr. Kuhn. This is the question whether *Bos frontalis*, the gayal, exists as a distinct species in the wild state, as stated by Lambert, Colebrooke, Horsfield, Blyth, and others, or whether; as lately urged by Mr. J. Sachs (*Proc.* Z. S., 1883, p. 142), there is no such thing as a wild gayal. A very valuable contribution to the history of these animals was published twenty-five years ago by Blyth in the *Journal* of the Asiatic Society of Bengal, vol. xxix. p. 282, in a paper "On the Flat-horned Taurine Cattle of South-East Asia." This paper was, I think, subsequently republished in either *Land and Water* or the *Field*, but I am not certain. One most important circumstance mentioned by Blyth on apparently excellent authority is that the gaur is kept tame in the interior of the Chittagong hills, and, as a tame animal, is quite distinct from *Bos frontalis*. If this is the case hybrids are very likely to occur, for the gayal breeds freely with the much less nearly allied zebu, and such hybrids may account for the occurrence of forms intermediate between the gayal and gaur. An indication that such forms exist is, so far as I can see, the only evidence brought forward by Dr. Kuhn in favour of the gayal being a domesticated race of the gaur, his main argument; his supposed discovery that the tame gayal and wild gaur inhabit the same country being a singularly fine example of a *nidus equinæ*.

It will, I hope, be understood that these observations apply solely to the zoological portion of Dr. Riebeck's work; though, in connection with this, in another part of the book, I remark that Plate 14, Fig. 2, which represents a rodent's—probably a squirrel's—skull, is called in the explanation of the plate "the skull of a musk-deer"! Your reviewer's opinion of the work is doubtless founded on the anthropological and ethnological portions; I only dissent from the views expressed as to the zoological monograph.

W. T. BLANFORD

July 11

"The Fauna of the Seashore"

IN the abstract of Prof. Moseley's interesting lecture on "The Fauna of the Seashore," published in the current number of NATURE (p. 212) several agents are referred to as competent to call into play the tendencies to vary which are embodied in each species. These, whether suggested by Prof. Lovén or the author of the lecture, include—light and shade, temperature, currents, food, enemies, favourable condition of water for respiration, and the variation of conditions produced by tides. I venture to think that one very important factor in the variation of the marine fauna, if not the most important, has been left out of the list: I refer to marine waves.

The action of waves on the littoral fauna is not only extremely severe, but it is of constant recurrence; and failure to resist it does not merely involve some minor disadvantage or inconvenience to the object attacked, but its very existence.

A point commonly overlooked by naturalists is the severity of the wave-action arising from the reciprocal character of the wave-currents. Human bipeds occasionally experience the inconvenience of a shifting current when encountering opposing blasts of wind at some street corner during a gale. The marine littoral fauna, living in a much denser medium, encounter two analogous currents for every passing wave heavy enough to affect the bottom, and have to encounter these currents without cessation for the days or weeks the storm may last. Any failure to resist this inexorable enemy on the part of the shallow water denizens of the sea or any encroachment on exposed areas during fine weather by animals unfitted to meet the storm will incur the penalty of death.

The prime necessity for every member of the littoral fauna is the power of resisting the attacks of waves; and every development and variation undergone by such littoral fauna must of necessity have been carried out under the immediate control of waves.

If, as Prof. Moseley tells us, it was in the "littoral zone . . . that all the main groups of the animal kingdom first came into existence," we may go further and say that these main groups were modelled by the ceaseless action of waves, as these in their turn were brought into being by winds raised by solar heat. Thus the early stages of evolution can be carried back directly, by the two short links of wind and wave, to the sun itself.

One point that I have never published myself or seen recorded by others, is the curious conflict that may be observed between wave- and tidal action. For example, a shell with a wide bathymetrical range, from tide-marks to, say, fifty fathoms, may evince a tendeney towards the elaboration of a useful form and sculpture, in the deeper water; whereas, between tide-marks the two daily checks to growth arising from the fall of the tide would immediately check any such variation in sculpture, and the altered form would no longer be best suited to the alongshore conditions.

Moreover, as the form best suited to tide-marks is often in conflict with that best suited to deeper water, the form of a species living between tide-marks might soon diverge from that of the same species frequenting deeper water. As a possible instance I would adduce the case of *Trochus zizyphinus* and *T. granulatus*. These gasteropods have always, I believe, been considered distinct species; but I have in my possession specimens from about fifteen fathoms, showing a distinct passage between the smooth zizyphinus and the sculptured granulatus, and this both in outline and sculpture.

I regret that I have been unable to obtain odontophores of the intermediate forms to ascertain if they confirm the passage from the one species into the other. It is, I think, evident that though *T. zizyphinus* can retain its form in deep water, *T. granulatus* could not retain its symmetrical granulated sculpture were it to invade the tidal strand.

The variety of method exhibited by the littoral fauna in resisting wave-currents affords a most interesting subject of research. Take for instance an exposed ledge of rock—no hypothetical one—with sturdy limpets living on it, the fragile *Pholadidea papyracea* living in it, and the hardy little *Littorina obtusata* clinging to the sea-weed. A storm attacks the trio, and tests their several methods of defence. The limpet is safe on the rock, the Pholadidea in it, and the Littorina, though at once washed off its feeble support, is safe, thanks to its solid shell, from the utmost violence of the storm. The tenacious hold of the limpet on the solid rock and the feeble adherence of the Littorina to the sea-weed indicate very opposite methods of meeting a common danger.

In conclusion I would put in a plea for working-models of the sea in some of our new aquariums. When one sees in a tranquil tank such a fish as the gurnard with its far-spreading feelers ready to steady itself amid swinging wave-currents, one would like to see its machinery brought into action. A gentle swinging motion could be easily imparted to the waters of a tank, and under such conditions the observer would see the animals use the special appliances they possess for resisting or evading their most formidable enemy. ARTHUR R. HUNT

Torquay, July 6

"New System of Orthography for Native Names of Places"

ALLOW me room for a few remarks on the Royal Geographical Society's "New System of Orthography for Native Names of Places," just published in your number for July 2. The Society has earned the thanks of the public for grappling with the neglected and vexatiously inconsistent question of place-name spelling. Attention was called by myself to this subject in *Notes and Queries* of May and July, 1884, and I can take no exception to the vowel and consonant system suggested by the Society, save to the retention of the un-English letter *x* and to one other particular.

This latter exception deals with the statement contained in paragraph (2) that "no change will be made in the spelling of names that have become by long usage familiar to English readers—as Calcutta, Cutch, Celebes, Mecca, &c." Now, why make even these exceptions to the excellent rules laid down? Exceptions are always a nuisance, and in the cases of justifiable reforms prove more often than otherwise the means whereby the benefits of such reforms are frustrated altogether. A little more boldness by the Society in grasping the nettle is wanted; and while an improved alternative spelling would soon become familiar to the public, the help given by this concession to logical consistency would encourage reforms both here and in other fields. The attempt to consider the public convenience here illustrated is, I believe, unnecessary; while the seeking to preserve historical spellings, as with other historical and venerable anachronisms, comes to this—that the progress of reform is continually becoming hidebound and stunted, if not stopped altogether, by the impossible attempt to energise distinct stages of growth at one and the same time. It is earnestly to be hoped that the Geographical Society, upon whom the mantle of "Bahnbrecher" in spelling reform has suddenly fallen, will do the wise thing here, and boldly declare against all "exceptions" to wholesome, justifiable improvement.

The need for, and the influence on other departments of spelling reform, of bold action on the part of the Society is illustrated by the retention of the letter *x*. In any reform scheme of the spelling of English place-names—the next urgent question to the above—the abolition of this letter will stand in the fore-rank of improvements. Witness its mischievous working in "Boxted" (Buckstead), "Hoxton" (Hogston in 1790), "Oxted" Ocksstead), Huxtable (Huckstable), &c.! N.

July 9

Recession of Niagara Falls in 133 Years

THE fallacy of Lyell's guess at the rate of recession was always plain if we referred to the first accurate account, that of the Swedish traveller Kalm, in *Gent. Mag.*, January, 1751; since which the gorge has both been enlarged full 100 acres, and had miles of its bed deepened many feet. In p. 16, col. 1, A, he said: "Canoes can go yet half a league above the beginning of the carrying place, . . . but higher up it is quite impossible, the whole course of the water, for two leagues and a half up to the great fall, being *a series of smaller falls, one under another*." Now plainly this whole series have so levelled their bed that the main falls now descend some 160 feet instead of the "137 feet" that he repeatedly maintained (col. 2, E) to be the utmost the engineers, "with mathematical instruments," then admitted. But as for the plan, he is yet more definite. P. 16, col. 1, E: "The river (or rather strait) runs here from south-south-east to north-north-west, and the rock of the great fall crosses it, not in a right line, but forming almost the figure of a semicircle or horse-shoe." (Prof. Tyndall has well remarked that, the upper stream having probably been always much wider than the gorge, the chief fall has always been concave; but Kalm's view makes it appear very slightly so, and we know that very flat segments are, by a perspective illusion, commonly thought semicircles or even "horse shoes.") "Above the fall, in the middle of the river, is an island, lying also south-south-east and north-north-west, or parallel with the sides of the river; its length is about 7 or 8 French arpents (an arpent being 120 feet). The lower end of this island is just at the perpendicular edge of the fall." He proceeds to tell how this island, once thought inaccessible, had been the scene of the heroic rescue, twelve years before, of two Indians by two others. Then, p. 18, col. 2, F.: "The breadth of the fall, as it runs in a semicircle, is reckoned to be about 6 arpents. The island is in the middle of the fall, and from it to each side is almost the same breadth" (barely 350 feet then, but in his engraving not half that). "The breadth of the island at its lower end is two-thirds of an arpent or thereabouts." His view makes it but *one*-third the height, *i.e.*, one-third of "137 feet."

Now this mere reef, about 900 feet by less than 80, was plainly one whose length the falls were reducing. Is there the least ground for holding they have ever reduced Goat Island (now ten times larger than that) or will reduce it one rood? But, prolong "Luna Islet" north-north-west till 900 feet long, and you will have the site, I submit, of Kalm's middle rock, barely 350 feet from the point Mr. Wesson marks, on Fig. 2, "New York Shore," and about as much from a Canadian point west-south-west of it. As for Goat Island, it cannot, in his time, have yet been touched by the falls, but may be one of those the hunters had habitually visited above. His description can be so well plotted on this last survey that the amount of gorge excavated since 1750 should be knowable to an acre. The west fall, then, only slightly the larger, has ever since been widening, lowering its edge, and getting more of the stream; so that the east one, comparatively stationary, retaining its height and decreasing in volume, must dry up, and its bed and all the isles become part of New York State. E. L. GARBETT

July 11

Sky Glows

EVER since the sunsets of 1883 and last year there has been at times an abnormal glare both before and after sundown. But I have seen nothing in the way of twilight effect so strange as that of Monday evening, the 6th, when about 10 p.m. a sea of luminous silvery white cloud lay above a belt of ordinary clear twilight sky, which was rather low in tone and colour. These clouds were wave-like in form, and evidently at a great elevation, and though they must have received their light from the sun, it was not easy to think so, as upon the dark sky they looked brighter and paler than clouds under a full moon. A friend who was with me aptly compared the light on these clouds to that which shines from white phosphor paint. This effect lasted for some time after 10 p.m., and extended from west to north, the lower edge of the clouds, which was sharply defined, was about 12° above the horizon. ROBT. C. LESLIE

6, Moira Place, Southampton, July 8

Black and White

MY daughter has two terriers, one black, the other white; she has noticed that in the dusk of the evening the black dog is much more visible than the white one, and has asked me the reason for this fact. I cannot properly explain why a white or light coloured garment shows much less in the dusk than a dark coloured dress, but this is a well-known fact to all sportsmen who shoot ducks at night, when it is their custom to wear a night shirt or other white dress over their ordinary costume. When the black and white dogs are playing together in the dusk of evening, the black dog can be distinctly seen when the white dog, at the same distance, is quite invisible. Will you please explain this? WM. E. WARRAND

Bught, Inverness, July 8

"Foul Water"

DURING a brief stay at Beaumaris in June 1883, and again in June 1884, I had frequent opportunities of observing the "gelatinous masses" mentioned by Mr. Shrubsole as occurring in large numbers at Sheerness-on-Sea. I first noticed them in 1883, while procuring a supply of water for my marine tanks at home. They then existed in very large numbers, and as I had no means of filtering the water before returning to Manchester, I almost expected to find it "foul" upon my arrival. I was, however, agreeably disappointed. The "gelatinous masses" had settled at the bottom of the jars, and were apparently dead. While at Beaumaris I subjected a few specimens to microscopical examination, but being busy with other work did not learn more than is given in Mr. Shrubsole's description.

Manchester HERBERT C. CHADWICK

Earthquake-Proof Buildings

UNLESS my memory plays me very false a number of lighthouses secured against earthquake shocks by saucers and balls were built in Japan just about twenty years ago from the designs of Mr. Stevenson of Edinburgh. WM. MUIR

The London Institution, Finsbury Circus, E.C.

THE QUESTION OF CIVIL AND ASTRONOMICAL TIME

ONE of the points made at the Washington Congress was that if Universal Time (surely Earth-Time or Prime Meridian Time would be a better term) were generally accepted, astronomical time might be abolished, astronomers accepting the new day of twenty-four hours commencing at midnight.

Since the Congress the question naturally has been well considered, and we think it desirable that we should now refer to some of the most important opinions which have already been given, not only as regards the desirability of the change, but as to the time at which that change should be brought about.

Among the first to accept the resolution was the Astronomer-Royal, for the internal use of the Observatory of Greenwich. Many opinions were collected at an early date and forwarded by Mr. Chandler, the Secretary of the U.S. Navy to the Senate. This action grew out of an order of Commodore Franklin, the Superintendent of the U.S. Naval Observatory, to adopt the new time on January 1, 1885; this was communicated to Prof. Newcomb, the Superintendent of the *American Nautical Almanac*, and drew a reply from Prof. Newcomb, from which we make the following extract:—

"(1) The Conference expresses the hope that as soon as may be practical the astronomical and nautical days will be arranged everywhere to begin at mean midnight.

"(2) That east longitudes shall be counted as plus and west longitudes as minus.

"The first of these recommendations proposes a change in the method of counting astronomical time which has come down to us from antiquity, and which is now universal among astronomers. The practice of taking noon as the moment from which the hours were to be counted originated with Ptolemy. This practice is not, as some distinguished members of the Conference seem to have supposed, based solely upon the inconvenience to the astronomer of changing his day at midnight, but was adopted because it was the most natural method of measuring solar time. At any one place solar time is measured by the motion of the sun, and is expressed by the sun's hour angle. By uniform custom hour angles are reckoned from the meridian of the place, and thus by a natural process the solar day is counted from the moment at which the sun passes over the meridian of the place or over the standard meridian. For the same reason sidereal time is counted from the moment at which the vernal equinox passes over the meridian of the place, and thus the two times correspond to the relation between the sun and the equinox.

"It would appear that the Conference adopted the recommendation under the impression that the change would involve nothing more than the current method of reckoning time among astronomers, and could therefore be made without serious inconvenience. A more mature consideration than time permitted the Conference to devote to the subject would, I am persuaded, have led that distinguished body to a different conclusion.

"A change in the system of reckoning astronomical time is not merely a change of habit, such as a new method of counting time in civil life would be, but a change in the whole literature and teaching of the subject. The existing system permeates all the volumes of ephemerides and observations which fill the library of the astronomer. All his text-books, all his teachings, his tables, his formulæ, and his habits of calculation are based on this system. To change the system will involve a change in many of the precepts and methods laid down in his text-books.

"But this would only be the beginning of the confusion. Astronomical observations and ephemerides are made and printed not only for the present time, but for future generations and for future centuries. If the system is changed as proposed the astronomers of future generations who refer to these publications must bear the change in mind in order not to misinterpret the data before them. The case will be yet worse if the change is not made by all the ephemerides and astronomers at the same time epoch. It will then be necessary for the astronomers of the twentieth century, using ephemerides and observations of the present, to know, remember, and have constantly in mind a certain date different in each case at which the change was made. For example, if, as is officially announced, the Naval Observatory introduces the new system on January 1, 1885, then there will be for several years a lack of correspondence between the system of that establishment and the system of the American Ephemeris, which is prepared four years in advance.

"It is difficult to present to others than astronomers who have made use of published observations the confusion, embarrassments, and mistakes that will arise to their successors from the change. The case can be illustrated perhaps by saying that it is of the same kind as—though in less degree than—the confusion that would arise to readers and historians in the future if we should reverse or alter the meaning of a number of important words in our language with a result that the future reader would not know what the words meant unless he noticed at what date the book was printed. The words would mean one thing if printed before the date of change, and another if printed after.

"It is worthy of attention that even the republican Government of France in 1790, which adopted a new calendar, did not venture to change the old system in its astronomical ephemeris.

"I see no advantage in the change to compensate for this confusion. If astronomical ephemerides were in common use by those who are neither navigators nor astronomers the case would be different. But, as a matter of fact, no one uses these publications except those who are familiar with the method of reckoning time, and the change from astronomical to civil time is so simple as to cause no trouble whatever.

"The change will affect the navigator as well as the astronomer. Whether the navigator should commence his day at noon or midnight, it is certain that he must determine his latitude from the sun at noon. The present system of counting the day from noon enables him to do this in a simple manner, since he changes his own noon into the astronomical period by the simple addition or subtraction of his longitude. To introduce any change whatever into the habits of calculation of uneducated men is a slow and difficult process, and is the more difficult when a complex system is to be substituted for a simple one. I am decidedly of the opinion that any attempt to change the form of printing astronomical ephemerides for the use of our navigators would meet with objections so strong that they could not be practically overcome.

"The second conclusion which I wish to consider is that which proposes to reverse our method of assigning algebraic signs to the longitudes by counting east longitudes as plus, and west longitudes as minus. The present system was adopted some forty years ago in Germany as being the most natural, because longitude was measured upon the earth by the apparent motion of the sun and stars from east to west, and it seemed most natural to count the direction of this motion as algebraically positive. This system has been adopted in the American Ephemeris since its origin, and all its tables and formulas which involve the application of longitudes have been constructed on this principle. To reverse this method will cause error and confusion to every one using the Ephemeris without, as far as I can see, the slightest compensating advantages. I am therefore of opinion that it should not be adopted.

"I respectfully submit that in view of these considerations no change should be made in the mode of reckoning time employed in the publications of this office until, by some international arrangement, a common date shall be fixed by all nations for the change."

Prof. Newcomb adds a list of changes in the *American Nautical Almanac* required when the astronomical day is reckoned from midnight.

"Page 1 of each month: The numbers on this page being given for Greenwich apparent noon, the question whether they shall remain unchanged or be given for Greenwich apparent midnight will have to be decided by competent authority.

"Page 2 of each month to correspond with the new mode of reckoning these numbers would be given for mean midnight, which would change the whole page.

"Page 3 of each month: Nearly the same remark applies to these pages as to page 2. When the change is made there will be a discontinuity of half a day in the comparison of the sun's longitudes before and after the change.

"Page 4 to correspond strictly to the new reckoning, the columns noon and midnight on this page would have to be interchanged. This might lead to errors on the part of the computer accustomed to the old system inadvertently forgetting the change which had been made. If not made the system would be a mixed one.

"Pages 5 to 12: All the numbers on these pages will be differently arranged when the hours are counted from midnight.

"Pages 13 to 18: The lunar distances will have to be given for midnight on the first column of the left-hand pages, and for noon on the first column of the right-hand pages, thus reversing the placing of the numbers on the two pages.

"Planetary ephemerides: These will naturally have to be given for midnight instead of noon, and the signification of all the numbers will therefore be different. There will also be a discontinuity of half a day in the progression of the series of epochs at the time the change is made.

"Moon's longitude and latitude: The indications of the times given in this part of the Ephemeris will be altered by half a day. The result would be that a computer inadvertently forgetting the change would take out a result half a day in error.

"Sidereal time of mean noon: Wherever this quantity was given throughout the Ephemeris it would, on the new system, have to be replaced by the sidereal time of mean midnight.

"Transit ephemerides: These would remain unaltered except the column of mean time of transit, which would be changed by 12 hours.

"Changes of nearly the same kind as in the planetary ephemerides would have to be made in giving the predictions of phenomena."

The following extract gives the gist of Commodore Franklin's reply to Prof. Newcomb's objections:—

"So far as the counting of astronomical time from antiquity is concerned, it is the argument of conservatism which desires no change in an existing order of affairs; yet, assenting to this argument, we might refer to a still remoter antiquity—to the time, not of Ptolemy, but of Hipparchus, the 'founder of astronomy,' who reckoned the twenty-four hours from midnight to midnight, just as the Conference has proposed.

"While it is unquestionably true that some confusion may occur, yet the liability to it will be almost entirely with the astronomer, who, through his superior education and training, could easily avoid it by careful attention to the ephemerides he was using. During the years of change, before the ephemerides are constructed in accordance with the new method, it will only be necessary to place at the head of each page of recorded observations the note that the time is reckoned from midnight, to call attention to the fact, and thus obviate the danger of error.

"It is an undeniable fact that the educated navigator finds the conversion of time a simple matter, yet experience has demonstrated that to the mariner who is not possessed of a mathematical education there is a decided liability to the confusion which is so greatly deprecated by all who are interested in this subject. I believe that to all navigators, at least to all English-speaking ones, the new method will prove itself decidedly advantageous.

"As is well known, for many years navigators kept sea time, by which the day was considered to begin at noon, preceding the civil day by twelve and the astronomical date by twenty-four hours. The change to civil time now kept on board ship was effected readily and without friction, so that the recommendation of the Conference regarding the commencement of the nautical day has already been largely anticipated. The navigator is concerned not with his longitude but with his Greenwich time, having obtained which he can take from the *Nautical Almanac* the data he seeks whether given for noon or midnight, and when the ephemerides shall have been made to conform to the new system there will be one time in common use by all the world.

"It seems to me eminently proper that the nation which called the Conference should be among the first to adopt its recommendations, and while it might possibly be better to wait until an entire agreement has been entered into by the astronomers of all nations, yet the fact that the first and most conservative observatory in the world has acceded to this proposal of the Conference would seem to be a sufficient reason why we should not wait for further developments. In deference, however, to the views so well advanced by Prof. Newcomb, and in view of the fact that the President has recently transmitted the proceedings of the Conference to Congress, as well also of the desirability of securing uniformity among the astronomers of our own country at least, I have suspended the execution of the order for the present with the view of communicating with those engaged in kindred work in order to ascertain their sentiments on the subject."

The replies received to Commodore Franklin's circular may be summarised as follows:—

Mr. STONE, Leander McCormick Observatory—

Change should be made completely on January 1, 1885.

Prof. NEWTON, Yale College—

Change desirable, may begin at once for internal use, and any communication from an observatory should state precisely what time is adopted.

Prof. PICKERING, Harvard College—

A general agreement more important than the mode of reckoning; will follow Greenwich absolutely.

Mr. HARRINGTON, Ann Arbor—
Will do as Greenwich does.

Prof. HOLDEN, Washburn Observatory—
Begin in 1890.

Prof. YOUNG, Princeton—
Begin January 1, 1885.

Mr. SWIFT, Warner Observatory—
Begin January 1, 1885.

Prof. LANGLEY, Alleghany—
Begin January 1, 1885.

Mr. PORTER, Cincinnati—
Begin January 1, 1885.

Prof. PRITCHETT, Washington University Observatory—
Wait a year at least for general concensus.

Prof. PETERS, Clinton. We extract his letter:—

"I have, from the beginning, attached very little importance to the object and the proceedings of the International Meridian Conference.

"The suggestions and recommendations which have been the result refer principally to things that are already in existence; for example, the reckoning of geographical longitudes east and west from Greenwich is in practice with most nations. The proposition to count the hours of the day from 0 to 24 also in civil life will scarcely ever be adopted, for nobody (except perhaps sick people lying in bed) will have patience enough to count the striking of the clock up to 24, not to speak of the greater liability of miscounting the strokes and of the difficulty in reading off the turret dial if the circle be divided into twenty-four parts. But what concerns astronomers directly is the change proposed by the Conference in the beginning of the astronomical day, in regard to the introduction of which you ask for my views. It is quite unimportant, of course, whether we begin from noon or from the preceding midnight; the reasons for taking the former as the starting-point exist no longer. Our clocks nowadays are not regulated, as in former times, by observing the culmination of the sun, and with the telescopes of increased size observations are continued not during the night alone, but are carried on as well in day-time, so that a break in the date at midnight is hardy more grievous than one at noon. While thus we might readily conform with the proposal of the Conference, and put our clocks back by twelve hours, we ought to hesitate nevertheless very much to do so at once, especially for two reasons: First, a general agreement and understanding among astronomers (not of the United States alone but of all nations) should be had; otherwise it would become necessary for avoiding confusion to add to every observation we publish some such words as 'old-style time' or 'new style time.' The subject undoubtedly will be discussed in the astronomical periodicals, and in societies representing our science. If authorities such as the Royal Astronomical Society, the German Astronomical Gesellschaft, the larger active observatories, &c., agree in favour of the change, the system of reckoning the astronomical day from midnight will soon be adopted universally. But a partial proceeding seems highly objectionable. Second, if we make a change in the time-keepers of the Observatory now, the use of the astronomical ephemerides, as they lie computed before us, will be made in many respects heavy. Take, for example, the places of the fixed stars, which are given for upper culmination from ten to ten days. When the sidereal day begins before noon, its date in the new arrangement of the solar day is changed. And every star place that we wish to take out of the ephemeris, therefore, requires some additional attention and reflection as to the corresponding date. In the *American Nautical Almanac*, where the tenths of the solar day are given, this inconvenience, to be sure, is not so great; we need only to diminish our argument by 0·5 day for having that of the table. A similar reduction of the argument must be made in using the lunar ephemeris, and of course in all the data expressed in solar time. In this way a source for at least possible mistakes is opened, and I think it therefore desirable that the change in the *Nautical Almanacs* should *precede* that in the observatories. The *American* as well as the *British Nautical Almanacs* are published as far as 1887, inclusive; the next or the next two following years may be under preparation.

"These considerations together lead me to the conclusion that it seems *not* advisable to introduce the change in the beginning of the astronomical day *before* the year 1890."

More recently two European astronomers have recorded their opinions. Prof. Struve in a pamphlet,[1] and Prof. Oppolzer in the *Monthly Notices*. The former thus expresses his views:—

"In regard to the change in the beginning of the astronomical day, thinks that the question before astronomers is not only of giving up a long-established custom, with consequent changes of rules of many years' standing, but it also involves a serious interruption of astronomical chronology. Without a doubt the astronomer would have to make a decided sacrifice in conforming to the wish of the Conference; but, after all, this sacrifice is no greater than our forefathers made when they changed from the Julian to the Gregorian calendar—a sacrifice to convenience of which we are still made sensible whenever we have occasion to go back to early observations.

"We need have little hesitation in making a similar sacrifice if it will prevent discordance between the civil and scientific custom of reckoning time, particularly troublesome where astronomical establishments come in contact with the outer world.

"Prof. Struve states that the Pulkowa Observatory is prepared to adopt the new time, the only question being as to the epoch when the change should be introduced in the publications of the Observatory. He is inclined to recommend that this should be deferred until some agreement can be reached by astronomers, and until the new time is adopted in the Ephemerides. This might be for the year 1890, or perhaps, better still, at the beginning of the next century."

Prof. Oppolzer's opinion is as follows:—

"When once such a universal time is introduced for all purposes it is quite natural that the question must arise, if there is indeed so great a necessity to retain in astronomy, and only in astronomy, a different reckoning of time. I fail to see this necessity, and I do not think that it would cause any serious trouble or confusion if a change were to be made in our astronomical reckoning; whilst a special mode of reckoning time in one science only, when all others use the generally-adopted standard, will, without doubt, be a source of error and confusion.' He then takes up in some detail the objections urged against the proposed change by Prof. Newcomb, and he discusses the changes which would be necessary in the Ephemerides. Prof. Oppolzer proposes to give practical effect to his views by adopting the new reckoning of time in an extensive list of 8000 solar and 5200 lunar eclipses which he is now preparing for publication."

Science, in an article on this subject, concludes as follows:—

"It is difficult to see how this matter will finally be decided. It is evidently a question for astronomers to settle among themselves; but so far they seem to be very evenly divided. For instance: out of some twenty-seven astronomers whose opinions, more or less decided, have been accessible for a count, thirteen seem inclined to favour the proposed change, while fourteen are opposed to it. And among the *pros* are Adams, Struve, and Christie; among the *cons*, Newcomb, Foerster, and Auwers."

MR. FREDERICK SIEMENS'S GAS LAMP

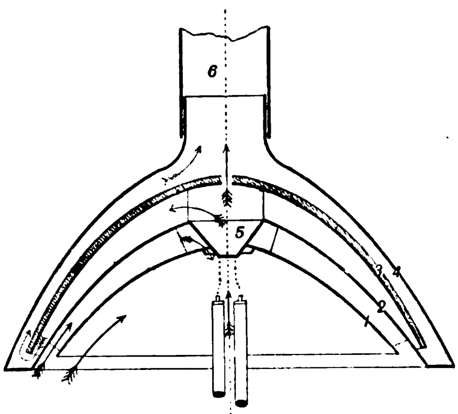
THE illuminating power of the most novel appliances for the production of light having, for economical reasons, been made more and more intense, and therefore more injurious to the eyesight, it follows that the eye must be protected as much as possible from the direct action of the light, with the least possible loss or diminution of effect. In other words, rooms should be lighted only by means of indirect rays or diffused light, the source of light itself not being directly visible. This is, in the author's opinion, a consideration of the highest importance as regards artificial illumination, which has only as yet received partial attention.

Until lately three main points only have been considered in any lighting application—viz. that the apparatus employed should be simple both in its construction and in its use; that the light should be of sufficient intensity for

[1] "Die Beschlüsse der Washingtoner Meridianconferenz."

the purposes required; and that the first cost and the maintenance of the plant employed should be very moderate. In public estimation, simplicity is the first *desideratum;* and hence a simple and direct form of illumination has always been preferred to a more complicated arrangement, even when the latter has been found more economical as regards first cost and maintenance, and more brilliant in its effects. At the present time, however, in addition to these requirements, a purer atmosphere and a more pleasant temperature in our apartments are desired, which matters received very little or no attention in former days, when people were content with a simple dim light, and took little interest in sanitary matters. The regenerative gas-burner may be regarded as a combined lighting and ventilating apparatus, by the employment of which the close oppressive atmosphere, so unpleasant at large gatherings, may be entirely avoided. In fact, it is the outcome of the demand for cooler and purer air in our apartments, combined with light of high intensity.

The lamp has been designed with a view to protect the eyesight from the direct action of the source of light, without diminishing its power; its construction will be understood from the following description:—Four hoods, 1, 2, 3, 4, of sheet iron or other suitable material, are arranged within one another in such a manner that the products of combustion travel downward between



2 and 3, and upward between 3 and 4, while the air to be heated for feeding the flame passes upward between 1 and 2. On the uppermost hood, 4, a chimney, 6, is provided, while the hood, 3, is shortened below so as to allow a clear passage for the products of combustion from the space between 2 and 3, to that between 3 and 4, and thus to the chimney. The hood, 2, carries at its apex an inwardly projecting outlet, 5, through which the products of combustion pass away as described, first downwards and then upwards, through the passages between the three upper hoods, into the chimney. The lowest or innermost hood, 1, is open, so that the air may pass upwards between the hoods, 1 and 2, as indicated by the arrows, to fill the inner space of the hood with heated air. The inner surface of this hood acts as a reflector, and in its focus are placed one or more fishtail burners of the usual type. As soon as the hood, 2, becomes sufficiently heated, through the action of the products of combustion passing between it and 3, the air between 1 and 2 will become heated, and, diminishing in its specific gravity, will automatically rise and fill the upper portion of the cone inside the hood, 1. By this arrangement the gas-jets burn within an atmosphere of heated air, with which they are consequently permanently supplied; the temperature of the air increasing with that of the gas-flames, and the brilliancy of the light increasing in the same ratio. The action is perfectly automatic, for, as the products of combustion pass away through the chimney 6, fresh heated air comes in at the same rate into the inner space of the hood 1 containing the gas-flames, to occupy the space which would otherwise be filled with cold air from the atmosphere below. The hot air which is supplied from the column of heated air formed between the hoods 1 and 2 will, on account of its *lower specific gravity*, always fill the upper space inside the hood 1, thus preventing the cold air of the atmosphere, which is at least three times as heavy, from rising inside the hood, 1, above a certain level, even in case of a disturbance in the atmosphere of the room. Thus no glass partition to exclude the cold air is required. The flame reflects its light directly downwards, as also from the inner surface of the hood, there being consequently an entire absence of shadows.

The light can be more or less concentrated or diffused, as desired, by varying the shape of the hood or reflector used. In some cases, where it is required to diffuse the light widely, or to diminish the downward radiation of heat, a bell-shaped glass, with its apex upwards, and its surface curving parabolically in the downward direction, may be employed, so as to cause all the rays of light it receives either to be refracted or to be reflected horizontally. If it is only desired to reduce the intensity of the downward radiation of heat, clear glass should be employed; if, however, it is also desired to diffuse the light, opaque glass is requisite, and the light may be thus more or less diffused, as may be required. The glass bell is suspended on a wire net of large mesh attached to a metal ring below, upon which and upon the netting the glass rests, so that, in case of accident, the broken glass would not fall below. It allows of free access to the flame, and does not form an integral part of the apparatus, so that its employment will not cause any particular trouble or inconvenience. As the intensity of the light depends entirely upon the up-current of heated air, the hoods may have any shape most suitable for the reflector and for the purpose of diffusing the light, provided that the height of the column of hot air between the hoods 1 and 2 be not relatively diminished.

The following tests of this lamp have been made:—The burners or jets removed from the dome were tested with the rays horizontal. The consumption of gas was 20 cubic feet per hour, and the illuminating power 57·5 candles, or 2·875 candles per cubic foot. They were then placed at an elevation of 1 foot 6 inches perpendicularly over a plain glass mirror placed at an angle of 45°, and in a line with the disk of the photometer. The distance from the standard light to the glass reflector was 18 feet 6 inches, which, added to the 1 foot 6 inches that the burners were placed above the reflector, made together 20 feet, the distance at which the light to be tested has to be fixed from the standard light in the photometer employed. In this case the consumption was again 20 cubic feet per hour, and the illuminating power was found to be 55 candles, or 2·75 candles per cubic foot; so that it would appear that there is an absorption by the glass in reflection of 4·35 per cent. The burners having been fixed in the dome reflector, the lamp, thus arranged, was tested again as in the last experiment. The consumption of gas was 20·5 cubic feet per hour, and the illuminating power 62·5 candles, or an average of 3·048 candles per cubic foot of gas, or 3·180 candles per cubic foot if the 4·35 per cent. found to be absorbed by the glass are added. The difference between 2·875 and 3·180 candles, or 0·305 candle, per cubic foot gives the increase of light due to the use of the reflecting cone. After burning for some time the lamp was again tested, the consumption of gas was found to be reduced to 15·5 cubic feet per hour, and the illuminating power to be increased to 115 candles, being an average of 7·42 candles per cubic foot; or, allowing for loss by absorption, 7·74 candles per cubic foot. The difference between this and 3·180 candles, or 4·560 candles, gives the gain in light per cubic foot of gas due to the regenerative arrangement, the gas burning within a highly-heated atmosphere.

Date.	Particulars of Burners.	Pressure of Gas.	Consumption in cubic ft. per hour.	Candle-power.	Candle-power per cubic ft. of gas.	Corrected for loss by mirror.
May 6, 1885.	Gas jets taken out of lamp	Ten-tenths	20·0	57·5	2·875	...
"	Same jets raised 18 inches to reflect light on mirror[1]	"	20·0	55·0	2·750	...
"	Same jets burning in cold lamp	"	20·5	62·5	3·048	3·180
"	Same jets burning in hot lamp	"	15·5	115·0	7·420	7·740

Of course light may be diffused or transmitted indirectly by other means than those described, though not perhaps in a more simple or economical way. The electric light has been to a certain extent already treated in a similar way by suspending arc lights at great altitudes, and by means of reflectors concentrating the light down upon certain areas. The intention has been, by this means, to illuminate whole towns or districts of towns from single sources of light. This can, in the author's opinion, be done if the concentration of the light is effected in a different way from what has been hitherto attempted—viz., by the employment of very much larger reflectors. In this way the loss of light sideways and the deep shadows that have been produced will be avoided. It matters very little at what height the light is placed, the chief question being what area has to be illuminated; and then the form of reflector suitable for the purpose can be easily determined upon.

In conclusion, it must be remembered that illumination from above downwards is in nearly all cases the preferable mode of distributing light, as Nature herself proves in having one light only, the sky being the diffusing agent by which the most perfect distribution of light is effected. Nature possesses, indeed, a gigantic reflector in the atmosphere and clouds; and the author has endeavoured to imitate Nature's reflector in a way suitable to our imperfect means and conditions, and to the circumstances of each individual case.

THE VOYAGE OF THE "CHALLENGER."[2]

II.

THE plan adopted in the narrative of the cruise gives the reader a good idea of the course of the voyage, the nature of the researches carried on, and the manner in which these researches have been followed up by the more detailed studies of the experts into whose hands the collections were afterwards placed. But it is necessarily desultory. We are led from station to station, from chemical to biological work, from physics to ethnology, from deep-sea temperatures to the anatomy of sea-slugs, with a rapidity and suddenness that are a little bewildering. Still, the general impression of the far-reaching aims of the expedition, of the skill and completeness with which the work was done, and of the enormous mass of new material obtained, is no doubt deepened by the difficulty or impossibility which the narrators have obviously experienced in giving within the brief compass of their chapters anything like a comprehensive digest of what the *Challenger* voyage accomplished in regard to the problems of the great deep. The reader must resign himself to be carried along as the naturalists of the expedition themselves were, and to listen to their story of what they saw and found.

In our notice of last week we left the *Challenger* at the Cape of Good Hope. From that station she strikes out boldly into the Southern Ocean, giving us glimpses of the Prince Edward and Marion Islands, with their proofs of recent volcanic action, the Crozet Islands and Kerguelen. In this part of the voyage the trawlings are extraordinarily rich, between one and two hundred animals coming up at each haul, representing nearly all the marine groups, and, with few exceptions, belonging to genera and species discovered now for the first time. Among the more interesting forms of life are various crinoids, the mention of which leads to a summary from Dr. P. A. Carpenter and Prof. L. von Graff of their Reports upon the additions to our knowledge of the recent crinoids made by the expedition Fig. 4). The figures of the living *Pentacrinus* remind the

Fig. 4.—*Metacrinus Wyvillii*, P. H. Carpenter.

[1] This shows a loss of 4·35 per cent. owing to absorption by mirror.

[2] "Report on the Scientific Results of the Voyage of H.M.S. *Challenger* during the years 1873-76." Prepared under the direction of the late Sir C. Wyville Thomson, and now of John Murray. "Narrative," vol. I., 1885. Continued from p. 207.

geologist of the familiar Liassic *Extracrinus*, and give a singularly antique aspect to the fauna. Not less interesting is the living *Rhizocrinus*, which is a dwarfed and degraded descendant of the well-known chalk fossil *Bourgeticrinus*, as this in turn appears to have been a dwarfed representative of the Pear-encrinites of the Jurassic rocks. The genus *Bathycrinus*, previously known only from a single immature specimen, is now shown to have a wide extension in the Atlantic, but is not known in the fossil state. While the stalked crinoids have been dying out, the Comatulæ, or Feather-Stars, are probably more abundant now than at any former geological period, no fewer than four hundred species being now known, and three of the six genera into which they are referable having been discovered by the *Challenger*. In connection with the subject of recent crinoids some interesting observations are given regarding the Myzostomid parasites that infest these creatures and produce singular mal-formations. The resemblance of these distortions to those found upon many fossil Palæozoic crinoids no doubt indicates the presence of similar parasites even in the waters of the Palæozoic oceans. From the rich trawlings below water we are led by the narrative to the abundant bird-life of the Southern Ocean and to the conclusions regarding the structure and affinities of the Petrels reached by that able and lamented naturalist, the late Mr. W. A. Forbes.

From the pages of the narrative a good notion of Kerguelen with its snowfields and lavas, and Heard Island with its ice-cliffs and glaciers can be obtained. The profusion of life in these southern waters is not a little remarkable—sponges, alcyonarians, holothurians, ophiurids, asterids, echinids, annelids, amphipods, polyzoa, gasteropods, cephalopods, and many other invertebrates. But the *Challenger* now pushes southward to the Antarctic ice-cliffs, and as these seas are but little known, full details of this part of the navigation are given, with the soundings, dredgings, trawlings, and temperature observations taken along the route. Numerous woodcuts, phototypes, and chromolithographs of icebergs observed in the Antarctic Ocean are inserted, and a special chapter is devoted to the history of exploration in these seas, and to an account of observations made by the scientific staff of the *Challenger* on Antarctic temperatures, the density of sea-water, the true composition of sea-water ice, Antarctic icebergs, the deposits formed on the sea-bottom in the icy tracts of the Southern Ocean, the surface organisms of these seas, and a detailed summary regarding the hexactinellid and tetractinellid sponges collected.

Fig. 5.—New Volcano, Camiguin Island.

Escaping from the perils of the ice-fields and Antarctic gales the vessel bears away to Australia, touching at Melbourne and Sydney and then, passing between the North and South Islands of New Zealand and northwards to the Fiji Islands, turns westwards again, through the Coral, Celebes and China Seas to Hong Kong. The account of this portion of the voyage is enriched with descriptions of numerous groups of animals collected during the expedition, particularly macrurous and brachyurous crustaceans, butterflies and moths, medusæ, star-fishes, amphipods, lamellibranchs, annelides, calcareous and horny sponges. The next track, from Hong Kong by Manila, Zebu, and the Admiralty Islands to Japan, takes up nearly 100 pages of the narrative. Among the more interesting observations recorded are those relating to the volcano of Camiguin Island, which burst forth upon a low plain in the summer of the year 1871 and in four years and a half rose to 1,950 feet in height, with abundant discharge of steam and with glowing lava at its summit (Fig. 5). The mountain is a dome-shaped mass rising from the seashore. It consists of various andesitic lavas but seems to possess no crater, resembling in this respect some of the trachytic domes of Auvergne. The lava is described as having apparently "issued from a central cavity and boiled over, as it were, till it set into the form of the dome." Probably the volcano is an example of the extravasation of viscous lava in successive shells, of which the outer are pushed outwards and upwards by the arrival of fresh material from below, as illustrated experimentally by Reyer. Mr. Busk supplies a *résumé* of his Report on the Polyzoa of the expedition. Professor E. Perceval Wright gives one on the Alcyonaria; Dr. Rudolph Bergh, one on the Nudibranchs; Professor Turner, one on the crania of the Admiralty and other Pacific Islanders; Professor G. O. Sars, one on the Schizopods and other crustaceans.

From Japan we are transported to the centre of the Pacific Ocean, and learn much by the way regarding the distribution of temperature in this vast expanse of water. A series of soundings taken from lat. 40° N. to lat. 40° S. affords a section of the very centre of the ocean through the volcanic peaks of Hawai and Tahiti. Perhaps no single part of the sounding work of the expedition offers a more impressive example than this of the boldness and success with which the problems of the deep sea can now be attacked. Down the middle of the widest and deepest ocean on the face of the globe a line of temperature soundings is taken with as much precision as if it had been an inland lake, and information is obtained that furnishes a clear picture of the depth of the water, the form of the bottom, and the manner in which the layers of different temperatures are superposed upon each other from the surface downwards. A careful survey of the coral-reef of Tahiti by Lieutenant Swire and Mr. Murray suggested to the latter observer the view which he has already published—that this reef and coral-reefs in general may be formed by the outward growth of the living coral upon a *talus* of coral-rock broken off by the waves, and do not prove subsidence as was believed by Darwin. Among the corals, briefly described by Mr. Moseley, probably the most beautiful of the madrepores is the delicately fragile *Leptopenus* trawled from a depth of 2,160 fathoms between Juan Fernandez and Valparaiso (Fig. 6). Prof. Hubrecht of Utrecht supplies some notes on the *Nemertea* in anticipation of his detailed Report on this subject. A summary is given of Mr. H. B. Brady's studies of the *Foraminifera*, which are so abundant in the surface waters and play so important a part in the formation of deep-sea deposits; and a digest of the Report of Dr. G. S. Brady on the copepod and ostracod crustaceans. But perhaps the most generally interesting section of this part of the narrative is that which treats of the nature of the organic deposits now forming on the floor of the deeper parts of the ocean. The important results obtained by the *Challenger* expedition in this novel department of enquiry have already been made familiar

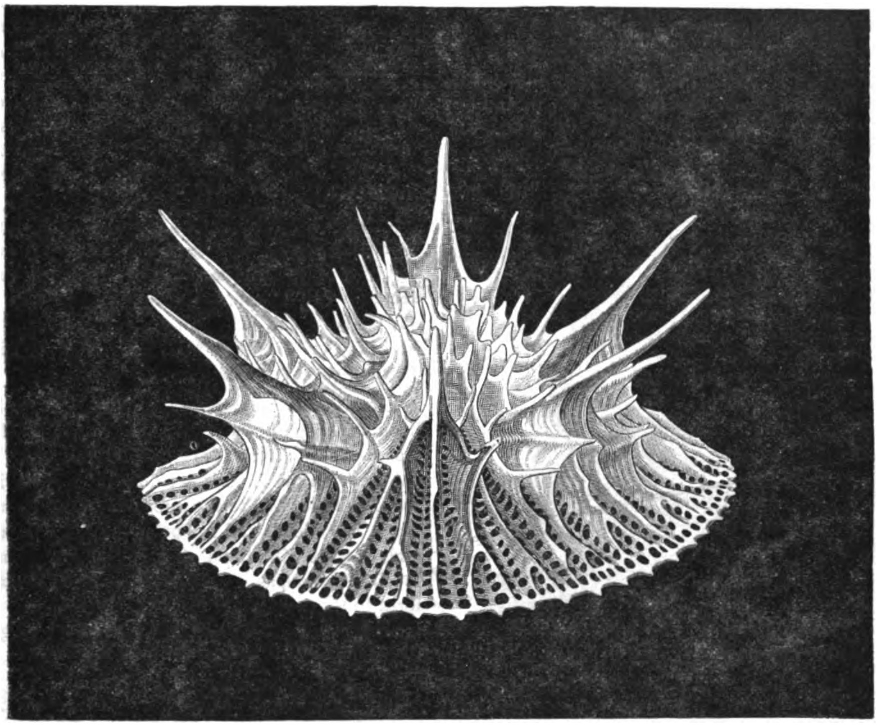


FIG. 6.—*Leptopenus hypocœlus*, Moseley.

by the writings of Messrs. Murray and Renard. But the reader will be glad to have them re-stated in the official account of the voyage, and to find them so admirably illustrated with woodcuts and a lithographic plate, which enable him to realise exactly the nature of the evidence for the extreme slowness of deposition at these great depths and so far from land. From no fewer than 116 sharks' teeth brought up with over two bushels of manganese nodules in a single haul from a depth of 2,385 fathoms, Fig. 7 has been selected for illustration. It differs in no essential particular from the tooth of *Carcharodon megalodon*, so common in Tertiary strata, except that it shows no large base.

Quitting Valparaiso, the *Challenger* pursues a southerly track to Port Otway, and then winding through the long line of sounds between the islands and the mainland passes through Magellan Strait to the Falkland Islands, and thence to Monte Video. During this part of the narrative we learn from Dr. Hoek what he has found out regarding the Cirripedes and Pycnogonids obtained during the cruise; from Mr. F. E. Beddard regarding the Isopods; from Mr. R. B. Watson about the Scaphopods and Gasteropods; from Mr. J. R. Henderson about the Anomurous Crustaceans; from Dr. Günther respecting the deep-sea fishes; and from Prof. E. Selenka regarding the *Gephyrea*. The course is then shaped eastward from Monte Video, across the South Atlantic to Ascension, and during the account of this *traverse* we are shown how the foraminiferal deposits of the deep sea were collected and investigated, and are supplied with a useful summary of the results arrived at by Messrs. Murray and Renard regarding deep-sea deposits in general, illustrated with an excellent coloured plate, which, in default of the actual objects themselves, brings their characters very clearly before the eye. As the narrative proceeds with the account of the homeward voyage from Ascension, we are told about pelagic diatoms, marine infusoria, coccospheres, rhabdospheres, bathybius, and the land-plants collected during the whole of the cruise, till at last the voyage ends at Spithead, on May 24, 1876. From the start on December 7th, 1872, till that date the vessel had traversed 68,890 nautical miles, and at intervals as nearly uniform as possible had established 362 observing stations.

The final chapter gives a summary of the results obtained by the officers of the Expedition, and by experts subsequently employed in the investigation of the density of sea-water, the composition of the salts of the ocean, the geographical and bathymetrical distribution of specific gravity, the carbonic acid, nitrogen, and oxygen present in sea-water, and a discussion of meteorological observations in their bearing upon oceanic circulation.

In this notice we have endeavoured merely to convey to the general reader some notion of the contents of the two portly volumes which contain the official narrative of the most important scientific expedition which has ever

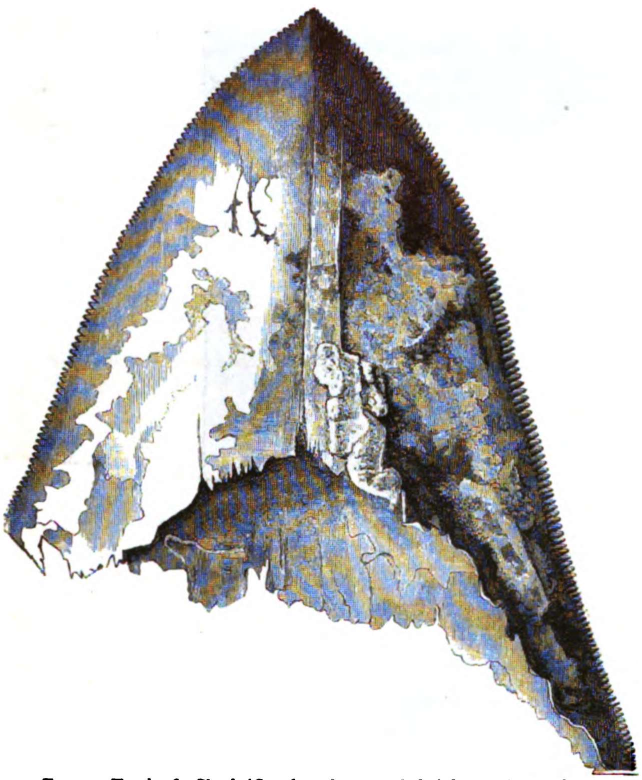


FIG. 7.—Tooth of a Shark (*Carcharodon megalodon*) from a depth of 2385 fms.

been despatched by any Government for the investigation of the depths of the ocean. The materials are not yet ready for a complete digest of the whole work achieved. But it would have been an important addition to the value of the Narrative had the authors endeavoured to give such a digest as far as the materials are now in their hands, marking those portions regarding which the final reports had not been received. Such a summary, carefully arranged in subjects and with precise references to the detailed Reports for fuller information, would have been of great service to those who cannot follow all the technical details of the Reports, as well as to the specialists who wish to learn to what source they have to turn for their own requirements. Let us hope that in a future edition of the narrative this want will be supplied. Meanwhile no one can rise from the perusal of these volumes without an admiration for the solid, painstaking, and conscientious way in which their compilation has been accomplished. They are not light reading, but they abound in material of general interest and form a fitting record of the great Expedition which they chronicle.

NOTES

THE fourteenth meeting of the French Association will take place on August 12 at Grenoble. M. Verneuil, Member of the Academy of Medicine, will be President. The public lectures will be "On the New Gallery of Palæontology of the Paris Museum," by M. Cotteau, ex-chairman of the Geological Society of France, and by M. Rochard, General Inspector of the Marine, on "The Victualling of France." A large number of medical questions will be dealt with in the several sections of the congress. The Ferran cholera experiments are sure to be discussed at full length. Numerous excursions will take place in the Alps under competent guidance as far as Chambery.

IN the course of the present summer the *Geological Magazine* will be twenty-one years old. During that period Dr. H. Woodward has been one of its editors, and for almost the whole time the principal editor, on whom the burden of the work has fallen. Further, the arrangement made with the publishers, in order to secure the continuance of the *Magazine*, would have actually resulted in pecuniary loss, but for illustrations presented by authors. Of the ability with which the *Magazine* has been conducted, and of its value to geologists, there can be no question. A committee has been formed, with Prof. Bonney as chairman, to give expression to their sense of the services which he has rendered to geology by presenting him with a testimonial, of which a piece of plate will, at any rate, form a part. The secretary and treasurer of the committee is Mr. G. J. Hinde, 11, Glebe Villas, Mitcham, Surrey, to whom subscriptions may be paid, or to the "Woodward Testimonial Fund," at the London and Westminster Bank, Limited.

ELABORATE preparations have been made in the neighbourhood of Niagara Falls for the formal transfer to-day to the Government of New York State of the strip of land adjoining the Falls on the American side. This strip will be thrown open for the future, free to the public, as "The Niagara International Park." Officials and troops representing both New York State and Canada will attend the ceremonies. This transfer attracts much attention, as it renders America's great cataract free henceforth to the world. We have already alluded at some length to the acquisition of the Falls and immediate neighbourhood by the State.

THE annual meeting of the Royal Archæological Institute will be held at Derby from Tuesday, July 28, to Wednesday, August 5, inclusive. The presidents of the three sections will be:—Antiquarian, the Rev. J. C. Cox, LL.D.; Historical, the Dean of Lichfield; Architectural, the Right Hon. A. J. Beresford-Hope.

THE observations made at the Ben Nevis Observatory have been received to the end of June. During the twelve months ending with June the rainfall, snow, and hail have been measured with all possible care every hour. During the year the whole of the rainfall, inclusive of melted snow and hail, amounts to 152·15 inches. Averaging the monthly falls from June, 1881, the mean annual rainfall on the top of Ben Nevis is 145·73 inches, which is thus the largest mean annual rainfall of any place at which rain has been observed in Scotland. The largest rainfall in any single month was 25·30 inches in December, 1884, and the smallest 4·85 inches in April, 1885. Falls of an inch a day, or upwards, are of comparatively frequent occurrence, having been recorded during one day in seven out of the 365 days. On two of the days upwards of four inches of rain was measured at the Observatory.

A TELEGRAM from Cooktown to Berlin, July 8, announces the arrival there of the New Guinea Company's steamship *Samoa*, with Dr. Finsch on board, who is returning to Europe from his recent exploring expedition along the unknown portions of the coast of Kaiser Wilhelm's Land (New Guinea) which are situated between Astrolabe Bay and Humboldt Bay. Dr. Finsch reports the discovery of several good harbours and of a navigable river. The land is suitable both for agriculture and stock-raising. The natives were friendly.

THE Comptroller-General of patents, designs, and trade marks has issued, in the form of a Parliamentary paper, his report, the second since the passing of the Act of 1883. That the new Act has worked well in the interest of inventors may be seen from the fact that the number of applications for patents, which had risen, with some variations, almost constantly in the course of thirty years, from 1211 in the year 1852, to 6241 in 1882, leaped with a bound to 17,110 in 1884. The increase is, in fact, as between the years 1883 and 1884, no less than 195 per cent. Seventy-nine per cent. of the applications were made by persons resident in the United Kingdom—namely, 12,356 being residents in England and Wales, 901 in Scotland, and 254 in Ireland. Of the rest the largest numbers were from the United States, 1181, from Germany 890, and from France 788. Residents from twenty-seven other countries also made application to the office, thirteen such countries being British possessions, from which 175 applications were made, and three, it may be added, were made from Egypt. Only three appeals were made in the course of the year against the decision of the Comptroller, so that it may be taken that his decision is almost invariably satisfactory to applicants. The receipts of this office amounted to 103,827*l.*, of which 88,996*l.* were for patents' fees, 3477*l.* for designs' fees and stamps, 7014*l.* for trade-marks' fees, and more than 4000*l.* for the sale of publications. The chief payments made were 36,225*l.* for salaries—all of which are set forth in detail in the report—and 17,000*l.* to Messrs. Eyre and Spottiswoode for printing. There was a surplus income of nearly 40,000*l.*

THE International Telegraph Congress, which meets in Berlin on August 10, will be attended by delegates from all the European states, and from Brazil, British India, Dutch India, Egypt, Algeria, Cochin China, Japan, Natal, New Zealand, Persia, Siam, Cape Colony, South Australia, and Victoria, as well as from all the great cable companies. The chief subjects of deliberation will consist of various technical questions, including more especially a general reduction of tariffs.

THE Council of University College, London, have instituted a Professorship of Electrical Engineering, and have appointed Dr. J. A. Fleming thereto. Dr. Fleming retains his connection as advising electrician with the Edison and Swan Electric Light Company.

WE give the following extracts from Prof. Adams's report to the Senate as to the proceedings in the Cambridge Observatory for the year ending May 26, 1885:—The total number of observations made with the transit circle during this interval, for determinations of right ascension and north polar distance, is 3253. These include 658 observations of clock stars made on 152 nights; 69 observations of Polaris at the upper transit involving 151 circle readings, and 73 observations at the lower transit involving 180 circle readings; 11 observations of stars compared with Wells's Comet; and 2442 observations of zone stars made on 100 nights, the greater number at five or seven wires, and all, without exception, read off with four microscopes. For instrumental adjustment the Nadir Point was observed 203 times, the level 203 times, and the collimation 207 times. Twenty pairs of observations for flexure of the transit telescope made June 18 to 23, 1884, give for the coefficient $-0''.651$; this will need confirmation, as it differs considerably from the former determination, $-0''.936$. The observations of clock stars and those of Polaris are completely reduced, and the mean places for January 1 obtained up to the end of 1884. The true apparent places of all the other stars observed in 1884 is also obtained both in Right Ascension and North Polar Distance. As regards the observations of former years:—The mean R.A. and N.P.D. of the Zone Stars are obtained up to December 12, 1877, and the true apparent R.A. and N.P.D. to the end of 1882, and the reductions are far advanced in 1883. The reductions from mean to apparent place at date are calculated to the end of 1882. The means of transits and microscope readings are deduced up to the present time. The intervals of R.A. wires used in the reductions for 1884 were obtained from 63 observations of Polaris made January 18 to July 10, 1884: (1), by taking the mean of the intervals for Polaris and the mean of the declinations, and using the formula $\sin E = \sin P \cos \delta$; (2) by deducing the equatorial intervals from each individual observation, and taking the mean of the results. The intervals by the two methods almost exactly agreed. The meteorological observations are communicated daily by telegraph to the Meteorological Office. The sunshine recorder has been regularly employed, and the records sent at intervals to the office.

COL. PRJEVALSKY telegraphed to St. Petersburg from Kiria, in Khotan, on June 20, that during April and May he and his party had explored the region between Lob Nor and Kiria, and that, leaving stores at the latter place, he was about to go into the neighbouring Tibetan mountains, whence he would return to Kiria at the end of August, and then come back to Russia.

PROF. THALÉN, whose classical researches on the spectra of the metallic elements have won for him such wide renown, has recently published a new memoir on, and a revised list of, the lines of iron, presented to the Royal Society of Upsala last September (published by Berling, Upsala). The new work has been done by means of a gramme dynamo, and much higher dispersion than that employed in 1864. An upper carbon pole being rejected on account of the spectrum of "acetylene," about which we have heard so much in this country, and which we now know to be due to carbon vapour, three tubes of iron 15 mm. in external diameter were used to prevent fusion of the points. The size of the laboratory did not permit the use of a lens, but the poles were placed in a horizontal position. The spectroscope employed had six and sometimes nine prisms of flint of 60°, the focal length of the object-glasses of collimator and telescope being 81 cm. and magnifying power 62. The wave-lengths have also been re-determined by a process which he gives.

Bulletin No. 8 (1885) of the U.S. Department of Agriculture (Division of Entomology) is occupied by a particularly interesting memoir by Prof. C. V. Riley on the occurrence of "Periodical Cicada" (*C. septendecim*). This insect is one of the marvels of entomology, because ordinarily a period of seventeen years elapses between the deposition of the egg and the appearance of the perfect *Cicada*, and practically all but a few weeks of that period are passed in the preparatory underground larval condition. But even such a Methusaleh amongst insects is liable to have its development hastened (and its whole life thereby shortened) by temperature, for Prof. Riley discovered that (principally in the Southern States) there is also a thirteen-year brood of the same species, although each condition impinges on the domain of the other. That the larva sometimes penetrates to a great depth is shown by the fact that the perfect insects, true to time, once came through the floor of a cellar 5 feet deep, a building having been erected over the site of their underground quarters; in another instance the larvæ were found 10 feet below the surface.

Occasionally, at very long intervals, the 17-year and 13-year forms appear simultaneously. Such an event as regards one of the largest broods happened in the year 1647, again in 1868, and will not again occur till 2089. But it must not be supposed that the broods are simultaneous over all the United States; they vary according to locality, so that somewhere or other there is nearly always a brood on the wing. Prof. Riley has, through his agents, collected information from many states, and for thirty-two different districts is able to predict the particular year of appearance during the next 13 and 17 respectively in these districts. 1887, 1890, and 1892 are the only years omitted as not likely to produce the Cicadas. One would imagine that in the course of 17 years a larval *Cicada* must occasion great damage to the roots of trees, &c., but it would seem that any damage in this way is as nothing compared with that inflicted on the foliage by the perfect insect during its brief existence.

AN air-balloon railway is about to be constructed on the Gaisberg, near Salzburg, a mountain of no great height, but offering a magnificent view over the beautiful neighbourhood of the town. The balloon, which will have grooved wheels on one side of its car, will ascend a perpendicular line of rails, constructed on the principle of the wire-rope railway invented years ago for the Righi, but never realised.

M. FOUQUÉ has established at Meudon Observatory, with the kind assistance of M. Janssen, an apparatus for registering electrically the propagation of earthquakes in underground layers. Experiments have been made by the fall of a weight of 600 kilogrammes from 7 metres; the results having been deemed satisfactory, measures are being taken for procuring the fall of 900 kilogrammes from 9 metres, which represents a shock of 81,000 kilogrammes. A steam elevator will be procured for further investigations.

AT the recent distribution of prizes at University College, Dundee, Prof. Gairdner, of Glasgow, strongly advocated the formation of a School of Medicine in Dundee. Dr. Gairdner not only urged the duty of setting a medical school afoot, but he showed how in some ways a new school may be made more attractive and more efficient than the old, so as both to supply the educational needs of its own neighbourhood and even to draw students from a distance also. Tradition, prejudice, and the vested interests of professors make all reform slow in the old Universities, and cause many changes which are admittedly desirable to seem well-nigh impossible of attainment. The matter in which Prof. Gairdner chiefly indicated the possibility of reform is the present separation of practical from theoretical instruction and the long delay in bringing a student face to face at the bedside with disease. In a new school, he thought, the attempt should be made to give men hospital instruction from the very beginning of their student life; to illustrate to them in the wards what they are at the same time learning in the lecture-room in chemistry, anatomy, and physiology; and to give the longest possible training to hand and eye and ear in the subtle discrimination of disease.

THE University College of Wales at Aberystwith was the scene of a destructive fire during Wednesday night last week, which resulted in the loss of two lives, including Prof. James Macpherson, and serious injury to three other persons. The College buildings were the largest and handsomest in the Principality, having been built at a cost of 80,000*l.*, and they include the necessary rooms and offices for the education of a large number of students. The flames spread with alarming rapidity, and in a short time had complete hold of the museum, library, professors' rooms, and students' apartments. By great exertions all the articles of value in the museum and library were removed. The Principal's residence and examination hall escaped, but the northern wing was gutted. The College was insured for 10,000*l.*, but the damage will amount to 40,000*l.*

A TELEGRAM from Simla, July 9, states that shocks of earthquake continue to be felt in Cashmere at intervals of two or three days. A severe shock occurred at Srinagar on the 4th inst.

A SEVERE earthquake, which lasted for some time, and was felt, with varying intensity, over the whole province, occurred at Calcutta on Tuesday morning, at twenty-three minutes past six. Some of the shocks were very serious, and the walls of a number of houses were cracked, causing the utmost alarm to the inhabitants.

THE death is announced, at the age of forty-seven years, of Mr. N. W. Posthumus, director of the Higher Burgher School at Amsterdam, one of the founders of the Dutch Geographical Society, and from the beginning its secretary and one of the editors of its *Journal*. Many contributions to the "Tijdschrift Aardrijkskundig-genootschap" are due to him.

WE have received from the Observatory of Brussels the volumes of the *Annales* of the Royal Observatory there, giving the documents and observations made on the Transit of Venus in 1882 by the Belgian party ordered to Texas. Drawings are given of the contacts, which require careful study; almost everything but the "black dip" was seen in a Dolland of 11 cm. aperture.

THE American Government have forwarded a consignment of catfish to the National Fish Culture Association with a view to their being acclimatised to the waters of this country. They arrived per s.s. *Britannic* in perfect condition, all being alive, which, considering the long voyage they had been subjected to, is remarkable. The catfish is a very valuable food-fish, and would assume a high rank amongst the freshwater fishes of our waters if cultivated. Pending their removal to the Fish Culture Establishment of the Association at Delaford, they are being exhibited at the Aquarium of the Inventions Exhibition, where they attract considerable attention.

SEVERAL of the picked dogfish in the tanks of the Aquarium at the Inventions Exhibition brought forth young last week. They lived for several days, but ultimately died.

A FURTHER stock of landlocked salmon were turned into the Thames on Thursday last by the Thames Angling Preservation Society, in the presence of various gentlemen interested in the matter. This species is exactly suited to this river, being non-migratory, for salmon once quitting for the sea the polluted water of the Thames are not likely to return thereto.

WE have received a new edition of Mrs. Lankester's "Wild Flowers Worth Notice," revised, improved, and increased in size. Allen and Co. are the publishers.

"FACE and Foot Deformities" is the title of a book of curious interest, by Mr. Frederick Churchill, C.M., published by J. and A. Churchill.

THOSE interested in glaciology should read Prof. Forel's little *brochure* on "Les Variations Périodiques des Glaciers des Alpes," separately reprinted from the *Jahrbuch* of the Swiss Alpine Club (Staempli, Berne).

DR. J. E. TAYLOR's latest contribution to popular science is "Our Common British Fossils and where to find them" (Chatto and Windus). A prettily illustrated book of a similar character is Mr. F. G. Heath's "Where to find Ferns," published by the S.P.C.K.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♂)

from South Africa, presented by Mr. G. C. Barnes; an American Badger (*Taxidea americana* ♀) from North America, presented by Mr. F. J. Thompson; a Common Fox (*Canis vulpes* ♀), British, presented by Mr. Christopher Heseltine; a Rufous Rat-Kangaroo (*Hypsiprymnus rufescens* ♀) from New South Wales, presented by Miss Laidlaw; a Red-throated Amazon (*Chrysotis collaria*) from Jamaica, presented by Mrs. S. Waite; three Rufous-vented Guans (*Penelope cristata*) from Central America, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Leopard Tortoise (*Testudo pardalis*) from South Africa, presented by Mrs. Henrietta Hodges; two Crowned Horned Lizards (*Phrynosoma coronatum*) from North America, presented by Master Chas. E. Napier; a Cinereous Vulture (*Vultur monachus*), European, a Nonpareil Finch (*Cyanospiza ciris*) from North America, deposited; an Axis Deer (*Cervus axis* ♂), a Mule Deer (*Cariacus macrotis* ♂), three Long-fronted Gerbilles (*Gerbillus longifrons*), seven Mandarin Ducks (*Œx galericulata*), four Chilian Pintails (*Dafila spinicauda*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, JULY 19-25

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 19

Sun rises, 4h. 7m.; souths, 12h. 6m. 1·2s.; sets, 20h. 5m.; decl. on meridian, 20° 47′ N.: Sidereal Time at Sunset, 15h. 56m.

Moon (at First Quarter) rises, 13h. 10m.; souths, 18h. 28m.; sets, 23h. 38m.; decl. on meridian, 10° 33′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 3	13 34	21 7	16 27 N.
Venus	5 56	13 31	21 6	17 6 N.
Mars	1 18	9 33	17 48	23 23 N.
Jupiter	7 44	14 41	21 38	10 23 N.
Saturn	2 8	10 18	18 28	22 32 N.

Occultations of Stars by the Moon

July	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
20	o^2 Libræ	6	22 58	0 1*	136 272
22	29 Ophiuchi	6	22 31	23 1	33 356

* Occurs on the following day.

Phenomena of Jupiter's Satellites

July	h. m.		July	h. m.	
20	21 21	III. tr. egr.	22	21 4	II. tr. egr.
22	20 55	I. tr. ing.	23	21 9	I. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

A TEACHING UNIVERSITY FOR LONDON

An extraordinary meeting of the Convocation of London University will be held on the 28th inst., when the report of the Special Committee appointed on February 24 to consider the question of a Teaching University for London will be presented by Lord Justice Fry, who will also move the following resolutions:—

1. That the report of the Special Committee and the scheme therein comprised be received and adopted.

2. That the Senate be requested to consider and approve the said scheme, and to take such steps as they may think fit to carry the same into effect.

3. That a Committee of this house, consisting of five members, be appointed to confer with the Senate in respect of the said scheme in case the Senate shall desire such conference.

The following is the scheme for the constitution of the University proposed by the Special Committee:—

1. The University to consist of—(1) Senate; (2) Convocation; (3) Constituent Colleges; (4) Faculties; (5) Boards of Studies, with the Queen as Visitor.

I.—Senate

2. To consist of:—(1) Chancellor; and (2) Vice-Chancellor (to be appointed and retain office as at present); (3) the Chairman of Convocation *ex officio*; (4) and not more than thirty ordinary members (including the Vice-Chancellor), of whom six shall be nominated by the Crown, six shall be elected by Convocation, and three shall be elected by each of the four Faculties. And if and when the following bodies respectively shall become Constituent Colleges—one shall be nominated by the President of University College, London; one shall be nominated by the Principal of King's College, London; one shall be nominated by the President of the Royal College of Physicians of London; one shall be nominated by the President of the Royal College of Surgeons of England; one shall be nominated by the Chairman of the Council of Legal Education, and one shall be nominated by the President of the Incorporated Law Society.

3. The nominating bodies to determine for themselves on what recommendation the nominations shall be made.

4. One-third of each of the groups of six and three members of the Senate to retire each year; such one-third to be those who have been longest in office, or, when several have been in office for the same period, to be ascertained by ballot.

5. The six representatives of colleges to serve for three years.

6. Power to fill up occasional vacancies.

7. Power to re-nominate and re-elect.

8. In the first place, the faculty and college members to be added to the existing Senate; but no new members to be appointed by the Crown or Convocation till the number of Crown and Convocation members respectively has fallen below six, and then only so as to bring the number up to six.

II.—Convocation

9. To remain unchanged.

III.—Constituent Colleges

10. The Constituent Colleges to consist of the following bodies in or near London:—(*a*) such bodies as may be named in a schedule to be settled by a joint committee of the Senate and Convocation; (*b*) such other bodies being colleges or institutions incorporated by Royal Charter, or otherwise established on a permanent and efficient footing, in which the majority of the students are of the age of seventeen years at least, as the Senate with the concurrence of the faculty or faculties interested may from time to time admit.

11. Admission as a constituent college shall be subject to such terms as may be agreed upon between the body becoming a constituent college and the joint committee or the Senate with the concurrence aforesaid (as the case may be).

12. The constituent colleges shall be arranged in three groups —viz. (*a*), those colleges which are principally intended to occupy the entire time of their students; (*b*) those colleges in which lectures are given of the most advanced kind, whether professional, literary, or scientific; (*c*) those colleges which are intended to aid the evening studies of persons engaged in business, or otherwise do not fall under either of the preceding groups.

13. By the terms of agreement on the admission of such constituent college the following points shall be determined:—(*a*) The group to which it shall belong; (*b*) the faculty or faculties to which it shall belong; (*c*) the number of members of the faculties to represent the college; (*d*) the class or classes of professors or teachers in the college who are to take part in the election of members to represent the college.

14. In a college of the first and second group the number of its representatives on the faculties shall *prima facie* bear a larger proportion to the total number of professors and teachers in the college than in the case of a college in the third group.

15. A constituent college and the Senate with the concurrence of the faculty or faculties interested may revise the terms of the agreement between the University and the constituent college.

16. No person shall be eligible as a member of a faculty representing a college unless he be in the class of professors or teachers in that college and capable of taking part in the election of members to represent that college.

17. Power to be given to the Senate with the concurrence of the faculty or faculties interested—(*a*) to diminish or increase the number of teachers in a college who shall be members of a faculty or faculties; (*b*) for good cause to remove any college from being a constituent college.

18. The affiliation of colleges to the University to cease.

19. The institutions from which the University receives certificates for degrees in Medicine (hereinafter called the recognised Medical Institutions) to retain their right of giving such certificates whether they be or be not constituent colleges.

20. The list of recognised medical institutions to be subject to the existing power of revision, but so that the Senate shall not report thereon without the previous advice of the Faculty of Medicine (see Charter of January 6, 1863, section 37).

IV.—FACULTIES

21. There shall be four faculties—viz. (1) Arts; (2) Laws; (3) Science; (4) Medicine.

22. All departments of knowledge in which examinations may be held by the University, and not included in any of the other faculties, shall be included in the Faculty of Arts.

23. Each faculty shall consist of—(a) the representatives of the constituent colleges; (b) the examiners in the faculty during their periods of office and three years afterwards; (c) such persons eminent in the studies with which the faculty is concerned not exceeding six in number as the faculty may elect and for such periods as they may determine.

24. Each faculty shall elect—(a) a chairman for three years; (b) three members of the Senate; (c) members of a board of studies.

25. The persons to be elected under the last clause must be members of the faculty not being examiners in office, and on ceasing to be members of the faculty or accepting the office of examiner such persons will vacate their seats as chairman or member of the Senate or board.

26. On any matter connected with its subjects a faculty may—(a) make recommendations to its board of studies in all matters within the competence of the board; (b) represent its views to the Senate.

V.—BOARDS OF STUDIES

27. There shall be a board of studies in each faculty.

28. Each board shall consist of such a number of members being a multiple of three, and not less than six nor more than twenty-one, as the faculty shall from time to time determine, together with one member of Convocation to be elected by Convocation.

29. One-third of the faculty members shall retire each year.

30. The member elected by Convocation shall sit for three years.

31. Power to fill up occasional vacancies.

32. Power to re-elect.

33. Each board shall elect a chairman every year.

34. Each board of studies shall have the following powers and duties:—(a) To consider the recommendations of its faculty; (b) to consult together on all matters connected with the subjects of its faculty and the examinations therein and the teaching thereof; (c) to advise the Senate from time to time as to the institution of new degrees or any change in the degrees, or as to the regulations in force with regard to the degrees and examinations in its faculty (without which advice the Senate shall not act in the said several matters); (d) to consult with and advise the examiners in the faculty; (e) to represent its views on any matter connected with the subjects of its faculty to the Senate; (f) to make by way of report to its faculty such recommendations as it may think fit, with the object of insuring suitable and efficient teaching in the subjects of its faculty, and generally to report to its faculty on all matters connected with its subjects as the board may think desirable; (g) to summon a meeting of its faculty for the discussion of any matter relating to its subjects.

35. Boards of studies may, if they or any of them shall from time to time think it desirable, meet and act concurrently on particular subjects.

VI.—EXAMINERS

36. The examiners in each faculty may from time to time make such reports and recommendations to the faculty or its board of studies as they may think fit.

VII.—DEGREES

37. Candidates to be admitted to matriculation and all degrees other than degrees in the Medical Faculty without regard to the place of their education.

38. Candidates for degrees in the Faculty of Medicine to show that they have passed the required course of instruction in a constituent college in the Medical Faculty or in a recognised medical institution.

VIII.—GENERAL PROVISION

39. Except so far as altered by the foregoing provisions either directly or indirectly, the existing constitution of the University to be retained.

DANISH RESEARCHES IN GREENLAND

DURING the last few years the Danish Government have despatched several scientific expeditions to her great but sparsely populated dependency, Greenland, for the purpose of exploring it geographically, zoologically, botanically, and mineralogically, while efforts have also been made to learn something of the Norse archæological remains in South Greenland. Glacial researches, too, have been prosecuted and valuable observations made of the enormous ice-field—the inland ice, which fills the entire interior—and of its movements to the sea through the numerous fjords, the birth-place of the greatest icebergs in the northern hemisphere.

The results of these varied researches have only been published after a long delay. It should, however, be stated that the Danish Government have followed a carefully prepared plan on this point, as the Royal Commission appointed for the purpose of supervising the same, consisting of Prof. Johnstrup, Admiral Ravn, and Dr. Rink, have decided that the results of the researches should not be made public until their analysis was completed in every detail. These have been embodied in the work published by the Commission: "Videnskablige Meddelelser om Grönland" (Scientific Informations about Greenland), a publication which has gained one of the gold medals of the French Academy, and of which six or seven volumes have been published. In addition to this work we have received another, equally great, containing 109 tables, with facsimiles in colour of fossil plants found in North Greenland, defined and described by the late Prof. Oswald Heer, of Zurich, who also defined the fossils which Mr. E. Whymper, in 1867, brought home from the Disco Island and the peninsula of Noursoak, an account of which was published in the *Transactions* of the Royal Society, 1869, pp. 445-488, with eighteen lithographed plates.

Last year no less than three Danish expeditions were at work along the Greenland shores.

The first of these, under Lieut. A. Jenssen, known for his wanderings on the inland ice—was engaged in exploring and charting the district on the west coast, between Sukkertoppen and Holsteinborg (65¼°—67° N. lat.), where there is a network of little unexplored fjords, between mountains rising from 6000 to 7000 feet in height, penetrating upwards of 100 miles into the broad coast-land.

The results of this expedition were very important, as the flora, fauna, and geology of this part of Greenland were ascertained. Several new plants were brought home, and the flora on a "nunatak," viz. a mountain rising above the inland ice, was collected. Lieut. Jensen is still occupied in finally drawing and describing the explored part of the coast, embracing about 1000 square miles.

The second expedition, under Lieut. J. Holm, is, in its second year, engaged in penetrating from Cape Farewell, along the barren and difficult east coast, always encircled by pack-ice. It comprises four scientists, and has for its object the exploration of the country between the 63° and 70° lat. N., where the formation of the land is much like that of Iceland.

Besides having to explore the east coast as far north as circumstances may permit, two of the members, viz. Lieut. Garde and Dr. Eberlin, have established a station at Nanortalik (lat. 60° N.), where they have, last winter, prosecuted meteorological, magnetical, and auroral observations, being a continuation of those effected during 1882-83 at Godthaab. Observations of ice and sea are also made. The two scientists who have wintered in some spot on the east coast, started, according to latest advice, from Fluidlek (lat 61½° N.), where a depot has been established, at the end of July last year, northwards, in the company of Greenlanders, eighty-two of whom lived on the east coast, and were on their way home from trading on the south coast. There were thirty-six boats in all. Late in July the great glacier Puisortok, which reaches down to the sea, and which in 1830 caused Graah, the only European who had hitherto visited it, so much trouble—was passed without much difficulty. Soon after Tingmiarmint (lat. 62° 40′ N.) was reached, the northernmost place whence we have news of the party. It was their intention to attempt to reach a place, Augmaksalik, in lat. 65½° N., before the winter, where there is a settlement of Greenlanders, but which has never been visited by Europeans. It lies near the place where Nordenskiöld landed in 1883 without seeing any natives. In the spring of the present year the coast will be explored, but we shall have no news of the party until they return home. Lieut. Holm states that the east Greenlanders were very kind and friendly. They were all heathens. They were particularly remarkable for their features, being tall people, generally with dark eyes and hair, and without any trace of the Eskimo. However, that they should be descendants of Norsemen seems hardly probable on account of their uncivilisation and want of religion, Norse language, and traditions. The party at Nanortalik have explored eight great fjords, between lat. 62½° and 60½° N., right to the bottom, without finding the least trace of Norse remains.

The expedition may be expected to return at the end of 1885. There is, however, great probability of the party under Lieut. Holm having to spend another year on these inhospitable shores, where the European, in order to exist, has to live like the Eskimo.

While the above-mentioned two expeditions were chiefly confined to explorations, the third one despatched last entered upon an almost unbroken field for research, viz., the sea on the west coast. Between 1876 and 1879 researches of the Denmark Sound—*i.e.*, the sea between Iceland and Greenland—were effected by the Danish Admiralty Expedition, whereas Davis Strait and Baffin's Bay have only been cursorily studied, as, for instance, by H.M.S. *Valorous* on its return journey in 1875, after having provisioned Sir George Nares, and by the Nordenskiöld Expedition of 1883.

The vessel employed for last year's researches was the *Fylla* gun-boat, in command of Capt. C. Normann. The scientific staff were—Prof. E. Warming, botanist; Mr. Th. Holm, zoologist; and Dr. H. Topsöe, chemist and mineralogist. The hydrographical researches were made by the officers; and for the purpose of examining the flora and fauna of the sea the expedition was provided with trawls and scrapers of most improved American pattern, and, for the deep-sea researches and measurements of temperature, with a Sigsbee's sounding-apparatus with wire rope and a good collection of the necessary instruments. For the determination of the temperature of the sea, thermometers by Negretti and Zambra were mostly used, some of which were fitted with the splendid automatic reversing apparatus invented by Capt. Magnaghi, of the Italian Navy, and some with one constructed by Capt. G. Rung, of the Copenhagen Meteorological Institute, by which the turning of the instruments is effected at a given time by the simultaneous freeing of a weight running in the line. The Miller-Casella thermometers, with which the expedition were furnished, were used very little, on account of the existing high bottom temperatures.

For fetching water from various depths, water-carriers on Sigsbee's (American), Ekman's (Swedish), and Rung's (Danish) principles were used, the latter being a new invention, which was very practicable for lesser depths, as it not only brings the sample of water required, but also gives the exact temperature, a thermometer being hidden in the axis of the vessel, the mercury column of which is broken as soon as it is full.

The *Fylla* left Copenhagen at the end of May, and arrived, at the end of June, at Godthaab, a colony with 300 to 400 Eskimo inhabitants, on the west coast of Greenland, in lat. 64¼° N. Hydrographical researches were commenced early by following the edge of the Polar ice from Cape Farewell, which, during the summer, filled the southern and eastern parts of Davis Strait in vast quantities, and by studying the position of the ice-belt and the composition of the water inside and outside the ice current.

We have no space to give a detailed account of the movements of the expedition in the Greenland seas; it must be sufficient to state that the expedition, being chiefly stationed at Holsteinborg (67° N. lat.), visited most of the Danish settlements in Central Greenland, its field of research lying between 64° and 70° N. lat., and from the innermost creek at Disco Bay (about 50° W. long.) to the middle of Davis Strait,—*i.e.*, to about 57½° W. long. An attempt to get further west, and, if possible, reach the coast of America at Cape Walsingham and Cumberland Bay, had to be abandoned on account of the enormous ice-masses which were encountered there in July, and which, in the middle of August, when the *Fylla* was on her return journey, had, in 67° N. lat., approached within 50 to 60 miles of the shores of Greenland, which is very unusual at that season.

The deep-sea researches consisted in sounding, trawling, and scraping, both on the extensive banks which, between 62° and 68° N. lat., nearly everywhere surround the shores of Greenland with a deep channel between them and the coast, and in the Davis Strait.

The researches did not extend to very low depths, the greatest found being only about 900 fathoms south-west of Godthaab, while on the *bridge* connecting Greenland with Cape Walsingham, at the place where Davis Strait is narrowest—in about lat. 67° N.—depths of 400 fathoms only were struck. In the Disco Bay, where no soundings had previously been taken, a depth varying from 200 to 270 fathoms was found, and it has been discovered by the *Fylla* Expedition that at the mouth, at a depth of 180 to 190 fathoms, a barrier separates this basin from Davis Strait, and thus prevents icebergs of a greater draught from passing from the great fjord of Jacobshavn into the ocean. Judging by the results of the measurements of icebergs effected during recent years in this fjord by Prof. Steenstrup and Lieut. Hammer for the purpose of ascertaining the proportion between the part above and the part below the surface of the water, it has been found that only icebergs with an *average* height above the surface of 150 feet can float over this threshold, the proportion between the part above and the part below water being 1 to 8·8—*i.e.* 1 : 8·41 for blistered glacier ice, and 1 : 9·23 for glacier ice without blisters. For sea-water ice with a water saltness of 3·3 per cent. the proportion is only 1 : 5·29.

The numerous samples of water taken from the surface, bottom, and intermediary depths, during the voyage have not yet been thoroughly analysed, and before this has been done, it is hardly possible to say anything definite as to the currents at various depths. This much is, however, certain—that a comparatively warm current of water fills the eastern and central parts of the narrowest portion of Davis Strait—as far as the western ice limit—but that the highest temperature of the same, when the depth is more than a couple of hundred fathoms, is not, as is generally the case, found at the surface, *but nearest the bottom*, and that the coldest layer seems to lie between 30 and 100 fathoms. As an example may be taken the following series of temperatures obtained in lat. 67° 07′ N. and long. 56° 31′ W. on July 8, 1884, the temperature of the air being ÷ 1°·9 C.

At the surface	+ 2°·8 C.
,, 10 fathoms	1·9
,, 30 ,, ...	0·9
,, 100 ,, ...	1·1
,, 200 ,, ...	3·6
,, 362 ,, (bottom)	4·2

Similar conditions were also found everywhere in Disco Bay, but the surface water in this confined basin was considerably warmer, while the bottom temperature was proportionately lower.

We will give an example from lat. 69° 14′ N. and long. 52° 54′ W., on the morning of July 23, the temperature of the air in calm sunny weather being + 10°·2 C. in the shade :—

At the surface	+ 7°·7 C.
,, 5 fathoms	7·1
,, 10 ,, ...	4·2
,, 20 ,, ...	1·4
,, 30 ,, ...	+ 0·1
,, 50 ,, ...	+ 0·2
,, 70 ,, ...	+ 0·1
,, 100 ,, ...	0·6
,, 130 ,, ...	0·9
,, 200 ,, ...	1·8
,, 264 ,, (bottom)	2·1

That the influence of the ice-fjord is here felt at the intermediary depths is obvious even without any chemical analysis of the water of the various layers. It is, however, very remarkable that the surface-temperature in such a high latitude, and in water constantly covered with enormous icebergs, *can*, in the short summer, reach such a height as the above series show. This is, by the bye, so far from being a solitary example that most serial temperatures from this locality, which were, however, all taken in calm weather, and extended over seven days, show a much higher surface-temperature.

The highest temperature was registered off the colony of Christianshaab, in the Disco Bay, in the south-eastern corner, viz. + 11°·4 C. at the surface. At five fathoms it fell, however, to 2°·8, and stood from 30 to 100 fathoms at + 0°·2 C. That the icebergs in these waters must melt rapidly, particularly at the water-line, is clear, which was also corroborated by experience, all being deeply furrowed and heeling over.

The trawlings and scrapings extended to a depth of 300 fathoms, and were effected as well in Davis Strait, Disco Bay, on the banks, as in the fjords. The result was considerable, and several varieties of fauna previously unknown in the Greenland seas were caught, as well as some entirely new species. Among the rarest forms may be mentioned *Amblyops abbreviata*, *Mysideis grandis*, and *Boreomysis nobilis*, which are only known in a few species from the west coast of Norway, and *Spirorbis cancellatus*.

The harvest was richest on the banks, as was the case under previous expeditions, and poorest in Disco Bay, where several hauls at a depth of 200 to 250 fathoms brought up absolutely nothing, or only a couple of specimens of the same species. The trawl worked here so far down in the soft black clay, which everywhere covers the bottom, that the line constantly threatened to break. The expedition has brought home a total of 300 specimens of the deep-sea fauna.

During the stay in port the officers of the vessel were engaged in hydrographical labours, chiefly the measuring of certain harbours, and the botanists in excursions into the long, narrow fjords, where the vegetation is richest, but neither the mountains nor the islands were forgotten. The harvest was very rich. Of phanerogams and higher cryptogams alone specimens of 230 varieties were obtained, and five new plants were discovered, among which a new species of Carex, while several were found in entirely new places, whereby their geographical distribution has been increased with several degrees of latitude. Thus, *Linnæa borealis*, for the first time, in 1883, discovered in Greenland, and then in lat. 61° 10′, was this year found as far north as 67°. Special attention was also given to the collecting of materials for illustrating the development of the Arctic fauna, which has hitherto been neglected. Great attention, too, was paid to the algæ fauna, although it is very poor in the places visited by the expedition.

The mineralogical harvest of the expedition was poor, for the reason that Greenland has already been thoroughly explored, geologically and geodetically, by such eminent scientific men as Sir C. L. Giesecke, Dr. Rink, Profs. Johnstrup, Steenstrup, and Nathorst, that little more is to be learnt. One object of interest was, however, brought home—viz. a block of ironstone found on the shore of the Disco Island at Uifak, in lat. 69° 20′ N., of the same kind as those discovered there by Baron Nordenskiöld some years ago, and which were at first believed to be meteorites, but whose terrestrial origin must now be said to be beyond question, in consequence of Prof. Steenstrup having discovered nickel iron in lumps of all sizes, of exactly the kind as that contained in these blocks in the great basalt strata of the Disco Island. The block which weighs about 1800 lbs., has been presented to the Mineralogical Museum at Copenhagen, where it will be mounted, with those already brought thither from the same locality.

The scientific material collected by the expedition is under treatment, but considerable time must elapse before the final result is ascertained.

This spring another expedition has been despatched to Greenland, being the tenth since 1876. It is commanded by Lieut. Jensen, and has for its object, besides natural history and photographical studies, the survey of the west coast between Sukkertoppen and Godthaab, lat 65½°—64° N. This is the last stretch of the west coast which remains to be surveyed, and if Lieut. Jensen succeeds in finishing the work this year, the entire west coast of Greenland from lat. 59¾° to 72¼° N. will have been surveyed and charted.

That the Danes are proud of the accomplishment of this great and difficult work is only natural.

THE ROYAL SOCIETY OF CANADA

THE fourth annual meeting was held at Ottawa on May 26 and following days to the 29th inclusive; the President, T. Sterry Hunt, LL.D., F.R.S., in the chair. The following papers were read in Section III. (Mathematical, Physical, and Chemical):—On the analysis of silk, by Dr. H. A. Bayne, Royal Military College. The author selected samples of pure silk and linen and cotton (their purity being carefully determined beforehand by the use of the microscope), and after removing dressing material, colouring matter, &c., by ether and dilute hydrochloric acid, submitted all four samples to the action of a large number of reagents in order to determine to what extent solvents of silks affect other fibres also. The result of a large number of analyses showed that, for mixtures of silk and wool, basic zinc chloride is the most reliable reagent; while for mixtures of silk and cotton or linen, Lœwe's alkaline glycerine solution of oxide of copper gives the most trustworthy indications.—Mémoire sur l'introduction et l'interprétation rationelle des quantités négatives et des quantités imaginaires dans le calcul, by Dr. D. Duval.—Classification of natural silicates, by Dr. T. Sterry Hunt, F.R.S.—Blowpipe reactions on plaster tablets, by Prof. Haanel. This was in continuation of previous investigations.—Note on the quantitative blowpipe assay of Cinnobar, by Prof. Haanel.—On the determination in terms of a definite integral of the value of the expression—

$$\frac{1}{\underline{|m+n}}\left\{\left(x+\frac{n}{2}\right)^{m+n} - n\left(x+\frac{n}{2}-1\right)^{m+n} + \ldots \right.$$
$$(-1)^r \frac{\underline{|n}}{\underline{|n-r}\,\underline{|r}}\left(x+\frac{n}{2}-r\right)^{m+n} + \ldots +$$
$$\left.(-1)^n\left(x-\frac{n}{2}\right)^{m+n}\right\}$$

the series to be continued only as long as the quantity raised to power $m + n$ is positive, n being a positive integer, and m a positive integer, zero, or a negative integer numerically less than n; and on the deduction therefrom of approximate values in certain cases, by C. Carpmael, M.A. In this paper, after pointing out that the investigation of M. Cauchy fails when m is zero or an integer, although he assumed without comment that it would hold, the author proceeds to determine the values of a number of "extraordinary integrals" and obtains results different from those obtained by M. Cauchy, although his final approximate values agree with them if we correct certain numerical errors in Cauchy's results. — The geognosy of crystalline rocks, by T. Sterry Hunt, F.R.S.—Concernant la théorie de M. Steckel sur la veine liquide contractée, by C. Baillargé.—On tidal observations in Canadian waters, by A. Johnson, L.H.D., showing the very imperfect state of our knowledge of the tides, and the need of systematic observations on both the Atlantic and Pacific coasts.—On iron ores from Central Ontario. This paper comprises a series of analyses of magnetic and other iron ores from the counties of Peterborough and Hastings in the province of Ontario, with brief references to the conditions of occurrence of the various deposits from which the ores were taken, by Prof. Chapman.—A commentary on section ix. of Newton's "Principia," by Prof. Cherriman, M.A.—The density of weak aqueous solutions of certain salts, by Prof. MacGregor, D.Sc.—Redetermination of the difference of longitude between the observatories of McGill College, Montreal, and Harvard Observatory, by Prof. W. A. Rogers (Harvard) and Prof. McLeod (McGill College).—Redetermination of the differences of longitudes of Montreal, Toronto, and Coburg, by Messrs. Carpmael, M.A., McLeod, M.E., and Chandler, M.A.—Notes on (1) Clausius's theory of the virial; (2) the motion of a rigid body with one point fixed; (3) the equation of energy in generalised coördinates.—Geometrical methods in optics, by Prof. Loudon.—Notes on the economic minerals of New Brunswick, with a revised list of mineral localities in the province, by Prof. Baily. This paper being of the nature of a catalogue of localities, was not read before the Section.—Geology of Cornwallis or McNab's Island, Halifax Harbour, by Rev. Dr. Honeyman. A study of the local geology in which special reference was made to the occurrence of amygdaloidal boulders which were considered to have been derived from the vicinity of Cape Blomidon.—A Catalogue of Canadian Butterflies, with notes on the distribution of the genera, by W. Saunders. Explained merely in a few remarks, not being suited for reading in full.

The following papers were read in Section IV. (Geological and Biological):—On the Mesozoic floras of the Rocky Mountain region of Canada, by Sir W. Dawson.—Fossil plants from the Trias and Permian of Prince Edward Island, by Sir W. Dawson.—Illustrations of the fauna of the St. John group (third part), by G. F. Matthew. This paper was in continuation of former communications. It describes a large number of Cambrian forms, particularly trilobites, and discusses the relations of the subdivisions of the Cambrian of the vicinity of St.

John with those of the same formation in Europe.—On the Wallbridge Hæmatite Mine, as illustrating the mode of occurrence of certain ore deposits, by Prof. Chapman. The particular mine referred to has been practically worked out, and in the process a clear idea of its character has been gained. It is found to be a "stockwork," or irregular mass, and not, as had been supposed, a vein. Prof. Chapman regards it as typical of a large class of deposits in the vicinity.—On Cambrian rocks of the Rocky Mountains, by Dr. G. M. Dawson. These rocks are the oldest of those shown in the mountains between the 49th parallel and the Bow River. They are of great thickness, and include at one horizon red beds with pseudomorphic salt crystals, suncracks, &c. Fossils have so far been obtained from four localities only, and these appear to indicate the horizon of the Prospect Mountain group as olevellus shales of Eureka, Nevada. —On the geology of South-Eastern Quebec, by Thos. Macfarlane.—On the geology of Thunder Cape, Lake Superior, by Thos. Macfarlane. The last two papers were read merely by title, Mr. Macfarlane adding a few explanatory remarks.—Notes on the geology and fossils of Prince Edward Island, by Francis Bain, communicated, with remarks on the fossils, by Geo. Wm. Dawson. The paper contained the results of explorations by Mr. Bain, with mention of fossil plants found by him in different parts of Prince Edward Island. It appeared from these observations and fossils that the red and grey sandstones and shales of which the island is composed are divisible by superposition and fossils into three groups: (1) the Permo carboniferous as originally established by Sir Wm. Dawson, with local additions made by subsequent observers; (2) a formation regarded by Mr. Bain as probably Permian, and corresponding to the Lower Triassic of Dawson and Warrington's report; (3) an overlying series, probably Triassic, and corresponding to the Upper Trias of the above report. Sir Wm. Dawson discussed the evidence of the fossil plants as bearing upon the above views.

In Sections I. and II. the following (among others of a more or less literary character) were read:—(1) Population française du Canada de 1608 à 1631; (2) A travers des registres du XVII. siècle, by the Abbé Tanguay.—The manifestation of the æsthetic faculty among primitive races, by Dr. Daniel Wilson. This paper discusses the evidence of the æsthetic faculty, and the practice of imitative art among ancient and modern uncivilised races. The archæological investigations in European prehistoric remains showed a nearly universal absence of imitative art throughout the whole Neolithic period and the subsequent age of bronze. But behind this lay the vastly more remote age of the Cave-men of Southern France, with their singular indications of remarkable artistic skill. This the author compared with such evidences of imitative art as are familiar to us in the work of many native American aborigines, and stated his reasons for tracing all alike to efforts at sign-language and ideographic expression of facts and thought. This was illustrated from an analysis of native Indian languages in their terms for giving expression to the language of art.—Palæolithic dexterity, by Dr. Daniel Wilson. In this paper Dr. Wilson drew attention to the ingenious profile drawings now familiar to us as the products of the ancient Cave-men of Southern France, and showed that by the direction of the profiles they were divisible into right and left-hand drawings. In so far as the examples can yet be adduced, the right-hand drawings are to those of the left hand as about two to one. The percentage of left-hand drawings is thus greatly in excess of what would now be found. But it probably shows at that extremely remote period the bias of prevalent usage which, however originating, has sufficed to determine the nearly universal predominance of the preference for the right hand within the whole historical period.

ON THE OBSERVATION OF EARTH-TIPS AND EARTH-TREMORS

IN a paper read before the Seismological Society of Japan on February 15, 1883, I collected together a number of facts which lead to the belief that districts in all quarters of the globe have from time to time been subject to slow changes in level.

Amongst these evidences may be mentioned the changes which have been recorded by many observers in the position of the bobs of pendulums. That pendulums had not always hung in the same vertical line was sometimes indicated by the position of a multiplying index, and sometimes by the position of the stile of a pendulum as seen through a microscope. Another class of observations have been made by recording the position of a spot of light reflected from a small mirror, the mirror being so suspended that it was caused to turn by the slightest displacement of the pendulum relatively to the earth. A third class of records have been made with horizontal pendulums, the multiplying indexes of which have been observed to move from side to side as if the foundation on which the pendulums rested was being slowly tilted.

A fourth order of observations have been those which have been made with delicate levels, the bubbles of which slowly move along the containing-tubes in a manner difficult to explain. A fifth class of records indicating changes in level are those which have been made by observing the displacement of an image reflected from the surface of mercury.

A sixth kind of records are the changes sometimes observed in the levels of lakes and ponds. At the time of great earthquakes, at places remote from its origin, where there was no perceptible motion of the ground, the water of lakes and ponds have been observed to slowly rise and fall as if the basin in which they rested was being slowly tilted.

To the above six classes of records a number of miscellaneous observations might be added, all of which find an easy explanation if we admit that from time to time there are slow tips in the soil.

Another phenomenon which has been observed is that the surface of the ground is from time to time in a state of tremulous motion. These movements have been noted by observing the stile of a pendulum with a microscope, the end of a light multiplying index attached to a pendulum, the quivering and erratic motion of a spot of light reflected from a mirror connected with a pendulum or reflected from the surface of mercury.

An historical account of the various observations which have been made upon earth-tips and earth-tremors may be found in the reports of George and Horace Darwin to the British Association in 1881 and 1882.

Detailed accounts of the observations made in Italy are contained in Rossi's "Meteorologica Endogena."

An account of a considerable portion of the work which has been accomplished in Japan may be found in the *Transactions* of the Seismological Society, in the reports which from time to time I have had the honour of forwarding to the British Association, and in the pages of NATURE.

As it seems that these phenomena are gradually attracting an increasing attention, it is my intention in the following notes to give a brief account, not so much of the results I have obtained by observing earth-tremors and pulsations, but of the methods by which these results have been obtained, trusting that my experiences may be of value to those who are desirous of experimenting in this direction.

Among the first instruments I employed were microphones in conjunction with telephones and delicately-suspended short-period light pendulums. From time to time the telephones emitted strange sounds. As to what was the cause of these noises I am unable to say. Unless you kept your ear continually at the telephone there did not appear to be any method of obtaining a satisfactory record, so that, after much labour, these instruments were eventually discarded. For very similar reasons the small pendulums which were often in a state of tremor were also discarded.

The next class of instrument which I employed was similar to an apparatus suggested by Sir William Thomson and used by George and Horace Darwin in the Cavendish Laboratory when experimenting on the lunar disturbance of gravity. Any one who has read Mr. Darwin's account of these experiments will recognise the unusually great care which is required by any one who undertakes to make observations with such instruments. As I was without either assistants or a laboratory, and as my instruments were of the roughest description, my attempts at making satisfactory observations altogether failed. I certainly saw that the spots of light were continually shifting in position, but whether this was due to a tip of the soil or simply to contractions and expansions in portions of my instrument, I was unable to determine.

After much trouble and considerable expense, I very reluctantly gave up the pendulums and mirrors, and sought for apparatus of a still simpler kind. Having accidentally read an account of Plantamour's observations with levels, the simplicity of the apparatus induced me to borrow a pair of astronomical levels from the Imperial Observatory and follow his example.

For a long time these levels were installed beneath cases on a column kindly lent to me by the Professor of Natural Philosophy in the Imperial College of Engineering. Here they remained for over a year, after which they made many journeys. At one time they were nearly 13,000 feet above sea-level on the top of the conical Fujisan. At another time they were some hundreds of feet below sea-level at the bottom of the Takashima mine. These observations attracted the attention of the authorities at the Imperial Observatory, who, recognising the bearing they might have upon work which was going on in the observatory, they supplemented my observations with a second set of levels. All the usual precautions were taken to guard against the effects of temperature, and observations were carried out every three hours both day and night for more than a year. As the books of records accumulated, and the curves grew until some of them were 30 to 40 feet in length, experience showed that the errors chiefly due to changes in temperature might be equal to and even exceed the effects which were being sought. Now, I am inclined to an opinion communicated to me in a letter from M. d'Abbadie, who remarked that two levels upon the same column might be parallel, and yet their bubbles might move in

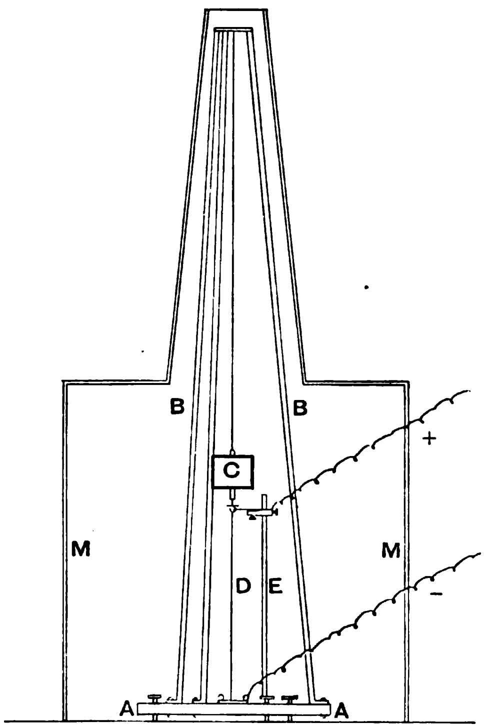


Fig. 1.

opposite directions. Notwithstanding this, the observations of levels have led to some interesting results.

First, there is the fact that level bubbles may wander without there necessarily being a change of level. Second, that level bubbles continue to move long after the sensible motion of an earthquake has ceased, thus giving us a means of observing the movements of long periods which usually bring the phenomenon of an earthquake to a close. After the earthquake the bubble will sometimes take up a position slightly different to that which it had before. Changes in the position of bubbles have been observed a short time before some of our earthquakes. Another result is the fact that the greatest irregularities in the curves showing the position of the bubbles of a level occur when earthquakes are most numerous. This is during the winter months. A last result is the fact that during a typhoon, or when the barometer is unusually low and fluctuating, a level bubble may be distinctly seen to pulsate through a small range, as if there were continuous changes of level going on.

While working with the levels another kind of instrument which I employed was a pendulum suspended from an iron stand, and so arranged that its stile could be viewed in the field of a microscope. By placing a prism beneath the end of the stile, the image of its end could be looked at horizontally, and the motion of the pendulum could be seen in any azimuth. At first I employed two microscopes placed at right angles, but by the adoption of the prism one microscope became sufficient. With these instruments, which are similar to those employed by Messrs. Bertelli, M. de Rossi, and other Italian observers, I verified for myself some of the more important results which had been noted in Europe.

For instance, it was seen that the pendulum was seldom at rest. Storms of tremors would take place with a low barometer. The pendulum did not always vibrate over the same point. It appeared as if there had been a tip in the soil, and the stand of the apparatus had been slightly inclined. These, together with other results which in many respects are little more than repetitions of results obtained by Bertelli, Rossi, and other observers, I have already published. Without attempting to describe other experiments which I have instituted, I will now give a brief description of an instrument which has been reached gradually, and which has given me the greatest satisfaction. From a letter received from M. d'Abbadie, whose researches regarding the change of vertical are amongst the most important yet instituted, I learn that my instrument has many points in common with one employed by M. Bouquet de la Grye. When I first set up this instrument, it was simply as a contrivance intended to make electrical contact, and set certain machines in action at the time of an earthquake. I next employed it as an instrument to record the occurrence of slight earthquakes. In its third form it was used to indicate earth-tremors and devia-

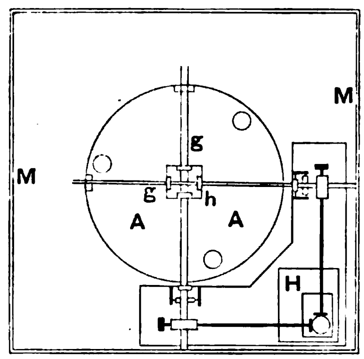


Fig. 2.

tions in the vertical. It will be readily understood from the accompanying sketches, Figs. 1 and 2: A A is a circular disk of cast iron about ¾ inches in thickness, resting on levelling screws. Bolted to this is a tripod of angle iron about 5 feet high, B B. This forms the support for a pendulum, C. The bob of this pendulum weighs about 7 lbs. It is made of a brass tube (3 m. diameter and 2¼ m. long) filled with lead. This is carried by a fine iron wire 3 feet 3½ inches long, soldered into a small hole in a plate at the top of the tripod. A spike, C, projects from the base of the bob (see Fig. 3). As the bob with its spike were turned in a lathe, the end of the spike, the point of support and the centre of figure of the bob are fairly in a straight line.

A long, light pointer, D, made of a strip of bamboo which has been varnished, is kept in contact with the base of the pointer, as shown in Fig. 3. At the top of the pointer there is a light brass ring, *c*; at the top of this there are two fine needle-points, *a* and *b*. The point *a* is kept in contact with the base of the pendulum by turning the screw T, which raises the flat spring S on which *b* rests. T is carried by a strong stand, E, which rests at three points on A; *ff* is a disk of lead which is nearly equal in weight to that of the pointer below *b*.

In one instrument *a b* is 6 mm. whilst the total length of D is 415 mm. With these dimensions we may suppose that if the base pendulum moved, say, 1 mm., then the lower end of the pointer would move about 68 mm. The values to be given to the defections observed in the pointer have also been estimated by giving a slight turn to one of the levelling screws of the base plate, and thus tipping the plate through a known angle.

Records were at first made by reading a scale of millimetres placed beneath the end of the pointer. Experience showed this method to be inconvenient and without satisfaction. What occurred between the hours of observation was unknown, whilst the records which were made were liable to greater or less errors due to the observer. This led me to seek for some method which would render the observations automatic. To attach a hair to the end of the pointer and let it be dragged across the surface of a smoked glass created too great friction. The necessary appliances for photographic registration were too costly and too troublesome to be employed as I was situated in Japan. A very near approximation to frictionless registration was obtained by sending a current down the pointer, the end of which trailed on the surface of a thick film of iodised starch covering a strip of paper. The strip of paper, which was on a metal tray, moved slowly by clockwork beneath the lower end of the pointer. On taking out the paper I found that the film of starch, with its blue line, could be dried down to form a brown line on the paper. The process was troublesome and the line subject to distortion by the flow of the starch. The next idea was to discharge a spark from the end of the pointer and perforate a band of paper moving beneath the end of the pointer at the distance of about 5 mm. This feature in the apparatus, M. d'Abbadie writes me, is an essential feature in the apparatus of M. Bouquet de la Grye. To avoid losing a record, should the pointer move parallel to the length of the paper, two bands of paper, *gg*, moving at right angles (by means of the clock, H), are employed (Fig. 2). One band passes beneath the other over the surface of a brass plate, *h*. The paper used is the ordinary paper employed in a Morse telegraph instrument. By allowing the hand of a clock to pass every five minutes across a wire the current from two of Thomson's tray-cells is sent through an indirection coil which yields the sparks to perforate the paper. Every hour the hand of the clock makes a long contact by

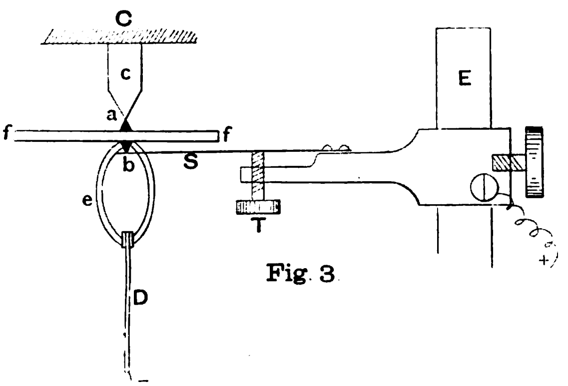


Fig. 3

passing across a small strip of platinum. In this way a large hole is made in the moving bands of paper and the hours are recorded.

To secure myself against error the same secondary current which perforates the paper of one machine is carried by wires to perforate the paper of a second instrument of slightly different construction placed on a stone column in a distant room.

The only work required is to wind the clocks which pull the paper and the clock which makes the contacts. This being done, records are automatically made every five minutes.

Up to the present the records which have been obtained have not been analysed, but certain of the results which they indicate are evident. These are as follows:—

1. Sometimes for days the pointers remain stationary, as is indicated by the sparks being regular and in a straight line (see Fig. 4).

2. Sometimes the pointers are in a state of tremor, and the sparks perforate the paper at many points, giving a line of several millimetres in breadth (see Fig. 5). These tremors may continue for ten or twelve hours. From the diagram, the duration of these tremors and the range of motion can be accurately measured. The instruments in both rooms agree as to the occurrence of tremors and periods of rest.

3. Sometimes the pointer will slowly wander from the straight line, and then slowly return. This usually takes place two or three times in succession. It would seem as if the ground had been slowly tipped through one or two seconds of arc, the period of each tip being from fifteen to sixty minutes (Fig. 6).

In regard to the occurrence of these tips, the instruments in the two rooms only occasionally coincide.

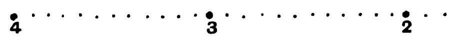
As to whether they are really to be regarded as true disturbances of level, or simply as movements due to local causes, I shall be better able to speak after a more carefal examination of the records.

4. Sometimes I find the bands of paper perforated over their whole breadth by sparks in all directions. This indicates that an earthquake has occurred and the pointer has been swinging (see Fig. 5, about 9.15 p.m.). All these figures have been produced by pricking through from the original diagrams. The clocks which I have used are made from small American spring clocks costing in Japan about 12*s*. each. The total cost of the portion of the apparatus figured, including the case, M, the doors of which and the parts which come in contact with the column are edged with flannel, is about 25 yen, or £4 10. In Europe an instrument of better construction would cost more. One of the columns on which an instrument is placed measures 6 feet by 3 feet and 5 feet high. It is constructed of brick and rests on concrete. The other column, which also rests on concrete, is made of stone. It measures 2 feet 2 inches × 2 feet 2 inches and is also 5 feet in height.

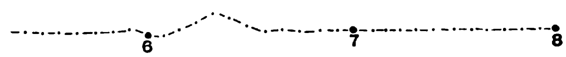
This latter column is rather too slight, as I found that even the pressure of my thumb is sufficient to cause the pointer of the instrument to move several millimetres.

Amongst those who may possibly have a practical interest in this matter are those who have to deal with mines—especially, perhaps, coal-mines.

In the columns of the *Japan Gazette*, in NATURE, in the *Mining Journal*, and other papers, references have been made to the attempt to observe earth-tremors and other phenomena in the Takashima Colliery near Nagasaki. At the conclusion of a



February 24th. 2-4. A.M. (No movement)
Fig. 4



March 28th. 1885. 6 & 7. P.M. (An earth tip?)
Fig. 6.

March 16th. 1885. 8-10. P.M. (Tremors & Earthquake)
Fig. 5.

report to the British Association, 1884, on the earthquakes of Japan, a letter from Mr. John Stoddart, the chief engineer at that mine, tells us that, owing to the working of the mine and other causes, he finds it impossible to make observations with delicate instruments. He therefore proposes to move the instruments to some distant station, assuming that any natural cause which would cause tremors in the mine will be generally felt over a considerable area. As to whether there is a connection between earth-tremors and the escape of gas in collieries, we do not yet know. Mr. Walter Browne, in a paper to the North of England Institute of Mining and Mechanical Engineers, thinks it desirable that investigation on this subject ought to be made, and quotes what is being done at Takashima. Mr. Galloway, writing in NATURE of February 5, if I read him correctly, does not encourage Mr. Brown's suggestions, and enters into an argument about the possibility of an earth-tremor forming a fissure. Earthquakes often form fissures on the surface, but these effects in mines are usually nothing. I make this statement on the authority of personal inquiry in many mining districts.

With the exception of the disturbances near an epicentrum, the movements due to ordinary earthquakes are so superficial that the range of motion at the depth of 10 feet is sometimes only one-fortieth of what it is at the surface. Earth-tremors are phenomena usually lasting many hours, and they certainly occur with low barometers. That they could by any possibility form fissures it is difficult to imagine.

As to what may be the cause of earth-tremors I am not prepared to offer a definite opinion; but, inasmuch as their association with barometric fluctuations renders it possible that in their occurrence they may also be associated with the escape of fire-damp, about which we have so little knowledge of practical value, it seems impossible that their study should be neglected.

Whether the results of such a study would be of practical value to the miner is not known, but that results of scientific value would be obtained is indisputable.

As the making of such observations are neither a matter of trouble or serious expense, I sincerely trust that they may be undertaken. On some future occasion I hope to describe the experiments which I made with one of these instruments on the summit of Fujiyama (13,365 feet), where movements were of a very marked and decided character.

Tokio, Japan JOHN MILNE

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—"The Removal of Micro-organisms from Water." By Percy F. Frankland, Ph.D., B.Sc., F.C.S., Associate of the Royal School of Mines.

The author has investigated the efficiency, as regards the removal of micro-organisms, of methods of water-purification depending upon

(*a*) Filtration.
(*b*) Agitation with solid particles.
(*c*) Precipitation.

The method of investigation consisted in determining the number of organisms present in a given volume of the water before and after treatment, the determinations being made by Koch's process of gelatine-culture on glass-plates.

Treatment of Water by Filtration.—The filtering materials examined were greensand, silver sand, powdered glass, brick-dust, coke, animal charcoal, and spongy iron. These materials were all used in the same state of division, being made to pass through a sieve of 40 meshes to the inch, and in columns of 6 inches in depth. The following results were obtained:—

	No. of organisms in 1 c.c. of water before filtration	Ditto after filtration
Greensand	80	0
ditto (after 13 days)	8,193	1,071
ditto (after 1 month)	1,281	779
Silver Sand	11,232	1,012
Powdered Glass	11,232	792
Brickdust	3,112	732
ditto (after 5 weeks)	5,937	406
Coke	3,112	0
ditto (after 5 weeks)	5,932	86
Animal Charcoal	very numerous	0
ditto (after 12 days)	2,792	0
ditto (after 1 month)	1,281	6,958
Spongy Iron	80	0
ditto (after 12 days)	2,792	0
ditto (after 1 month)	1,281	2

Thus greensand, coke, animal charcoal, and spongy iron wer at first successful in removing all organisms from the water pass ing through them, but after 1 month's continuous action this power was in every case lost, the improvement still effected, however, by spongy iron and coke was very great indeed, whilst the greensand and brickdust were much less efficient, and the number of organisms in the water that had been filtered through animal charcoal was greater than in the unfiltered water.

Treatment of Water by Agitation with Solid Particles.—Water was agitated with various substances (in the same state of division as above) and after the subsidence of the suspended particles, the number of organisms in the water before and after treatment was determined. 1 grm. of substance was in nearly each case shaken up with 50 c.c. of water. The agitation was in nearly all cases continued for 15 minutes, but the duration of subsidence was varied according to the length of time which it required for the water to become clear. The following results were obtained:—

	No. of organisms in 1 c.c. of water before treatment	Ditto after treatment
Spongy Iron (1 minute agitation, ½ hour subsidence; 5 grms. used)	609	28
Spongy Iron (15 minutes' agitation, ½ hour subsidence; 5 grms. used)	609	63
Chalk (15 minutes' agitation, 5 hours' subsidence)	8,325	274
Animal Charcoal (15 minutes' agitation, 5 hours' subsidence)	8,325	60
Coke (15 minutes' agitation, 48 hours' subsidence)	Too numerous to be counted	0
China Clay (15 minutes' agitation, 5 days' subsidence)	—	Too numerous to be counted

In order to ascertain whether subsidence alone would diminish the number of organisms contained in the upper strata of water, bottles containing infected water were allowed to remain at perfect rest, and then the upper layers in the several bottles were tested for organisms at different intervals of time. Thus:—

Hours of rest	No. of organisms found in 1 c.c. of water
0	1,073
6	6,028
24	7,262
48	48,100

Thus, without agitation with solid particles and subsequent subsidence of the latter, there is no diminution, but on the contrary an increase in the number of organisms in the upper strata of water.

Treatment of Water by Chemical Precipitation.—The effect of "Clark's process" in removing organisms from water was investigated both in the laboratory and on the large scale. In the laboratory experiments the following results were obtained:—

	Organisms in 1 c.c.
Untreated water	85
ditto (after 18 hours' rest)	1,922
Water after Clark's process and 18 hours' subsidence	42

In a second series of experiments the following results were obtained:—

	Organisms in 1 c.c.
Untreated water	37
ditto (after 21 hours' rest)	42
ditto (after 48 hours' rest)	298
Water after Clark's process and 21 hours' subsidence	22
ditto (after 48 hours' subsidence)	166

On the large scale the efficiency of the process was examined at the Colne Valley Waterworks, Bushey:—

	Organisms in 1 c.c.
Hard water	322
Water after softening and 2 days' subsidence	4

A recent modification of Clark's process devised by Gaillet and Huet was also examined:—

	Organisms in 1 c.c.
Hard water	182
Soft water	4

Thus a very great reduction in the number of organisms present in a water may be effected by submitting it to Clark's process. It appears also that the clear water should be removed as rapidly as possible from the precipitated carbonate of lime, as otherwise the organisms may become again distributed through the water.

Micro-organisms in Potable Water.—The number of organisms in natural waters of various origin has been determined by the author, who appends the results of a monthly examination, in this respect, of the various waters supplied to London during the first three months of the present year:—

	1885 No. of organisms in 1 c.c. of water Jan.		Feb.		March
Chelsea	8	...	23	...	10
West Middlesex ...	2	...	16	...	7
Southwark	13	...	26	...	246
Grand Junction ...	382	...	57	...	28
Lambeth	10	...	5	...	69
New River	7	...	7	...	95
East London	25	...	39	..	17
Kent...	10	...	41	...	9

General Conclusions.—Of the substances experimented with only greensand, coke, animal charcoal, and spongy iron were found to wholly remove the micro-organisms from water filtering through them, and this power was in every case lost after the filters had been in operation for one month. With the exception of the animal charcoal, however, all these substances, even after being in action for one month, continued to remove a very considerable proportion of the organisms present in the unfiltered water, and in this respect coke and spongy iron occupy the first place.

The results obtained by agitating water with various solid materials show that a very great reduction in the number of suspended organisms may be accomplished by this mode of treatment, and the complete removal of all organisms by agitation with coke is especially worthy of notice.

Again, the results obtained with Clark's process show that we possess in this simple and useful mode of treating water a means of greatly reducing the number of suspended organisms.

Thus, although the production in large quantities of sterilised potable water is a matter of great difficulty, involving the continual renewal of filtering materials, there are numerous and simple methods of treatment which secure a large reduction in the number of organisms present in water.

Physical Society, June 27.—Prof. Guthrie, President, in the chair.—Dr. Ramsay, Messrs. T. Hands, F. W. Sanderson, W. A. Shenstone, and T. H. Nalder were elected Members of the Society.—The following communications were read:—On the specific refraction and dispersion of the alums, by Dr. J. H. Gladstone. The refraction, dispersion, and specific gravity of nineteen different alums in the crystalline form were published by M. Charles Soret, of Geneva, in the *Comptes rendus* for last November. These, together with some additional data from Soret, Topsöe, and Christiansen, were employed by the author for comparison with certain experimental results of his own and of Kannonikof. In this way additional proof was obtained that a salt has the same specific refraction, whether it be crystallised or dissolved, and that the refraction equivalent of a compound body is the sum of the refraction equivalents of its components. The refraction equivalents of the alkalies in these alums are in the following ascending order—sodium, potassium, ammonium, rubidium, methylamine, calcium, and thallium; and of the other metals—aluminium, chromium, and iron. This is in accordance with what was previously known, but Soret's observations do not afford the means of determining the equivalents more accurately than before. The refraction equivalents of iridium and gallium were determined for the first time, giving respectively 17·4 and 14·8. The specific dispersion of the same compounds, measured by the difference between the specific refractions for the lines A and C, was also examined. The differences of dispersion are much greater comparatively than the differences of refraction. The order was also determined, but not the actual dispersion equivalents of the different elements.—On a form of standard Daniell cell, and its application for measuring large currents, by Dr. J. A. Fleming. The author first referred to the careful and thorough investigation of the circumstances affecting the electromotive force of Daniell's and allied cells by Dr. Alder Wright. He then described a form of all that had been found most convenient and reliable in practice. It consists of a U-tube in the two limbs of which are the two solutions of sulphate of copper and sulphate of zinc of the same specific gravity. Electrodes consisting of freshly electro-deposited copper and pure zinc that has been twice distilled dip into the two limbs. The E.M.F. of this cell is 1·102, and the variation of E.M.F. with temperature is practically *nil*.—On the phenomenon of molecular radiation in incandescent lamps, by Dr. J. A. Fleming. Some years ago Dr. Fleming had called attention to a phenomenon in incandescent lamps very analogous to that of discharge in high vacua observed by Mr. Crookes. The inner surface of the lamp-glass was sometimes found to be coated with a deposit of carbon, with the exception of a clear line marking the intersection of the glass with the plane of the loop, and being in fact a shadow of the loop apparently caused by an emission of matter from the terminals. Dr. Fleming has since found how to produce this appearance at pleasure by passing a very strong current momentarily through a lamp, and has succeeded in obtaining similar deposits of various metals that had been used as terminals. These deposits show colours by transmitted light, and as a general result the author concludes that red metals such as gold and copper appear green by transmitted light, whereas white metals like silver and platinum appear brown, a conclusion which, however, was challenged by Capt. Abney in the discussion ensuing.—On problems in networks of conductors, by Dr. J. A. Fleming.—Lecture experiments on colour mixtures, by Capt. Abney. The apparatus employed by Capt. Abney is a modification of Maxwell's colour-box: the spectrum, instead of being formed upon a screen, is received upon a convex lens which forms an image of the face of the prism upon a screen. If all the light from the prism falls upon the lens this image is colourless, but by interposing a screen with a slit in the spectrum close to the lens, so as only to allow light of a given colour to fall on the lens, the image appears coloured with that light. By using two or more slits different lights may be mixed in any required proportions.—On stream-lines of moving vortex-rings, by Prof. O. J. Lodge. The communication described a method of drawing vortex stream-lines, consisting in superposing uniform motion represented by a series of parallel lines upon the lines of a stationary vortex as given by Sir W. Thomson in his memoir on vortex motion, and joining up the corners of the quadrangles so formed. This operation is very simple, and by its application a number of the more remarkable properties of vortex-rings may be obtained, the general analytical investigation of which involves mathematical methods of the highest order. Drawings were exhibited showing the nature and behaviour of a single vortex-ring moving with different velocities, a vortex-ring approaching a large distant obstacle, the chase of two unequal rings, and many other cases.—On the thermo-electric position of carbon, by Mr. J. Buchanan. It having been observed that the carbon filaments of incandescent lamps usually gave way at the negative end, experiments were instituted to find if the destruction could be due to the "Peltier effect" causing a local generation of heat. Observations on a platinum-carbon thermo-couple showed that a generation of heat would result from a current passing from carbon to platinum, but the effect was too small to account for the observed phenomenon. It was found that a couple of carbon-iron rose considerably in E.M.F. by maintaining the hot joint for some time at 250° C.—On some further experiments with sulphur cells, by Mr. Shelford Bidwell. The paper contains (1) a description of a class of cells which give a constant voltaic current, the electrolyte consisting of a solid metallic sulphide; (2) an explanation of the unilateral conductivity exhibited by selenium and by sulphur cells; and (3) a description of a cell which gives, as the result of passing a current through it, a current in the same direction as the primary current.

EDINBURGH

Mathematical Society, July 10.—Mr. A. J. G. Barclay, president, in the chair.—Mr. R. E. Allardice gave an account of a paper by Mr. Charles Chree on physical applicatious of polar co-ordinates to the displacement of elastic solid and fluid bodies, and contributed some notes of his own on solid geometry.—Mr. J. S. Mackay submitted a paper by Mr. Robert J. Dallas on the method of orthogonal projection.—Mr. A. Y. Fraser, the hon. secretary, and Dr. Rennet, of Aberdeen, were appointed by the Society to represent it at the ensuing meeting of the British Association.—The president, in his closing remarks, stated that the membership of the Society at the end of its first session was 58, at the end of its second 92, and now, at the end of its third, 147.

PARIS

Academy of Sciences, July 6.—M. Bouley, president, in the chair.—New methods for determining the absolute coordinates of the polar stars without the necessity of ascertaining the instrumental constants, by M. Lœwy.—On the movement of a heavy revolving body fixed at a point in its axis, by M. G. Darboux.—On some new properties of the differential parameter of the second order for the functions of any number of independent variables, by M. Haton de la Goupillière.—A reply to

M. Mascart's recent note on the great movements of the atmosphere, by M. Faye.—Researches on vegetation: on the carbonates in living plants, by MM. Berthelot and André. In this paper the authors explain the methods followed by them in determining the quantity of the simple organic salts now known to be largely, if not universally, diffused throughout the vegetable kingdom.—Anatomy and physiology of Phœnicurus, a remarkable parasite found largely associated with certain mollusks, by M. de Lacaze-Duthiers.—On the homography of two solid bodies, by M. Sylvester.—Report on the experiments made in Holland and Belgium on an application of the large movable tubes of the hydraulic system constructed at the sluices of the Aubois; further modifications of that system, by M. A. de Caligny.—Spectrum of ammonia obtained by reversal of the induced current, by M. Lecoq de Boisbaudran.—A process of prophylactic inoculation against splenetic or charbon fever, by M. A. Chauveau. The peculiarity of this process consists in the method adopted for attenuating the cultivated virus, which is effected by means of compressed oxygen. Three points are established: (1) that it suffices to inoculate animals a single time in order efficiently to protect them both from experimental inoculations with strong, unattenuated virus and from the effects of spontaneous contagion; (2) that the virus attenuated by means of compressed oxygen is as harmless as that obtained by other methods constituting what is known as the first charbon vaccine; (3) that the most attenuated virus continues still active and serviceable long after its preparation.—Remarkable solar protuberances observed at diametrically opposite points of the disk on June 26, in Paris, by M. E. L. Trouvelot.—On some formulas in the theory of left curves, by M. Ph. Gilbert.—On the reductive properties of pyrogallol; its action on the salts of iron and copper, by MM. P. Cazeneuve and G. Linossier. The authors' experiments establish a complete parallelism between the reactions of ferric and cupric salts.—On the action of acetic acid in decomposing the hyposulphites of sodium and potassium, by M. E. Mathieu-Plessy.—Description of a new method of quantitative analysis for cadmium, by MM. Ad. Carnot and P. M. Proromant.—A new process for detecting and rapidly analysing small quantities of nitric acid in the air, water, earth, &c., by MM. Al. Grandval and H. Lajoux.—On the formation of large deposits of nitrates in Venezuela, the Andes, the Orinoco Basin, and other intertropical regions, by MM. A. Muntz and V. Marcano. From their observations the authors conclude that these nitrates have a purely animal origin, developed without the intervention of atmospheric electricity. Their position, the constant presence of large quantities of sulphates and of the nitrifying organism, combined with the study of the phenomena observed in deposits now in process of formation, all tends to exclude the recently advanced hypothesis of electric influences.—On the composition and fermentation of interverted sugar; a reply to M. Maumené, by M. Em. Bourguelot.—On the fermentation of the jéquirity plant, by MM. J. Béchamp and A. Dujardin.—On the production of the hydrate of crystallised magnesium (artificial brucite) and of the hydrate of crystallised cadmium, by M. A. de Schulten.—On the determination of the mineral group of zeolites in the absence of determinable crystalline forms, by M. A. Lacroix.—On a new group of felspar rocks in the district of Four-la-Brougue, Puy-de-Dôme, by M. F. Gounard.—On the position of some serpentine rocks on the road between Granada and Jaen in the north of the province of Granada, Spain, by M. W. Kilian.—On the augite and hornblende eruptive formations (diorites and serpentines) in the Sierra de Peñaflor, Andalusia, and on the genesis and dissemination of gold throughout these rocks, by M. A. F. Nogués.—Contributions to the study of the oolitic flora of West France, by M. L. Crié.—On the structure and growth of whalebone in the Balenopteræ, by M. Y. Delage.—On the structure and action of the stylets in the sting of the bee, by M. G. Carlet.—On the respective toxic properties of the organic and saline matters present in the urine, by MM. R. Lépine and P. Aubert.—Epilepsy of auricular origin: a contribution to the study of otopiesis (auricular compression), by M. Boucheron.—New metalloscopic processes applicable especially to cases of lethargy, catalepsy, and somnambulism, by M. Moricourt. The author shows that patients subject to these morbid affections are peculiarly sensitive to the action of metals, many cases having been successively treated by his new metallotherapic processes.—Clinical studies on the leprosy still surviving in the rural districts of Norway, by M. Paul Bert.—On the passage of pathogenic microbes from the mother to the fœtus, by M. Koubassoff.—M. Grandidier was elected a member of the Section for Geography and Navigation in place of the late M. Dupuy de Lôme.

SYDNEY

Royal Society of New South Wales, May 6.—Annual Meeting.—H. C. Russell, B.A., F R.A.S., President, in the chair.—The report of the Council stated that 34 new members had been elected during the year, making the total on the roll 494. Sir G. B. Airy, K.C.B., F.R.S., and Prof. John Tyndall, F.R.S., had been elected Honorary Members in the room of Sir F. B. Barlee, K.C.M.G., and George Bentham, C.M.G., F.R.S., deceased. The sum of 380*l.* had been expended on books and periodicals during the year. The Clarke Memorial Medal for 1885 had been awarded to Sir J. D. Hooker, K.C.S.I., C.B., and the Society's Medal and a prize of 25*l.* to Mr. W. E. Abbott for his paper on the water-supply in the interior of New South Wales. The Society had presented its *Journal* to 313 kindred societies and institutions, and received 1147 volumes and pamphlets in return. The following papers had been read at its monthly meetings:—Presidential Address, by Hon. Prof. Smith, C.M.G.; the removal of bars from the entrances to our rivers, by W. Shellshear, A.M.I.C.E.; notes on gold, by Dr. Leibius, M.A.; some minerals new to New South Wales, by Prof. Liversidge, F.R.S.; the oven-mounds of aborigines in Victoria, by Rev. P. MacPherson, M.A.; notes on the trochoided plane, by L. Hargrave; a new form of actinometer, by H. C. Russell, B.A.; notes on some mineral localities in the northern districts of New South Wales, by D. A. Porter; notes on Doryanthus, by C. Moore, F.L.S.; water-supply in the interior of New South Wales, by W. E. Abbott; notes on a new self-registering anemometer, by H. C. Russell, B.A.; researches upon the embryology and development of the Marsupials, Monotremes, and Ceratodus, by W. H. Caldwell, M.A. —A *conversazione* was held on October 8 in the Great Hall of the University, attended by about 900 members and their friends. The Council had issued the following list of subjects with the offer of the Society's Bronze Medal and a prize of 25*l.* for each of the best researches, if of sufficient merit (to be sent in not later than May 1, 1886):—On the chemistry of the Australian gums and resins; on the tin deposits of New South Wales; on the iron ore deposits of New South Wales; list of the marine fauna of Port Jackson, with descriptive notes as to habits, distribution, &c. (to be sent in not later than May 1, 1887); on the silver ore deposits of New South Wales; origin and mode of occurrence of gold-bearing veins and of the associated minerals; influence of the Australian climate in producing modifications of diseases; on the Infusoria peculiar to Australia.—The Chairman delivered the Presidential Address, and the officers were elected for the ensuing year.

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THURSDAY, JULY 23, 1885

A NEW DEPARTURE FOR THE UNIVERSITY OF LONDON

THE influential movement which has grown out of the Educational Congress held during the Health Exhibition last year at South Kensington, and which has for its object the establishment of a Teaching University for London, has placed the existing University on the horns of a dilemma. Either it must be content to see itself altogether outdistanced by a new organisation which of necessity would absorb into itself all the teaching eminence of London, or it must rise to the occasion, and, bursting the cramped limits of its present contracted sphere of activity, show itself competent to the performance of larger duties.

The Convocation of the University, composed of the general body of graduates, has for its part shown at any rate a disposition to choose the latter alternative. After two successive debates it appointed a committee of forty of its members to see how far the proposals of the Association for a Teaching University could be carried into effect by the existing University. The report of the Committee has now been issued, and was printed by us in last week's NATURE. It will be submitted to an extraordinary meeting of Convocation to be held on Tuesday next.

What the action of the graduates will be it is of course impossible to predict with certainty. But it is hardly conceivable that, having assented to the principle of developing the University in the direction proposed by the Association, they will find much difficulty in accepting the scheme of reorganisation presented to them by Lord Justice Fry.

The scheme itself is necessarily cast in a somewhat technical form, and it is unaccompanied by any memorandum explanatory of its leading principles. These, however, it is not difficult to glean from it, and some account of them will, we think, be not without interest to many of our readers.

A priori the name of the University of London would call up to the mind of any one unfamiliar with the reality the image of a very splendid institution. This enormous city, which sooner or later absorbs into its life everything and everybody that rivets attention in the mind of the nation at large, might be expected to possess in its university a seat of learning where all the best of its intellectual activity would, as it were, be brought to a focus. That is the ideal. The reality is quite different. It is, in fact, a Government office which only by a kind of grim jest bears the name of a university. It is true it gives degrees; its graduates array themselves in gowns of surpassing brilliancy; it has a library and portraits of vice-chancellors; it has even a member of Parliament, But these are the mere accidents of its nature. Pierce below these insignificant academic symbols, and you find nothing but a mere State examination board supported by a Parliamentary grant; its expenditure controlled by the Treasury; its accounts audited by the Audit Office; and every academic regulation requiring the approval of the Home Secretary. Of any provision for the advancement and cultivation of knowledge there is none.

London however abounds with institutions of more or less eminence, in which studies of an academic kind are pursued. The first step which the Association saw to be necessary was to endeavour in some way to federate these. The task is one of no small difficulty. No educational establishment of any standing would care to sacrifice any portion of its autonomy, or to see taken from it any possible field of activity to which it might legitimately aspire. On the other hand, universal experience has shown that it is only those who are actually engaged in the higher kind of teaching who can be counted upon to supply the propulsive force needed for a real University activity. It is only those who work in the ultimate allotments of the fields of learning who can say how the achieved results in each area can be adapted to educational needs, and what help a University can give in securing harvests still ungrown and unreaped.

The leading feature of the scheme is—frankly following the principle on which the examining staff is secured—to bring into the University, irrespective of their previous connection with it, the best of the London teachers of University rank. These are to be obtained as representatives of Colleges who have agreed to come into the scheme. What these bodies sacrifice by so doing is scarcely appreciable. What they may gain may be very considerable. The teaching representatives so obtained (with some additional members) are to be grouped into four Faculties. In these Faculties the teaching arrangements of the several constituent Colleges may, though not necessarily, be brought into discussion. The result, it may be hoped, will be a better division by amicable arrangement of the higher educational appliances of the metropolis. And where (with the approval of the faculty) any particular constituent College undertakes the charge of some slenderly-supported branch of learning, it can hardly be doubted that the approval of the faculty will at least go a long way to securing public interest in the venture.

The faculties, then, can hardly fail to promote cooperation among the University teachers in London, and to better organise the attack on ignorance. But besides this they will enable the teaching bodies to gain for the first time a direct influence upon the examinations. Each Faculty will appoint a Board of Studies, and this will be charged with the duty of watching the examinations, keeping up something like a continuous tradition, and seeing that examination and teaching are in reasonable adjustment. Furthermore the Faculties will have direct representation on the Senate and that august body will in time be no longer a mere assemblage of notables holding their seats for life, but a real Academic Council for London at large, the members of which, being removable after a term of years, will always be in touch with their constituents.

These are the main outlines of the scheme. They appear to us to have been dexterously drawn between interference which the Colleges would resent and responsibility for their administration which the University could not accept. But though all this is admirable, it would not satisfy us if it were to be regarded as the final outcome of the scheme. Its great merit in our eyes is the provision we see in it for continuous development. The Faculties, the Boards of Studies, the Senate, are all under the scheme subject to provisions for renewing their composition. There will be therefore, we hope, a properly controlled flow of new life through every branch of the governing authority of the University. The present condition of crystalline rigidity will dissolve. As new objects of University enterprise come to the surface and assume definite shape, the men who advocate them will find their way to the Faculties and succeed in making their voices heard. At the same time there is sufficient opportunity for discussion to prevent the University being launched unadvisedly in any rash development.

We do not conceal our own hope that the most important outcome of the new scheme will be the ultimate provision of appliances for the prosecution of the higher studies in London. These never can be self-supporting, and never can, therefore, be properly undertaken by the constituent colleges. Ths voice of the faculties must be in the long run the voice of the men who compose them. That they will, therefore, if constituted, take some action in the matter, can scarcely be doubted. But instead of individual voices crying in the wilderness, there will be the mature utterances of a responsible body carefully guarding the interests of the constituent colleges on the one hand, and looking to the distinction and influence of the University on the other. Properly considered schemes will be put forward, and whether their execution devolves on the State, or is undertaken by private munificence, the public will for the first time have in the Faculties an authority competent to advise it in such matters, and whom it can listen to with confidence. The ultimate expansion of the University into all that can be desired, appears to us the inevitable outcome of Lord Justice Fry's scheme, if it is carried into effect.

THE WOOL FIBRE

The Structure of the Wool Fibre in its Relation to the Use of Wool for Technical Purposes. By F. H. Bowman, D.Sc., F.R.S.E., F.L.S., &c. (Manchester: Palmer and Howe; London: Simpkin Marshall and Co., 1885.)

THIS is a series of lectures delivered by Dr. Bowman to the students of the Bradford Technical College and the members of the Dyers' and Colourists' Society, and is in continuation of a similar series on the "Cotton Fibre."

The subject is one of so great importance that Dr. Bowman is amply justified in concluding that the information contained in his lectures ought to be accessible to others than students; for, if there is anything to learn with respect to a great national industry like the woollen trade, it is highly desirable that no time should be lost in communicating it to those who are now engaged in the trade, rather than that we should wait half a generation for the knowledge to become available in the hands of the students.

It is no doubt very difficult to introduce new methods and to banish old ones, except by the introduction of young blood; but even so, something may be done in the way of preparing the minds of the older workers to receive the new ideas of the young ones, and this at least Dr. Bowman's work is likely to do.

Whether Dr. Bowman has been wise in preserving the lectures in their original form in his book we take leave to doubt. It makes the book very much larger than it would otherwise have been, owing to the unnecessary recapitulation at the commencement of each lecture, and not only so, but the labour and attention which would have been required to remodel the lectures would have prevented some glaring errors and defects of style which are by no means creditable to a writer of Dr. Bowman's attainments. A careful perusal of the proof-sheets would surely have removed such errors as "the appearance of the bulbous parts are very similar;" "the Exmoor sheep are the smallest of the two;" and the vulgarism, "some of the sheep in the northern districts have four and even six horns, *the same as* the Iceland sheep."

These literary defects notwithstanding, the book is most opportune and valuable. The key-note of the whole is perhaps to be found in the following sentence:—"All our machines and processes are only a means to an end, and the correct method of proceeding is ever to have the end in view from the beginning. Strange as this may appear, such is not always the case in our manufactures, and especially in those where the materials pass through many hands in different works before reaching the final stage. How often do we find the farmer, for example, quite careless in regard to the nature of the dips, and washes, and smears which he uses for his sheep, in utter forgetfulness of the fact that, although he may gain a temporary advantage, he is spoiling the wool for future use in spinning and dyeing."

Dr. Bowman puts forcibly before his readers the fact that wool is a part of the skin of the animal on which it grows, and is capable of being modified to a very great extent indeed—much more than most people are aware—by change of climate, food, and other surroundings, and especially by judicious breeding. One-sixth of the book is devoted to an enumeration of the various breeds of sheep to be found in the world, for the purpose of illustrating this. Perhaps, if we may be permitted to say so, this division of the work might have been judiciously shortened by the omission of details respecting numerous breeds of sheep which are now of little more than historical importance, especially as Dr. Bowman appears to be of opinion that the course which has been followed is the right one, and that we are now in possession of practically the best breeds of sheep which we could have for wool-producing purposes.

The lectures are five in number, of which the first is chiefly introductory. In it the author discusses the difference in composition and structure of animal and vegetable fibres and minutely describes the structure of cotton, silk, and wool as disclosed by the microscope. He points out the distinction between hair and wool so far as any real difference exists, and describes the constitution of the skin and the mode of production and growth of hair or wool.

The second lecture is chiefly devoted to a description of the various breeds of sheep and of the results of cross-breeding.

In the third lecture the author describes the typical structure of wool fibre under the two heads: (*a*) in regard to the mechanical arrangement of its ultimate parts; (*b*) in regard to its chemical composition.

The fourth and fifth lectures deal with, first, the variations from the typical structure found in fibres taken from the same animal and grown at the same time, in fibres from the same animal grown in different years, in fibres from the same animal grown under different climatic and other conditions, and in fibres from different breeds of sheep grown in different countries; and, secondly, the effect of these variations in the manufacturing processes.

There are a number of excellent illustrations which materially assist the reader.

It has hitherto been too commonly supposed that the sheep might be turned out upon our bleak and barren hillsides, of which no other use could be made, and left to its own resources; but this is doubtful economy, even as regards the land, and Dr. Bowman shows that as to the sheep it simply ruins the wool. "The wool and its character depend very largely not only on the health of the sheep, but also upon climatic and other influences. The mildness or severity of the season and the plenty or scarcity of food very largely affect the character of the wool. In very severe seasons there is a tendency to a thickening of the fibres, with greater irregularity in the length of the general staple and a greater rankness of the fleece, with undergrowth of short fibres and a greater irregularity in the diameters of the individual fibres and the different parts of the same fibre. The general character of the wool is also affected because from constant wetting and drying in the bad seasons the wool becomes tender and rotten and loses its brilliancy and lustre." "When examined under the microscope the individual fibres are found to be injured in their structure by the want of proper nourishment and the deficiency in the natural suint or grease, a great part of which is soluble in water, and when removed leaves the fibres dry and hask. Of course amongst well tended flocks these variations are reduced to a minimum, because they are supplied with suitable shelters from the storms and fed artificially when there is a scarcity of pasture." Most farmers think more of the mutton than of the wool, but whatever improves the one improves the other, and it would pay them well to devote more attention to the comforts of our hillside sheep, and even of those which are pastured in more favourable situations.

Great improvements have, we believe, been effected in apparatus for washing wool, but perhaps Dr. Bowman is right in saying that even yet sufficient attention is not paid to the temperature of the water. It seems to be forgotten that wool is an animal matter and that "the real base of the wool fibre is a body which very closely resembles, and is allied to, the albumenoids, and all these bodies are subject to very great changes in molecular condition when subjected even to moderate degrees of heat." Dr. Bowman made a number of experiments with "a bright-haired wool" to determine the effect on its lustre and strength of washing at different temperatures in pure water. He found that "wool which looked quite bright when well washed with tepid water was decidedly duller when kept for some time in water at a temperature of 160° F.; and the same wool, when subjected to boiling water 212° F., became quite dull and lustreless." As Dr Bowman elsewhere says, when water is heated by blowing in jets of steam, as is not unusual in wool-washing, the temperature varies in different parts, being nearly or quite 212° close to the steam jet, whilst very much lower at a little distance.

W. H. S. W.

PHYSIOLOGY OF THE EMBRYO

Specielle Physiologie des Embryo. Untersuchungen über die Lebenserscheinungen vor der Geburt. Von W. Preyer. (Leipzig: Th. Grieben's Verlag, 1885.)

THE vital processes of the embryo present so many difficulties in their investigation that, in spite of their great interest, they have hitherto received only a small share of the physiologist's attention. Prof. Preyer's new book will therefore be received with welcome as an important contribution to our knowledge of the subject; and is likely, on account of its completeness, to become a standard text-book.

The work is an almost exhaustive summary (extending to more than 600 pp. 8vo) of the results of investigations into this branch of physiology from the time of Aristotle downwards. Indeed, so large a proportion of other men's researches are included, that the title "Untersuchungen . . . von W. Preyer" would seem to require modification.

The reader may be a little disappointed with the earlier portion of the book, on account of the trite nature of some subjects which could hardly have been omitted; but the matter increases in interest with the progress of the work, and especially where the author's own researches are described. The style is not as condensed as could be wished: but this fault is not uncommon in scientific writings.

Although the common chick most rightly receives a large share of attention, yet other animals—mammalia, reptiles, and fishes—are not in any way neglected, and even invertebrates are occasionally touched upon. The most valuable observations are those on the guinea-pig, dog, &c. The author laments the scarcity of material and of opportunities for observation on the human subject; and recommends that in foundling hospitals and lying-in institutions a supply of apparatus should be kept ready for observing the physiology and pathology of the new-born; since much may be learnt from the phenomena, especially the changes, which occur within the first minutes or hours after birth.

In the first section, which treats of the embryonic circulation, Prof. Preyer shows the probability that in the chick the primitive blood, or hæmolymph, begins to move before the occurrence of the first heart-beat. This he attributes to the effect of heat, the heart occupying a higher position in the embryo than the vessels, so that by convection the blood tends to rise towards the heart and distend it. This explanation is not satisfactory on physical grounds: for it is difficult to realise that there can be a difference of temperature between the contents of a minute vessel and its surroundings sufficient to cause such a movement. Is it not equally probable that the change of specific gravity may be due to chemical changes in the hæmolymph; or, more probable than either, that the fluid is formed in the peripheral vessels and driven onwards by the pressure of osmosis?

Among the most important results of experiments are those connected with the effect of temperature and of chemical agents on the embryo; especially the very potent action of quinine and atropine on the primitive heart; and the comparative inertness of strychnia, curarin, and hydrocyanic acid on the more advanced fœtus. These results, considered with those relating to the diffusion of substances between mother and fœtus, have a practical bearing on the medical use of the various drugs during pregnancy. No less important therapeutically are the effects of change of blood-pressure in the uterine vessels; and a very practical though old question is fully discussed—namely, whether the umbilical cord should be divided early or late after delivery.

In certain experiments the coagulation of blood from the embryo was observed to be very slow. It would be interesting if it were shown that coagulability is acquired only shortly before the birth of the animal, when it first needs this property of the blood to guard it against hæmorrhage.

The most interesting section of the book is that which deals with the secretions of the embryo. The experiments of the author and other observers are collated, with the result of showing the early appearance and activity of some of the digestive fluids, and the comparatively late acquirement of the amylolytic faculty, particularly in the human species. The origin of the amniotic fluid is here discussed—how far it is derived from the maternal or from the fœtal blood, and whether and to what extent the fœtal urine contributes to its formation.

Prof. Preyer endeavours to find a satisfactory derivation for the word *amnion*. It does not appear to him possible to connect it with ἀμνίον, a receptacle for the blood of a victim in a sacrifice, with ἀμνός, a lamb, or other proposed sources; so he suggests an origin from α-, and μένος, strength, because of the delicacy and lacerability of this membrane. This may be physiological, but it is hardly philological. If we cannot be satisfied with the explanation that ἀμνίον in either sense was something which appertained to a lamb, we may conjecture an earlier origin from the root *am*-, around, seen in ἀμ-φί, *amputare*, and German *um*; in which case ἀμνίον may mean a receptacle or envelope.

There is no doubt that spontaneous movements of the embryo take place long before its maturity, and Prof. Preyer considers that muscular action occurs earlier than is generally supposed. He adduces the fact that the umbilical cord has already begun to twist in the human embryo at the eighth week, and asks, "How else could this take place, if not through the fœtal movements?" Now it seems improbable that the muscular movements should be entirely or even mostly in one direction; and therefore some more satisfactory explanation must be sought. We would suggest that the twisting may be due to the excessive growth of the umbilical arteries, so that they are obliged to take a tortuous course: and, when a slight obliquity has once been established, every pulsation will tend to increase the spiral, and every movement of the fœtus or of the mother will be taken advantage of; the cord and fœtus revolving together until, with the growth of the fœtus, the friction of the amnion puts an end to the rotation.

The section dealing with the senses of the embryo is scarcely less interesting than that on the secretions. In connection with this we find a discussion on the state of the nervous system before maturity: whether it be in a waking or a sleeping condition, or whether these conditions alternate with one another.

Among the appendices is one, by Dr. R. Ziegenspeck, of Jena, treating of the fœtal circulation. There are also several coloured plates illustrating the circulation and other subjects. The usefulness of the book is much enhanced by the addition of a list of the literature on the special physiology of the embryo. The books and papers in this list (552 in all) are numbered and indexed; and, whenever either of them is quoted in the text, its corresponding number is given in the margin for reference.

F. J. ALLEN

OUR BOOK SHELF

The Animal Parasites of the Sugar Cane. By H. Ling Roth, late Hon. Sec. to the Mackay Planters' Association. Reprinted from *Sugar Cane*, March and April, 1885. (London: Trübner.)

It is within the knowledge of most people that when a matter of this kind is under consideration, there are never wanting those who are ready with suggestions—for the most part based upon a foundation anything but practical or logical. Quacks are always at hand with their "cures," greedy for the gain which it is the object of their impositions to intercept. Experience and common sense alike show that but two courses here lie open: either the cane-crop must be rooted up and something else substituted in its place, or the most searching inquiries must be instituted into the life-histories and conditions of existence of the organisms working the mischief.

The value of any publication on such a subject must, from the above considerations, be proportionate to the extent to which it assists the farmer in dealing experimentally with his enemies. Looked at from this standpoint, Mr. Roth's modest little pamphlet cannot fail to be of great service to the intelligent planter, for it embodies, together with the results of the author's practical experience, a bibliography of all that has been written on the subject.

Planters are beyond doubt largely a conservative body, and it is well known that years ago when first the failures of the Ceylon coffee-crops became disastrous, the attention of the grower was in vain directed to the tea-plant—then flourishing as an ornamental shrub in the gardens of certain residents. The deaf ear has since been opened, and the mourning of the disappointed coffee-grower is now being turned into the joy of the successful tea-planter. Unfortunately the conditions of growth of the sugar-cane will not admit of so easy a solution of the problem as that available in the above cited case, but the refrain of the paper before us is *more biology*. Nothing whatever can be done until the world is fully familiarised with the life-cycles and conditions necessary for the existence of the said parasites. The success which has recently attended the study of the liver-rot among sheep may be instanced as an example of what can be done in the field of applied biology, and there are among us young and competent workers ready to take the task in hand should opportunity offer.

The facts narrated on p. 2 of the paper are anything but encouraging to those who would seek Government aid. Much can be done by Governments, and it may be that when corporate bodies realise that pests of the category of those now occupying our notice are formidable even as an armed force, they will see fit to turn attention to them.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Nomenclature in Elasticity

In reference to a communication of mine which you published not long ago (see Nature, vol. xxxi. p. 504) on this subject, I have pleasure in enclosing for publication, should you think fit, photos from three automatically recorded stress-and-strain diagrams made in my laboratory. The originals were traced on smoked glass, the glass plate then varnished to fix it, and used at once as a negative. Test-piece No. 9461, of which Fig. 1 shows the behaviour, was a very ductile piece of Swedish bar-iron, turned to ¾-inch diameter. The extensions were measured

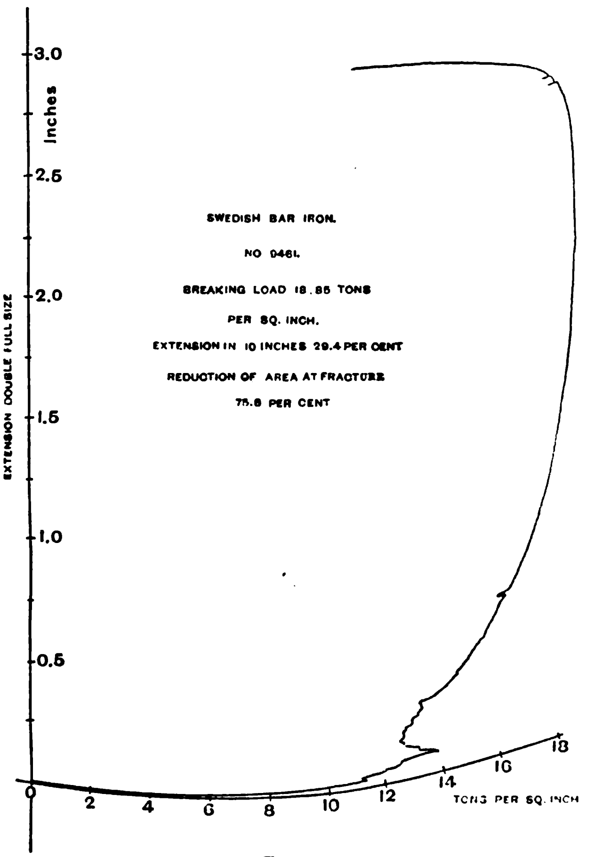


Fig. 1.

on a length of 10 inches, and recorded *double* full size; they are to be measured from the curved base-line, distances along which measure the total load on the piece (on a scale, as recorded, of about 1·9 tons per inch), and therefore the load per unit area (or, as I prefer to call it, the *intensity of stress*) up to the limit of elasticity, to which point the cross-section remains practically unchanged. The point where *instability* comes in is very marked, and also the release or going back of the stress after the material has "broken down." Lastly, the condition of local flow, or whatever it is to be called, is excellently shown. The material draws down in one place, so that the increase of extension, being confined to that place, is very small, and the total load diminishes, although the intensity of stress, on the now greatly reduced area, is much increased, as is shown further on in Fig. 4.

Fig. 2 is an autographic diagram similar to the last, taken from a piece of soft steel (No. 8397) 0·60 inch diameter and 10 inches long. It shows most of the same characteristics, except that the breaking-down is not preceded by any intermediate stage; the loss of elasticity comes very suddenly. The whole load was taken off the piece and then reapplied a number of times during the experiment, after the limit was passed, and the curves show most distinctly by their parallelism the (practical) constancy of the modulus of elasticity even up to the very maximum load. The curves show also the curious phenomenon—which I have often noticed in this form, and which, in some of its aspects, has been most carefully examined by Bauschinger and others—of increase of load borne, for a very limited time, after the material has been allowed a short rest—here only a few seconds. If the rest be for hours or days a similar thing occurs in a much more marked fashion.

Fig. 3 is a similar diagram from a piece of "S. C. Crown" iron, showing the same features, although in a less marked degree. In this case the load was removed and reapplied after the piece had begun to draw down visibly, and the curve to turn back, with the result of showing the piece to be still elastic up to the load it had just borne.

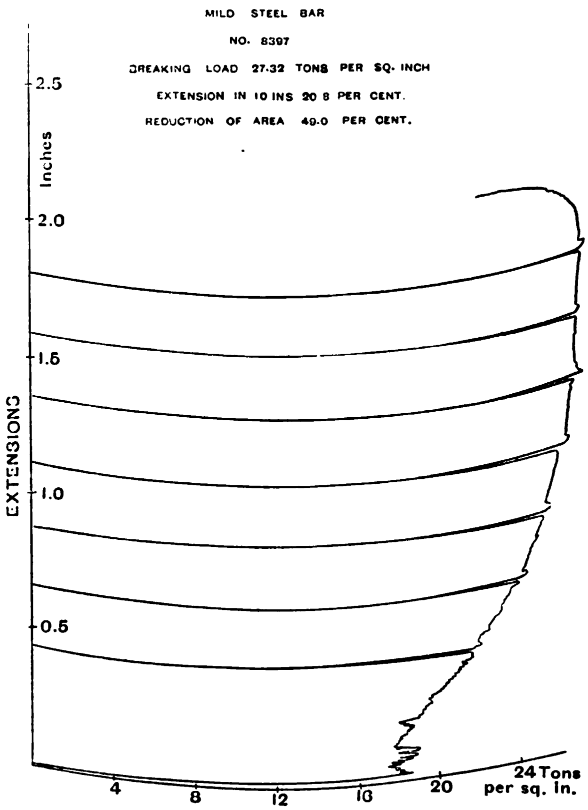


Fig. 2.

Fig. 4, which is a copy of a diagram obtained by consecutive measurements, not automatically, illustrates a question asked, I think, by Mr. Ibbetson. The diameter of the bar under test was measured each time the extension was noted, and the curve of actual stress on actual area (II.) is plotted out, as well as the usual load and strain curve (I.). The most interesting point about it is perhaps the way in which the curve ends nearly parallel to the axis, an excessively small additional extension corresponding to a very great additional intensity of stress. This arises, of course, from the fact that the extension is here confined to a very small length of the bar, the diameter and length of the main part of the bar remaining practically unaltered. If the extensions were plotted to stresses in this main part of the bar, the curve would take the shape (III.).

All these curves illustrate distinctly, I think, a point not very generally known, that the non-elastic extensions form really a curve passing through the zero point of stress and strain, just as do the elastic ones. It appears as if the *non-elastic*, the flowing or plastic state, were the *real* state of the material, the *elastic* condition being something consequent on the treatment which

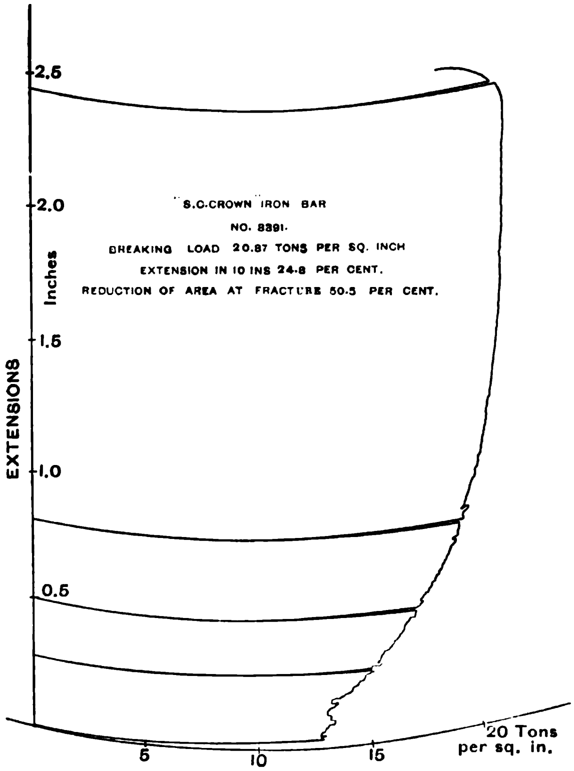


FIG. 3.

the material had undergone. I am bound to say, however, that I have no distinct evidence connecting the ratio $\frac{\text{limit of elasticity}}{\text{maximum load}}$ with the amount of previous work done on a material in manufacture.

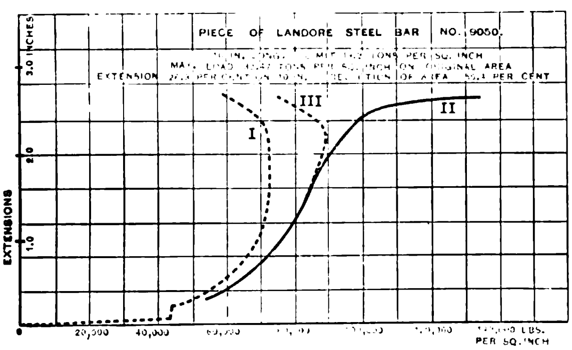


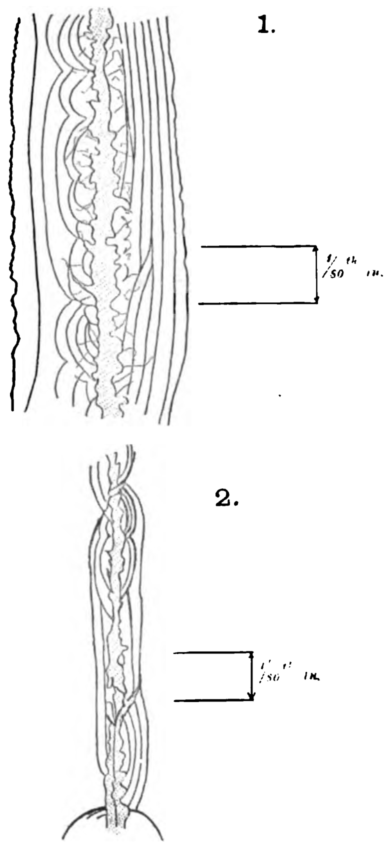
FIG. 4.

I should like to add that the credit of scheming and working out the very ingenious apparatus by which the autographic diagrams figured above were recorded belongs almost entirely to my friend Mr. A. G. Ashcroft, who has been working at the matter for me for some time. ALEX. B. W. KENNEDY

Spectra Produced in Glass by Scratching

A FEW weeks ago, while examining under the microscope a piece of glass on which a coarse scratch had been made by a file, in order to serve as a focussing mark in the determination of refractive index, I noticed a number of narrow, somewhat faintly coloured spectra running along both sides of the scratch. As I can find no account of such an appearance, and an examination of it seemed to throw a little light on the effects of a combined tangential stress and pressure on a brittle medium such as glass, I thought a short description of the phenomena might be interesting to the readers of NATURE.

The spectra (Figs. 1 and 2) run for the most part approximately parallel to the scratch, but those near the scratch are very much curved, the concavity being inwards, and often appear to commence and terminate at irregularities in the scratch. If the glass be left to itself after scratching, the spectra sometimes remain stationary, but not unfrequently spread outwards from the scratch; this process I have watched in three instances. In any case, sooner or later, the glass splits internally along the edge of the outermost spectrum, and sometimes along the others also. I was fortunate enough to watch this splitting in one instance: immediately before it took place the glass gave signs of great activity, the spectra waving about in the field of



FIGS. 1 and 2.—The shaded part in all the figures epresents the scratch.

view about three times in as many seconds, oscillating between two extreme positions (*a* and *b* in Fig. 3), and finally coming to rest in the position *b*, while the split developed with great rapidity from above downwards in the field of view. After this splitting has taken place, the spreading of the spectra ceases, and they generally, though not invariably, remain apparently unaltered. The time which elapses between the infliction of the scratch and the development of the split varies from a few minutes to several days or weeks.

The appearance is not shown by all scratches, but only by such as have produced considerable disturbance in the glass: thus they must be fairly deep and must produce some slight amount of splintering.

Next, as to the explanation of the phenomenon. Diffraction from the scratch is negatived by the great distance from the scratch to the spectra, and still more by the fact that they are farther apart the greater their distance from the slit; this important point was determined by careful measurement with a micrometer, using sodium light. They are clearly not due to polarisation, and examination between crossed Nicols failed to elicit any appearance indicating strains in the glass. The spectra seemed to be identical with the colours of thin plates, with which they agree in being much brighter in reflected than in transmitted light. The colours are also complementary in the two cases, as can easily be shown by the use of a micrometer eyepiece; the colour of the band lying on a certain division being noted, the moving of a suitably arranged screen cuts off the light from the mirror under the stage and allows that from a condensing lens above the stage to fall on the glass; the

3.

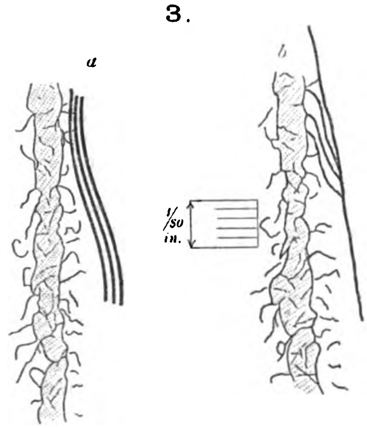


Fig. 3.

colour is then seen to change into its complementary, passing through white if the two lights are of suitable relative brightness. If the surface layers of the glass near the scratch are separated somewhat from those below, the interval forms a thin plate, and this would suffice to account for the spectra, as the separation would necessarily reach a maximum at the scratch, and we there find the spectra nearest together; moreover, along the edge of the outermost spectrum, the black of the first order is quite distinct wherever the spectra are broad enough to allow their colours to be distinguished. The splitting perpendicularly to the cleavage plane would then be quite analogous to that seen in other brittle

4.

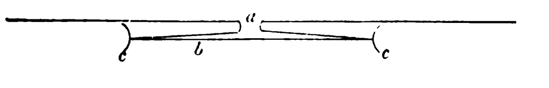


Fig. 4.—a = the scratch; b = the cleft under the torn-up surface layer; $c\,c$ = the splits.

substances, and as every one must have repeatedly observed it in cutting such substances as camphor, paraffin, or ice (Fig. 4 shows the condition of the glass on this supposition). That a tendency really exists in scratched glass for the surface layers to tear up we know from the fact that splinters of glass near the scratch will often keep peeling off for days together.

E. F. J. Love,
Demonstrator of Physics in the Mason College
Birmingham, July 14

Prof. Sylvester's Article on "A New Example of the Use of the Infinite and Imaginary in the Service of the Finite and Real"

I should like to be allowed to mention that Mr. Buchheim has drawn my attention to the fact that one of the theorems in the postscript to my recent article in Nature contained in the formula—

$$P' : Q = \frac{P : Q}{\sqrt{P : P}\ \sqrt{Q : Q}}$$

is virtually given under a slightly different notation in the second edition of Grassmann's "Ausdehnungslehre," p. 141.

July 12 J. J. Sylvester

Rainfall of N.W. England

The rainfall on the coast-line of the Dee and the sea from Chester to Llandudno in the spring and summer months presents some interesting features. As a rule the amount of rain is the greatest at the Chester end in the spring months (April to June), and at the Llandudno end in the summer months (July to September). This is shown by the following table:—

	1882		1883		1884	
	Colwyn Bay[1] In.	Chester In.	Colwyn Bay In.	Chester In.	Colwyn Bay In.	Chester In.
April	3·01	3·59	0·68	0·79	1·32	0·92
May	1·54	2·16	1·86	1·09	1·37	0·94
June	3·39	3·95	2·15	2·94	1·15	2·06
	7·94	9·70	4·69	4·82	3·84	3·92
July	3·20	3·52	1·13	1·86	4·43	4·08
Aug.	3·47	2·52	2·19	2·64	1·35	1·05
Sept.	2·45	1·80	4·34	5·07	1·67	1·95
	9·12	7·84	7·66	8·57	7·45	7·08

That this result is not a mere coincidence will be gathered from the following statement of the rainfall last month (June, 1885) at Chester, Colwyn Bay, and Bagillt, this last being between the other two places, at a distance of fifteen miles from the former or twenty-five miles from the latter:—

June	Chester In.	Bagillt In.	Colwyn Bay In.
5	0·12	0·07	0·18
6	·38	·21	·20
7	·33	·29	·24
8	·11	·05	·01
16	·18	·15	·03
18	·10	·06	·05
19	·04	·02	·02
20	·16	·09	·03
23	·79	·46	·32
24	·13	·08	·02
29	—	·02	—
	2·34	1·50	1·10

It will be seen that on every day, except one, the rainfall was highest at Chester, Bagillt coming next, and Colwin Bay being the lowest. There must therefore be some definite law which governs this gradual decrease from east to west; and in the hope of drawing out the opinions of more skillful meteorologists on the subject, I venture to suggest the following explanation.

It is generally admitted that atmospheric currents travelling across the Atlantic from the south-west reach our islands charged with aqueous vapour almost to saturation. These, meeting the mountains of Wales and Cumberland, are driven up into a higher and colder region where the moisture is condensed into rain, causing a very heavy rainfall on the *western* slopes. Now if a line be drawn south-west from Colwin Bay, it will be found to pass over some of the highest mountains in Wales, so that *in spring*, when the air above these mountains is still cold, the moisture is so effectually condensed that there is little left to fall on the north-east side. But if a parallel line be drawn south-west from Chester it passes over no very high region, and the moisture is therefore less completely drained from the atmosphere. But, as the summer goes on, the mountain-tops become warmer and the condensation on them less complete, and then more rain is left to fall on the north-east side, *i e.*, at Colwyn Bay. And as the *summer* day temperature is higher at Chester than Colwyn Bay, less rain is condensed at the former place.

Chester, July 18 Alfred O. Walker

"Foul Water"

My attention has just been called to Mr. Shrubsole's letter under above title. Having been for several weeks past engaged in dredging off the North Wales coast, I have continuously noticed the profuse amount of gelatinous bodies diffused throughout the sea, evidently of the same character as observed by Mr. Shrubsole off Sheerness. They appeared here early in June.

The little bodies are distinctly visible on holding a bottle of sea-water up to the light. They vary in size from 1/16th to

[1] Colwyn Bay is about five miles east of Llandudno.

1/10th of an inch in diameter, and are spherical or oblong in form, the translucent membrane appearing under the microscope to be composed of minute particles and spicules imbedded therein.

As my observations included the examination of surface-life, the tow-net was continuously employed, and was always rapidly filled with so much gelatinous substance that it was difficult to pick out the Copepoda or other pelagic life. But although all of the bodies were perfect in form when taken in a bottle, the rush of water into the tow-net was sufficient to fracture them, the result being a mass of broken gelatinous *débris* (apparently vegetable) which clung tenaciously to the muslin of the net.

They appeared to be most numerous a few feet below the surface, and are distinctly visible on looking down into the water from the boat-side. Weather does not seem to affect them, being apparently equally prevalent on a calm or a rough day; but I noticed while rowing across from Penmaenmaur to Puffin Island, a distance of seven miles, that they were less plentiful about the middle of the entrance to the Menai Straits than nearer each side.

Early in June they were in profusion about the mouth of the Dee. Associated with them I have invariably found quantities of *Noctiluca*, which soon congregated about the surface of the collecting-jar, while the gelatinous spheres remained suspended in the water, and the *débris* from the tow-net fell to the bottom.

Any light that can be thrown upon the nature and appearance of these curious bodies will be much esteemed.

Liverpool, July 16 ISAAC C. THOMPSON

The Banner System of Drainage

OUR attention has been called to a paragraph in NATURE (p. 221) in which you review, "Hygiene, a Manual of Personal and Public Health," by A. Newsholme, M.D., Lond. In your review or criticism you state that you "do not agree with Dr. Newsholme in thinking the 'Banner system of drainage one to be recommended,'" and you say your system coincides with that of *several practical sanitarians*. Now, as this is calculated to do harm, and as our system *has* been *approved* of by the *most* eminent sanitarians, and has also obtained the highest awards at all the most important exhibitions, including a Gold Medal at the Health Exhibition, 1884, and has been successfully applied to many noblemen's mansions, hospitals, and other important public buildings, as well as to thousands of houses, we hope you will think we are justified in asking you to tell us your reasons for expressing the unfavourable opinion you have, and that you will oblige us with the names of the "practical sanitarians" you refer to.

We are unacquainted with Dr. Newsholme, and until the paragraph in NATURE was pointed out to us we were not aware of the existence of such a gentleman. Nevertheless, in fairness to him as well as to the public, we will thank you to insert this in your next issue.

BANNER BROTHERS AND CO.,
per MANAGER

11, Billiter Square, E.C., July 14

[Exception having been taken by Messrs. Banner & Co. to a statement which appeared in our last issue in the review of the Elementary Text-books of hygiene, having reference to this system, we have no objection to state that (in the opinion of our reviewer) the Banner system, although correct in principle, is unnecessarily complicated in the details of its working. The "Banner Patent Closet" shown in diagram in the book referred to is a modification of the pan-closet, a closet which has been universally condemned and as almost universally acknowledged to be incapable of improvement.—ED.]

ON THE USE OF CARBON BISULPHIDE IN PRISMS[1]

IN the *American Journal of Science* for April, 1885, there is an account of some experiments of Dr. Draper's which will be read with great interest by all who have used liquid prisms in a spectroscope. The following is an abstract of the article:—

The photographs which were taken in the research on the presence of oxygen in the sun were obtained by the use of two hollow prisms filled with carbon bisulphide. The same prisms had been used by Mr. Rutherford to produce his celebrated solar prismatic spectrum. The photographic work for the oxygen research was done in New York in a back room of the third storey of Dr. Draper's residence. The temperature of the room was remarkably uniform and the definition was all that could be desired. When, however, the research was continued in the new physical laboratory which Dr. Draper completed in 1880, it was found practically impossible to use carbon bisulphide prisms in the room owing to the rapid variations of temperature. No definition whatever could be obtained with the same prisms which had performed so well previously. In consequence the use of these prisms had to be abandoned and a series of experiments made to obtain the spectrum by other means. A Rutherford silvered glass grating of 8640 lines to the inch and a train of six flint glass prisms made by Steinheil were each tried. The grating was not found satisfactory, partly because want of light rendered long exposure necessary, partly because the definition was not so good as had been originally obtained from the bisulphide prisms. The flint prisms gave excellent definition, quite as good as had been obtained with the bisulphide prisms, but there was less light, and it was found impossible to get the line H on the photographic plate, through the train. The dispersion between G and H with the six flint prisms was not quite so great as with the two bisulphide of carbon prisms.

Among the earliest experiments which were undertaken in the new laboratory was a series made to test the performance of a bisulphide prism of Thollon's construction, made by Hilger, of London. This prisms consists of a glass bottle having two plane sides, making an angle of 90° with one another, upon which are cemented two prisms of flint glass 4 by 2 inches on the face, having each a refracting angle of 18°. The refracting edges of these glass prisms are opposed to that of the bisulphide prism. Hence the refracting angle of the compound prism is 54°. The same difficulties were experienced with this prism as with the Rutherford bisulphide prism. Owing to the temperature variations the lines were "woolly" and no definition was possible. It was found that the dispersion power of the Thollon prism was equal to that of about four of the Steinheil flint prisms; and this fact, together with the unsatisfactory character of the results obtained with the train of prisms as well as with the grating, led Dr. Draper to undertake an investigation into the cause of this unsteadiness of the bisulphide with a view to remedying it if practicable.

While using these prisms Mr. Rutherford made an important observation. He noticed that if a good prism which, with a high power, refuses to define the soda line (a more stringent test than soda lines), is violently shaken and then placed in position, it will for a few minutes define beautifully, but gradually settle to its former condition.

It occurred to Dr. Draper, therefore, that possibly the striæ caused by convection-currents produced by inequalities of temperature, and which caused the bad definition, might be destroyed by an active agitation of the liquid. He therefore placed a small propeller wheel in the bisulphide contained in the Thollon prism, passing its shaft through the stopper so that he could drive it at any desired speed by an electro-motor. The result was marvellous: by thus keeping the liquid in agitation all inequalities in its density were prevented, and the definition became excellent. Thus arranged, the Thollon prism was found to be superior, especially in quantity of light, to the Steinheil train of prisms.

Now another source of error was developed. Although when the propeller was running the definition of the bisulphide was not affected by changes of temperature, yet now these changes of temperature, by changing the refractive index of the liquid, caused a continual shifting of

[1] Being an account of experiments made by the late Dr. Henry Draper, of New York.

the position of the lines in the spectrum. It is obvious, therefore, that during an exposure of any considerable duration, such as is often necessary with faint spectra, this change of position of the lines due to temperature-change would absolutely destroy the definition n othe photographic plate. The shifting of the lines on the plate were found to amount to 0·1 inch for 1° F. An even-temperature box of metal containing cotton was made, and the prism arranged within it. The temperature was regulated by a thermostat contained within the box, consisting of a compound bar of brass and ebonite, which turned on or off the gas as necessary. Afterwards one even-temperature box was placed within another, and it was then found that the temperature could be kept uniform for a long time within 0°·1 F., and then the lines did not shift at all so much as the distance between the sodium lines. With this arrangement many hours were taken by the box to settle down to a new temperature, so that, if a change of over 10° F. is to be made in the temperature of the box, it is doubtful whether the spectrum would become stationary in less than twenty-four hours.

The results have a two-fold bearing. In the first place they prove that, by the simple expedient of stirring the liquid in the prism, all striæ may be prevented and the definition rendered perfect. The practical value of this simple expedient is very considerable. The Thollon bisulphide prism, while giving seven-eighths as much dispersion as six flint prisms, gives four times the light in the entire spectrum and eight times the light in the region near G. For photographic purposes, now that the definition can be made permanently sharp and the shifting of the lines prevented, this prism must replace trains of glass prisms, and even gratings, unless these are of large size and are used with telescopes of proportional aperture.

In the second place, this investigation has called attention in a very marked manner to the change in refracting power with change of temperature. This subject has already been discussed by several authors, who agree with the statement of Arago and Neumann, that for glass the law is the reverse of that given for liquids, and that the refractive index increases with the temperature. In the case of the Thollon prism the refractive index increases as the temperature diminishes. As Mendenhall has shown that no change takes place in the angle of the prism with change of temperature, it follows that the observed change of refractive power of the Thollon prism is a differential result due to the excess of the index of the bisulphide in one direction over that of the glass in the other.

It will ever be a source of regret that Dr. Draper did not live to complete the research to which the foregoing investigation was preliminary. With his new and admirably equipped laboratory and with this powerful and thoroughly corrected photographic spectroscope at his command, no one can doubt that he would have secured with it results of the highest value to astronomical, and especially to solar, physics.

PREVENTING COLLISIONS WITH ICEBERGS IN A FOG[1]

THE recent accident to the steamer *City of Berlin* emphasises the importance of devising practical methods of ascertaining the proximity of icebergs in a fog. The precautions adopted by Capt. Laud, though they saved the lives of more than 1400 passengers, and prevented serious damage to the vessel, did not prevent contact with the berg. Even the "look-outs" were unaware of the proximity of the iceberg until it was actually upon them.

Under these circumstances the method proposed by Mr. Frank Della Torre, of Baltimore, deserves consideration. His experiments indicate the possibility of obtaining an echo from an iceberg when in dangerous proximity to a ship. Mr. Della Torre believes that even an object offering so small a surface as a floating wreck may in this way be detected during a fog in time to prevent collision. However this may be, it is certain that his method is worthy of a careful trial at sea, and that preliminary experiments, recently made in the presence of Prof. Rowland, of Johns Hopkins University, and the present writer, have demonstrated the feasibility of producing well-marked echoes from sailing-vessels and steamboats at considerable distances away.

These experiments were made on the River Patapsco, near the head of Chesapeake Bay, at a point about seven miles from the City of Baltimore. The party proceeded down the river in a steam-launch to the selected place, where the distance from shore to shore appeared to be about three miles.

The launch was kept so far from land as to prevent the possibility of mistaking an echo from the shore for one produced by a passing vessel.

The apparatus employed consisted of a musket, to the muzzle of which a speaking-trumpet had been attached. This gun was aimed at passing vessels, while blank cartridges were fired. After a longer or shorter time, according to the distance of the vessel, an echo was returned.

The ordinary river-steamboats, and schooners with large sails, returned perfectly distinct echoes, even when apparently about a mile distant. At shorter distances the effects were, of course, still more striking.

In order to test the effects under the most disadvantageous circumstances, blank cartridges were fired in the direction of an approaching tug-boat. The surface presented was, of course, much smaller than if the boat had presented its broadside to the launch. As the boat approached bow on it corresponded to a target somewhere about six feet square, presenting a convex surface to the impinging sound-wave. Even in this case a feeble echo was perceived when the boat was at a considerable distance (estimated to be nearly one-quarter of a mile). That any echo should have been perceived at all under such circumstances was a surprise. The sound was heard only by the closest attention, but in the case of larger vessels the effects were very distinct and striking.

Experiments were made which demonstrated the fact that the speaking-trumpet attached to the gun was of material assistance in giving direction to the sound-impulse, and in intensifying the audible effect.

Mr. Della Torre claims that a steam-whistle or siren, combined with a projecting apparatus like a speaking-trumpet, will prove as efficient as the gun.

During the experiments on the Patapsco River a curious rumbling effect like the rolling of thunder was often observed, which continued for some seconds. A similar sound was also noticed, as an echo from a well-wooded shore; but the effect alluded to above could not have been due in any way to the land, as the sound commenced immediately upon the firing of the gun, whereas the shore was distant at least a mile or a mile and a half.

The sound was probably due to the presence of ripples on the surface of the water, as the effect was much less marked when the surface was smooth. Such a sound might prove a disturbing element of importance in a rough sea, but would hardly be sufficient to prevent the detection of an echo from a large iceberg. Had shots been fired periodically from the bow of the *City of Berlin* it can hardly be doubted that the presence of an obstacle ahead would have been discovered in time to prevent the collision that actually occurred.

ALEXANDER GRAHAM BELL

[1] From *Science*

THE AURORA[1]

I.

MR. TROMHOLT has rendered a great service to science by the travels and observations recorded in these volumes; indeed, it would not perhaps be going too far to say that we have here, brought before us in the most interesting manner, one of the best organised attempts to study the aurora that has been made for many years, the credit for which must be given to the organisers of the International Polar Research Expedition of 1882-83. Mr. Tromholt's duty was to observe all auroral phenomena in the Lapp settlement of Koutokæino, and above and beyond this to observe in such a way that, in combination with other observations arranged for at the Norwegian station at Bossekop in Finmarken and the Finnish one at Sodankylä in the centre of Finland, certain conclusions might be arrived at regarding the height at which the various displays take place.

The results, however, recorded in these volumes are by no means limited to the height of the aurora. The constant study afforded to Mr. Tromholt and his *confrères* at the other stations of one of the most awe-inspiring phenomena which it is given to man to witness have permitted generalisations to be reached and hypotheses to be broached of the greatest scientific interest; and this must be our excuse for dwelling on the general results of this recent work in the present article, including also a notice of those of Nordenskjöld in the *Vega* Expedition 1878-79.

Let us begin by considering the general phenomenon of an aurora as seen in Northern Europe. Mr. Tromholt gives the following general description of a great display:—

"It is a lovely evening in spring or autumn. The light is fast fading away in the west, and one star after another comes out of the azure sky. Suddenly a peculiar vibrating luminosity appears high up in N.E., now with a soft purple tinge, and now diffused with long narrow streamers, reaching to the Pole star, or beyond. It is wafted to and fro like a curtain before a light breeze, and its light becomes more and more intense as Night spreads her dark veil over the sky. Suddenly the luminous cloud is furrowed from one end to another by a bunch of streamers, the lower, emerald-green ends of which rest almost on the horizon, while the upper diffuse points, which flame with a purple lustre, reach right up to the Zenith. Streamer oscillates by streamer, more and more follow, and, with a rapidity almost startling, the aurora expands westwards, and shortly after the whole northern sky is a bath of fire. Like a curtain woven of light and colour the streamers hang fairy-like in the air; here and there they form large graceful folds and sway to and fro in wonderful beauty, as if the wind played on the radiating drapery. Red and green play alternately in the lower border of the curtain. For a few minutes longer the marvellous play of light lasts, the varying forms, colours, and motions charm the mind as much as the eye—the forces are then exhausted, the lovely picture grows more and more obscure, and the forms are dissolved into large soft clouds of light, covering nearly the entire northern half of the heavens.

"Down by the horizon there is still, however, great activity, as here a couple of arcs have formed, the constant-changing play of which enchains the spectator during the *entr'acte* between the past and coming scene of the sublime drama which Nature performs on the great stage of heaven: now faint, then strong, soon symmetrical, soon serpent-like, in one moment split into three or four arcs, and again gathering into one, now woven with all the lovely colours of the rainbow, now throwing forth rays and resembling the ornamental pipes in an enormous organ—such is the spectacle I gaze on.

"At this moment a narrow, white streamer suddenly leaps up from the horizon in the east, a similar one appears in the west; they both grow rapidly in length, their points meet, and a grand arc spans the sky right above the observer. Simultaneously two long and broad sheafs of streamers, woven of white and red filaments, develop at the bases of the arc. The luminosities on the northern sky again catch fire, and soon after the whole heavens in the north is again ablaze. Quicker and quicker the motions become and intenser the colours, higher and higher the streamers travel, the points approaching the great arc, which is moving slowly southwards. Other groups of streamers form at greater altitudes, in east and west, and the luminous masses cover more and more of the sky. Now a number of white bands suddenly appear overhead, shoot right across the sky from east to west, and then rush southwards, and vanish. By this time the luminous masses have crossed the zenith, the points of the streamers meet in a spot high in the southern sky, while in the east and west the sphere of the streamers moves gradually southwards. A wonderful spectacle is now presented to view. In every direction the whole sky is covered with bunches of streamers, all of which point to this spot—the magnetic zenith—and transform the vault of heaven into one gigantic lustrous cupola, the beauty of which no pen can describe, no brush depict. All the marvellous *nuances* of colour of the rainbow contribute to ornament the vault; here is the tender green of the emerald, the grand purple of the ruby, and the charming blue of the sapphire, all blended together in a thousand shades. Here gamble a flock of yellow-green flames, and there mighty pillars rise as if to support the luminous vault, while yonder the sky is covered with a transparent drapery shot with red, behind which dazzling white streamers stand forth. It is the auroral corona.

"A lovelier spectacle is not given the human eye to behold; he who has not seen it cannot form an idea of its magnificence—it defies description.

"For a moment the glorious, luminous vault remains thus in majestic beauty, then the supporting arches tremble for a moment, and fall, the faint light-clouds remaining in the southern sky vanish, and the aurora recedes to the northern sky. Here the streaming and play of colour continues for a while in manifold variation; but the area of the luminosity grows smaller and smaller, and moves steadily downwards to the horizon. A remarkable phenomenon now occurs in the soft luminosities, which still stand high in the northern sky: they appear to leap upwards with the rapidity of lightning, and then disappear; in several other spots similar clouds come forward and chase each other over the sky. The eye is hardly able to follow their strange gambols. Again the streamers grow in length, the light-clouds cease their play, and once more the streamers approach the zenith. But now they do not cross it; they remain in majestic rest for a few seconds, and then slowly disappear.

"Hour after hour this marvellous display continues in the northern sky, now stronger now fainter, and often it does not cease before the first streaks of dawn appear in the east."

It must not be imagined, however, that the displays generally are of this brilliancy; auroræ are generally much weaker, and in these cases the phenomena are different. Here is a general description of a weak aurora:—

"The sun set some hours ago. The purple glow in the west has disappeared, myriads of stars stud the dark canopy. Far down on the horizon, in north-west and north, lies a faint vague cloud of light, upwards and downwards fading into the sky . . .

"Soon after, tiny spots of intense light begin to appear in the luminous cloud, while at times the entire oscillating luminosity disappears from the sky. But still the light is

[1] "Under the Rays of the Aurora Borealis." By S. Tromholt. Edited by Carl Siewers. (London: Sampson Low and Co., 1885.)

increasing in force, and in a few moments a broad arc of light stretches along the north-western sky, resting both its bases on the horizon in north-east and west, and whose highest point lies a few degrees above the horizon in north-north-west. Upwards the light is gradually lost in the sky, downwards the intensity is greatest, and the lower edge stands sharply out. Solitary, stronger spots of light, now here, now there, travel, with an unsteady motion, at times right or left through the arc, again to disappear in the cloud. Following the arc attentively it will be seen to rise gradually, its point of culmination travels upwards, and the distance between the two bases becomes greater and greater. The colour of the light is nearly white, with a weak yellow-green tinge, which is easily discovered by comparing it with the cold, white light of the Milky Way. Suddenly energy and life become manifest in the phenomenon. The lower edge of the arc changes in an instant into a small, intense stream of light, which is sharply defined by the dark space below —the 'dark segment'—appearing black or faintly violet. Higher up the luminosity gathers into a broad, but fainter arc, running parallel with the other. Only for a moment does the aurora retain this distinct form; stronger waves of light begin to appear in the lower arc, which soon generate groups of intense, short, and perpendicular streamers, reaching the upper arc, which sway right and left, at the same time travelling east or west. Below, the ends, strong in light, cut down into the dark segment, whose sharp curve is thereby broken. Of the upper arc only fragments now remain, while the lower is dissolved into quivering bunches of streamers, which die out one after another as new ones are being lit in their place. They move, here slowly, there quickly, oscillating apparently to the right or left, but it is impossible to say whether it is really the streamers which move horizontally, or merely the light which passes from streamer to streamer without the latter shifting their position.

"But this display is only of short duration, the streamers soon lose their motion and light, and in a few minutes there remain only some pale, diffuse luminosities. Slowly these now gather, until another arc is formed. It is not so symmetrical, and does not possess the classical rest of

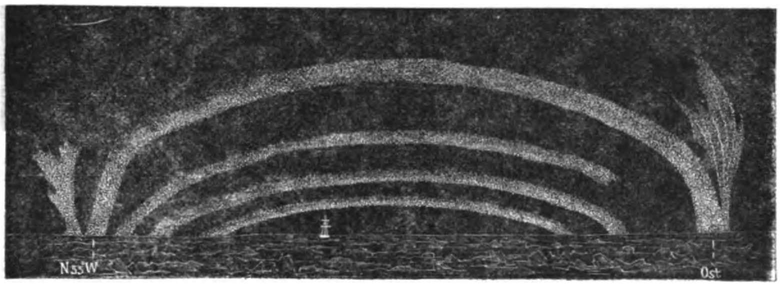


FIG. 1.—Auroral Arcs, Nordenskjöld.

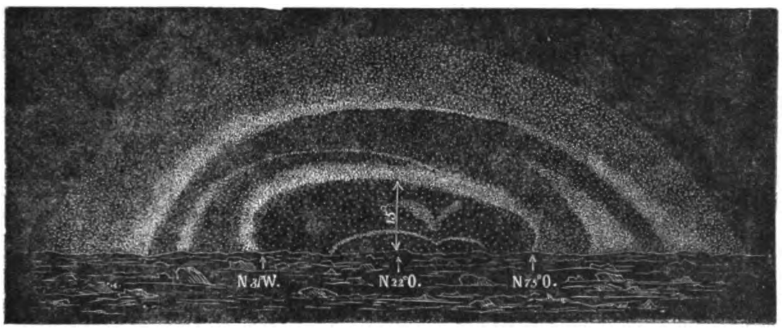


FIG. 2.—Auroral Arcs, Nordenskjöld.

the former. Constantly it changes form, position, and intensity until a fresh burst of streamers occurs; in two or three places the light shoots up into bunches of long streamers between which the space is nearly dark; in another second the streamers are isolated in groups, which, like the former, gracefully sway to and fro, their faint points reaching nearly up to the Pole star. The lower ends are broken at various heights, and develop as they move the soft colours of the rainbow. The culminating point in the display has been reached. The streamers vanish one by one, the light pales, and the remnants in the sky again form into a long, low-lying arc. Only for a short time it retains this pronounced form, the edges become obscure, the centre follows, and finally the last faint indications of the aurora sink into the unfathomable darkness of space."

Now the great variety in the appearance of the aurora depends to a great extent upon the various mixtures of certain component features. These have been designated *auroral arcs*, often very narrow, often degenerating into broad bands; *auroral streamers*, single or multiple shafts of light of various colours, nearly always vertical in direction, and long or short, with lateral and vertical motions; the *auroral corona*, a brilliant point near the zenith, from which, in most brilliant displays, streamers seem to radiate in every direction, the heavens putting on the appearance of a bright ribbed dome; and, finally, *auroral clouds*, which are amorphous and most irregular in their distribution.

Before we proceed further with more detailed descriptions of these various features, each of which in the main is seen more richly from certain positions on the earth's surface than in others, or puts on different aspects, a word must be said about the magnetic basis of the whole phenomenon, since it has long been known to be connected with the *magnetic* poles of the earth.

In the first place, the mariner's compass or declination-needle indicates the direction of the magnetic pole. At the present time in London the needle points 18° to the west of true or astronomical north; hence, if auroral arcs were seen here to-night, their highest points would be nearly certain to be west of north. Next, the dipping- or inclination-needle (a very cheap and admirable form of which is now sold by Mr. Casella) points to the magnetic zenith, which now in London lies 22° north of the true or astronomical zenith, in the magnetic meridian joining the north and south magnetic points of the horizon. Hence, if an auroral corona were seen here to-night, it would be nearly certain to lie in a point 22° north of the zenith.

Let us limit ourselves for the present to the arc. In our latitudes, as has been said, it is seen to the west of north, generally low down near the horizon; but in the far north on the same magnetic meridian as ourselves it is seen east of south, while also in the far north, but in a widely different longitude—that of Behring's Straits—it is seen north-north-east.

Evidently, then, this arc—this "common auroral arc," as it has been called by Nordenskjöld—is produced by a ring at some height between us and the north pole, but its centre does not lie at the north pole. Putting such observations as those referred to together, Nordenskjöld inferred the centre to be near the magnetic pole but not at it, in 81° N. lat. and 80° W. long., the thin ring of light having a radius of 18° and a height of 200 kilometres.

This, then, was Nordenskjöld's main conception—an immovable common arc (a permanent stria, to speak in vacuum-tube language), though he acknowledged additional ones sometimes, and shows by his observations that they are not always concentric.

He also attempted to explain the frequency and positions of arc auroræ in different places by dividing the polar lands into five concentric regions (see NATURE, vol. xxv. p. 368).

In Mr. Tromholt's volume we find what may prove to be an immense advance on this view. He holds that *the auroral zone moves northwards and southwards daily, yearly, and eleven-yearly.*

Again, to speak in vacuum-tube language, instead of one rigid stria, we may have many striæ, and these moving towards or away from the auroral pole as ordinary striæ move towards or away from the negative pole.

Next, as to the proofs of this movement, some more quotations from Mr. Tromholt may be given:—

"The daily period is apparent by a maximum of frequency and development which in most places in the globe occurs one to two, or three hours before midnight. This maximum seems, however, to occur *later* the nearer we approach the magnetic pole. This will be clear from the following series, in which the figure in parenthesis denotes the geographical latitude and the other the hour when the aurora attains its maximum in the place named:—

"Prague (50), 8¾; Oxford (52), 9¼; Kendall (54), 9¾; Makerston (56), 9⅓; Upsala (60), 9½; Christiania (60), 10; Bergen (60), 9⅘; Bossekop (70), 10½; Pustosersk (70), 11-12; Quebec (47), 10⅓; Fort Carlton (53), 12¼; Fort Simpson (62), 12; Point Barrow (71), 13½.

"For the Aurora Australis continuous series of observations are almost entirely wanting. It seems, however, from the fragmentary material which we possess, that the daily period for this does not differ from that of the Aurora Borealis.

"The individual types of the Aurora Borealis seem, like the phenomenon itself, to be confined to periods, and to attain their greatest frequency and highest development at certain periods. Thus, it appears from the observation of the previously mentioned French expedition to Bossekop, that the arcs appear on an average at 7h. 25m.; the streamers at 8h. 26m.; the auroral clouds at 11h. 18m.; the auroral waves between 13h. 12m. and 13h. 53m.; the intensest colours at 10h. 11m., and the greatest brilliancy between 10h. and 11h."

Next as to the yearly change.

Weyprecht was the first to advance the view that the auroral zone is furthest south at the equinoxes, and furthest north at the solstices. On this point Mr. Tromholt writes:—

"My researches have led me to endorse Weyprecht's theory. I feel satisfied that the *Aurora Borealis moves towards the autumnal equinox southwards, and then northwards, reaching its furthest northern limit about solstice. After this it again moves southwards, being in its most southern position at the vernal equinox, when the movement is again in a northerly direction.*

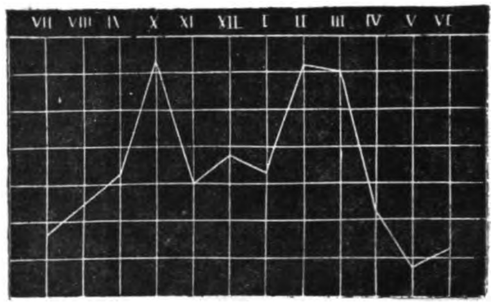


FIG. 3.—Curve of yearly auroral frequencies, Fritz. The Roman figures indicate the months.

"From this it follows that the two maxima occurring in the Temperate Zone at the equinoxes must approach each other more the further north the point of observation is situated. This is, in fact, the case. As some examples, I may mention that, whilst the two maxima occur in March and September in St. Petersburg, Åbo, Stockholm, Christiania, Worcester (Mass.), and New Haven, they occur in February and October in Aalesund, Newberry, Quebec, and Newfoundland; in December to January in Hammerfest and in January at Fort Reliance. Very instructive in this respect are also the observations from the three Greenland stations: Upernivik, Jacobshavn, and Ivigtut. At Ivigtut, the southernmost of the stations, the yearly maximum must certainly be said to occur in January, but there is a second maximum towards the autumnal equinox. At Jacobshavn, eight degrees further north, there is but one distinctly marked maximum, in January, and at Upernivik, the northernmost of the stations, the maximum falls at the winter solstice more marked and dominant than anywhere else in the world."

(*To be continued.*)

THE ECLIPSE OF CHUNG K'ANG

IN China an eclipse of the sun is, and has in all ages been, considered as a bad omen. Indeed anything which disturbs the regularity of the movements or appearances of the heavenly bodies is so considered. "On the first day of the last month of autumn the sun and moon did not meet harmoniously in Fang." This passage occurs in the ancient classic, the "Shu Ching," in the "Yin Cheng," one of the books of the Hsia dynasty. Chinese commentators say that this passage refers to an eclipse of the sun in Fang, the fourth of the Chinese twenty-eight constellations. The last month of autumn, according to the Hsia Calendar, is the ninth month, the month after that month which contains the autumnal equinox.

The constellation Fang extends from about π to σ Scorpii, a distance measured along the ecliptic almost equal to 5°. Approximately the limits of Fang were as follows:—

2250 B.C.	between	184° 12′	and	189° 12′
2150 ,,	,,	185 34	,,	190 34
2053 ,,	,,	186 56	,,	191 56

An eclipse near the constellation Fang will satisfy the conditions of the text, as at that early period, and for a great many centuries after, the Chinese were unable accurately to determine the position of the sun among the stars.

The date of the accession of the Emperor Chung K'ang, during whose reign this eclipse is said to have occurred, is unknown. Indeed all the dates in Chinese history before the Chou dynasty are unknown, the dates given in the common chronology being erroneous. The great importance of fixing the date of this eclipse is therefore apparent.

In all probability Chung K'ang reigned some time between the years 2050 B.C and 2158 B.C. I have therefore examined all years between these two dates on which an eclipse of the sun, in the constellation Fang, and on the first day of the ninth moon might be looked for.

Mr. Newcomb has published tables for the calculation of eclipses between the limiting dates 700 B.C. and 2200 A.D. I have extended these tables so as to embrace all eclipses of the sun between the dates 2200 B.C. and 2200 A.D. These tables thus extended I have used in the examination of this eclipse.

We might expect such an eclipse on or near the following dates:—

−2154 + ·64	years.	...	...	−2164 + ·82	years.
−2135 + ·25	,,	...	...	−2145 + ·43	,,
−2117 + ·86	,,	...	...	−2126 + ·04	,,
−2098 + ·47	,,	...	...	−2108 + ·65	,,
−2079 + ·08	,,	...	...	−2089 + ·26	,,
−2061 + ·69	,,	...	...	−2071 + ·87	,,
−2042 + ·30	,,	...	...	−2052 + ·48	,,

The dates on the left are the years and fractions of a year on which the ascending node is in longitude 180°, those on the right the years on which the descending node is in longitude 180°. The minus sign indicates B.C.

The situation of the capital of Chung K'ang is a disputed point. Some hold it was at An Yi Hsien, in Shan Hsi, latitude 35° 8′ N., and longitude about 111° 30′ E. of Greenwich; others say it was at T'ai K'ang Hsien, in Honan, latitude 34° 7′ N., and longitude about 115° E. of Greenwich.

Gaubil calculated the eclipse of the year 2154 B.C. to be the one in question. During this eclipse, however, it was night in China.

On October 22, 2136 B.C., the ninth of the cycle of days, the day Yen Shen, there was an eclipse of the sun, visible in the north of China. At An Yi Hsien it commenced about 10 a.m., and was over about half an hour after noon. The magnitude was about ·5. The longitude of the sun at the moment of true conjunction was 191°·38, so that the eclipse took place very near Fang. The day was the first of the ninth moon.

In the following year, 2135 B.C., on October 11, the third of the cycle of days, the day Ping Yin, there was an eclipse of the sun, also visible in the northern hemisphere. At An Yi Hsien the eclipse began about 4.30 p.m., and lasted till about 7 p.m. The magnitude was ·58. At the time of conjunction the longitude of the sun was 180°·28, so that the eclipse took place near Fang. Strictly speaking, October 11 was the first day of the eighth moon, but we need not expect the Chinese at that early date to have been able to determine the time of the equinox to a few hours.

We meet with no other eclipse visible in the north of China, and fulfilling the required conditions, till the year 2071 B.C. On October 23, the fifty-first of the cycle of days, the day Chia Yin of this year, there was an eclipse of the sun. At T'ai K'ang Hsien it began a few minutes after seven in the morning, and was over about 9.30 a.m. The magnitude was ·34. At conjunction the longitude of the sun was 193°·2. This eclipse also satisfies the required conditions near Fang, and occurring on the first day of the ninth moon.

The eclipse of the year 2127 B.C. deserves consideration, as it is generally considered to have been the eclipse in question. On October 13 of this year, the forty-seventh of the cycle of days, the day Keng Hsii (all dates are given according to the Julian calendar), there was an eclipse of the sun. The "Bamboo Books" say that this eclipse took place in the fifth year of Chung K'ang, the thirtieth of the cycle of years in the An Sunn and on the first day of the ninth month, the day Keng Hsii (forty-seventh of cycle). This account of the eclipse must have been the result of an after-calculation, and is a proof of the wonderful accuracy to which the Chinese astronomers attained in calculating back past eclipses. In this eclipse they are right in every particular. However, this eclipse was not visible in China so far south as either An Yior T'ai K'ang. The following table, which approximately gives the southern line of simple contact of the eclipse, shows this clearly:—

Latitude	Longitude
66° 14′ N.	96° 10′ E.
60 23 N.	139 27 E.
55 33 N.	152 28 E.
52 7 N.	158 35 E.

From the above investigation we see that the eclipse referred to in the "Shu Ching" in all probability must be that of one of the years 2136 B.C., 2135 B.C., or 2071 B.C.; which of these dates is to be taken must be determined by other considerations. The eclipse of the year 2136 B.C. may be the one in question. It occurred in the middle, the busiest part, of the day. A total eclipse would agree better with the accounts as given in the "Shu Ching." The hurry and bustle occasioned by the total want of preparation to perform the customary rites, and the penalty of death inflicted on the two astronomers, Hsi and Ho, seem to point to some adequate cause. However, I believe a great part of the account as given in the "Shu Ching" is legendary. It is taken for granted that Hsi and Ho were able to predict eclipses, and it is stated they were put to death because, giving themselves up to pleasure, they neglected their proper duties. But the Chinese at that early period, and for many centuries after, were not able to predict eclipses. They were not even able to observe the place of the sun with any degree of accuracy, which is proved by their Calendar so often falling into confusion. That the account of the eclipse itself is true, there is no reason to doubt. It is referred to in the "Tso Chuan," a book written about the time of Confucius. However, that the astronomers Hsi and Ho were put to death because they failed to predict the eclipse, appears very doubtful. It is much likelier they were put to death for rebellion, or some other political reason. Summing up the above investigation, we see that between the years 2164 B.C. and 2042 B.C. no eclipses of the sun in Fang, and on the first day of the ninth moon, were seen in the north of China, except in the years 2136 B.C., 2135 B.C., and 2071 B.C.

P.S.—In NATURE, vol. xxxi., p. 91, the eclipse of Thucydides is mentioned as having occurred on August 3, 431 B.C., and that, calculating this eclipse with Hansen's tables, the greatest phase falls at 5h. 9m. p.m., and the magnitude is ·75. Using Newcomb's tables of eclipses, I find the greatest phase falls at 6h. p.m., and that the magnitude was ·91. S. N. K.

NOTES

SIR L. PLAYFAIR asked the Secretary to the Treasury on Monday whether any answer had been given to the application of the Marine Biological Association for aid in establishing a station on Plymouth Sound to investigate the marine fauna and flora, especially in their relation to the food-fishes of these islands, and for which station 8000*l.* had already been subscribed from private resources. Sir H. Holland in reply stated that this application had received much consideration both from the present Government and its predecessors, and a letter was written to the association a fortnight since in which the Treasury undertook in general terms to ask Parliament for an annual grant for a term of years in aid of their undertaking, on condition that their work should be carried on in full concert with the Scotch Fishery Board, to whom Parliament has already granted considerable sums for similar objects. In the view of the Government these two bodies must be considered as working together towards the common benefit of the fishermen and fish consumers of the three kingdoms. On the whole this is satisfactory. No doubt it is desirable to form a central authority for dealing with fishery statistics and the scientific problems of fisheries for the three kingdoms. But this will take time; and in the meanwhile it is to be expected that the Marine Biological Association will receive Government aid so as not to delay its useful work. The condition as to common action and harmony with the Scotch Fishery Board is very proper and is not likely to give rise to any difficulty. The leading and we believe only scientific member of the Scotch Fishery Board, Prof. Cossar Ewart, is a member of the Biological Association, and will no doubt co-operate in every way with that body. The Marine Biological Association is now a very large and weighty body, comprising all British zoologists. It is not to be expected that it should be controlled in any way by the Scotch Board, nor are we sure it would desire to interfere with Prof. Ewart's valuable researches. But there need be no difficulty, we should think, about consultation and harmonious action. With the expected Government aid the Biological Association will be able to spend the greater part of its 8000*l.* on building and equipping a first-rate laboratory on the splendid site granted to it by the War Office. It will be able to carry out a definite series of investigations under the guidance of Profs. Moseley, Lankester, Günther, Huxley, and other leaders of the Association, and may be expected, step by step, to build up that knowledge of sea-fishes which is so much needed. The work to be done will no doubt be thoroughly systematised and apportioned to different workers. It should be remembered that the Marine Biological Association is not local: it aims at carrying on work on various parts of the English, Scotch, and Irish coasts, and in time, indeed, may become in all respects a national Association.

THE Astronomische Gesellschaft meets this year at Geneva from August 19 to 22. The first meeting will be held at 10 a.m. on the 19th, in the hall of the Aula of Geneva University. Geneva has been chosen for the eleventh meeting of this Association on account of its central situation. Although founded at Heidelberg twenty-two years ago, the Association includes among its members astronomers of nearly all civilised countries.

THE Paris students are making extensive preparations for celebrating the 100th birthday of M. Chevreul, the veteran chemist, who has been a member of the Academy of Sciences since 1826.

THE third session of the International Geological Congress, which was postponed last year on account of the cholera on the Continent, is fixed to be held this year on Sept. 28 at Berlin, under the honorary presidency of the veteran geologist of Rhineland, Dr. H. von Dechen. The President of the Organising Committee is Prof. Beyrich, and the General Secretary M. Hauchecorne, 44, Invalidenstrasse, Berlin.

To meet the requirements of ladies going up for the Preliminary Scientific or the Intermediate or Full B.Sc. examination at the University of London, under the new regulations, the Council of Bedford College, York Place, Baker Street, London, have arranged for a complete course of instruction in biology, to commence next October. Mr. A. G. Bourne will give lectures in animal biology, and will also have classes for demonstration. Mr. A. W. Bennett will lecture on vegetable biology, and Miss Mary Forster, of Newnham College, will give practical demonstrations twice a week. Provision is also made for adequate instruction in other branches of science required for the same examinations—viz. mathematics, physics and chemistry, the two latter including laboratory work.

THE secretary of the Royal Horticultural Society writes to say that the council of his society are prepared to offer their co-operation and assistance to such of the colonies as may desire as a feature of their courts examples of the indigenous flora in vestibules or plant-houses. The council, believing that collections of ornamental and economic plants in a growing state, and of fruits, would be of much interest and value, will be ready to give advice and practical assistance in preparing, arranging, and carrying out such illustrations, to any of the colonies who may apply to them.

THIS season the rains have set in early and with unusual force in Southern India and Burmah, and about the usual time in Lower Bengal, while in Western India they have been later in commencing and are deficient in amount. Thus far, therefore, Mr. Blanford's forecast of this year's south-west monsoon, founded on last winter's snowfall on the Himalayas, has been amply justified.

AN invention, which it is anticipated will be of importance in future warfare, was on Monday night exhibited in the grounds of the Albert Palace by Mr. Eric S. Bruce, the inventor. It consists of the application of electric lighting to balloons, by means of which signals may be flashed at night over very wide areas. Before giving a practical demonstration of the working of his invention, Mr. Bruce delivered a brief lecture in the concert hall of the Albert Palace, in which he stated the results of his experiments and explained the manner in which he had arrived at them. The invention consists of an ordinary balloon made of a material as translucent as possible (in the case of the one at present on exhibition the material is cambric) in which are fixed a number of incandescent lamps. The balloon is a captive one, and the rope which secures it is also utilised for conveying the electric current to the lamps inside the balloon. The Morse system of telegraphy is employed for the signalling, which illuminates the balloon with flashes of light of longer or shorter duration. The invention dates back only two months, and the experiments were made with a large balloon for the first time last night, and were completely successful. It is proposed to continue the exhibitions of signalling for a month. The chief obstacle to be overcome in introducing the electric light into the balloon was that occasioned by the highly inflammable nature of the gas with which the balloon is inflated. This has, however, been successfully surmounted. During the evening several sentences, including "God Save the Queen," "Rule Britannia," and "Health and Happiness to Princess Beatrice," were flashed from the balloon.

ON Thursday evening last, July 16, Finsbury Technical College was *en fête*, the students having organised a *conversazione* to mark the conclusion of the work of the session. The programme was of a very varied character, including, in addition to a large number of scientific items, a concert given in the Chemical Lecture Theatre, and a play and dance in the large hall of the Middle Class Schools in Cowper Street, which had been kindly lent for the occasion. The evening's entertainment proved most successful in every way, great credit being due to the secretaries of the various Committees, and especially to Mr. H. Newman Lawrence, the general and organising secretary, for the efficient manner in which all the arrangements were carried out. Most of the rooms were filled with exhibits of apparatus, the whole building being lighted by electricity, and the machinery, workshops, &c., in full action. In the course of the evening a lantern exhibition of polariscopic objects was given in the Physical Lecture Theatre by Prof. S. P. Thompson, who had also lent for exhibition various telephones, a phonograph, an "electric light compass" for detecting the direction of a current in a wire, a "cymatograph" (an instrument for compounding the resultant of two parallel, simple, harmonic waves), and a collection of historical electric-telegraph apparatus. In the Chemical Department Prof. Meldola exhibited a series of new organic products obtained in the course of recent researches. Messrs. Hopkins and Williams exhibited a series of chemical preparations. A large number of microscopes with objects were exhibited in one of the rooms by Mr. Beck. Amongst the electrical exhibits were a model telpher line by the Telpherage Company, the valve telephone lent by the New Telephone Company, Cardew's voltmeter lent by Messrs. Paterson and Cooper, a selection of ammeters, switches, incandescent lamps, &c., lent by Messrs. Woodhouse and Rawson and by Mr. Swan; and accumulators, dynamos, &c., made by the students of the Electrical Engineering Department. In the Trade Classes Department Mr. C. T. Millis exhibited some new geometrical models and students' paintings; models, and drawings were exhibited by the Applied Art Department. It is proposed to form an "Old Students' Association" in connection with the College, and the success which attended the first attempt at a public entertainment has encouraged the professors and students to make an annual institution of it.

Mr. Hele Shaw has been unanimously appointed to the new Chair of Engineering in University College, Liverpool. Mr. Shaw began his career by taking the Senior Whitworth Scholarship in 1876, which was followed by many other honours while pursuing his engineering studies. In the present year he was awarded the Watt Gold Medal and Telford Premium by the Institution of Civil Engineers.

According to the *Times* Roman correspondent an interesting discovery, illustrating the commerce and the luxury of ancient Rome, has been made close to Monte Testaccio and the English cemetery. The whole of the district to the west of the Aventine outside the Porta Tregemina was occupied by granaries and warehouses for the storage of imports of all kinds. Between the northern side of Monte Testaccio and the Tiber there still exist colossal remains of the great emporium built by Marcus Emilius Lepidus and Emilius Paulus nearly 200 years before the Christian era. In the year 1868 a considerable portion of the quays was discovered, together with some 600 blocks, many of them of large size, of rare, variegated marbles of all kinds, lying just where they were landed from the galleys which had brought them from Numidia, the Grecian Islands, and Asia Minor fifteen centuries ago. Now, in the course of the building operations in this locality, two warehouses have been discovered, one filled with elephants' tusks and the other with lentils. It is curious to find such products stored side by side; but as bags of lentils were sometimes shipped as ballast, they may have served that purpose. The discovery would have been a very valuable one if, unfortunately, the ivory had not been much decayed.

We have received from the Bureau des Longitudes ephemerides of circumpolar and moon culminating stars for the present year and an account of the determination of longitude between Paris and Bregenz, a town situated near the western boundary of the Austro-Hungarian Empire; a high value is claimed for the result.

Mr. Cleveland, the President of the United States, has given his assent to the nomination as American Ambassador at Rome of Mr. Stallo, a German by birth, but long since a naturalised American citizen. He devoted himself exclusively to scientific pursuits in his younger years, but was persuaded by his friend Draper to join the Bar, where he distinguished himself without relinquishing his former avocation. He is the author of several scientific works; the last was on "The Concepts and Theories of Modern Physics," noticed in Nature, vol. xxiv. p. 321.

Owing to the frequency of tornadoes in some parts of the valley of the Mississippi, we understand that a number of caves have been bored in some parts of the country to afford shelter to travellers chancing to meet such dangerous phenomena on their way.

On July 10, at about noon, a wonderful mirage was seen on Lake Wettern, in Sweden, by a number of people between the villages of Fogelsta and Vadstena. A small island in the lake appeared as if covered with the most gorgeous flora and tall gigantic trees, forming great groves, between which buildings having the appearance of the most splendid palaces were seen. The Sandö, another little island, seemed to rise out of the sea many times its actual height, its sandy shores looking like lofty castellated walls. It had the exact appearance of a mediæval fortress enclosed by four walls. Two other little islands, Åholmen and Risön, appeared also as lofty towers above the water. The mirage lasted for nearly half an hour, when it disappeared somewhat rapidly.

Mr. Clement L. Wragge is arranging for the establishment of a meteorological station in Northern Queensland and New Guinea. He hopes to establish an observing station at Port Moresby. An assistant will carry on the work of the Torrens Observatory. Mr. Wragge is also arranging for the continuance of his observatory on Mount Lofty.

On Tuesday morning last week an earthquake occurred in Eastern and Central Bengal which is said to have been the severest one experienced by the inhabitants for forty years. The shocks lasted for nearly a minute. In Calcutta the houses rocked and cracked and the plaster fell in large quantities. There was general consternation, the people all rushing out of doors. A wave was raised in the river like a bore, causing some anxiety with respect to the shipping. Luckily no accident occurred, and no damage was done beyond the cracking of the walls of some old houses; but had the shocks lasted some seconds longer the city would probably have been laid in ruins. Some of the up-country stations were less fortunate. At Serajgunge a chimney belonging to some jute mills fell. In many other places some of the houses fell and people were killed. Twenty-five deaths are reported to have occurred at Aheripore, five at Bogara, eleven at Azimgunge, and several at Dacca. The following morning another shock was felt in Cashmere which did some injury. According to the latest reports the earthquake caused altogether seventy deaths in Bengal.

A shock of earthquake occurred at Velez-Malaga on Monday night last week, but no damage was caused. A smart shock of earthquake occurred at Smyrna at 1.30 a.m. on July 15. The vibration was also slightly felt at Chesmé.

On June 30, at about 10 a.m., after a severe thunderstorm with heavy rain had passed over Stockholm, a little bright cloud was seen sailing in an easterly direction about 30° above the horizon, which at about 11 o'clock was suddenly illuminated by the intensest bright forked lightning, illuminating the cloud and the clear sky for upwards of half an hour, without any thunder being heard. The light was brighter than the electric light. Similar phenomena are very rare in these latitudes, and are believed to augur a good harvest. On the 12th inst. another phenomenon, perhaps of volcanic origin, was observed at Norrköping, the water in the river being seen suddenly to rise, and three large waves with frothy crests to roll thunderingly up the stream. After the lapse of a few minutes three smaller followed, of which the first only was froth-crested. Five minutes later it was observed that the water in the river had fallen quite four inches. The waves did not reach as far as the shore, and no earthquake or subterranean noise was felt or heard. After a quarter of an hour the river had resumed its wonted appearance. The phenomenon, it is suggested, may also have been caused by a sudden subsidence in the river basin.

A MOVEMENT is on foot in Christiania, at the instance of the Society for the Promotion of the Norwegian Fisheries, for the establishment in the Christiania fjord, near Dröbak, of a biological station for the hatching of sea-water food-fish and salmon, in consequence of the great success of other stations along the coast. In a report on this subject by Herr A. Landmark, Chief Inspector of the Norwegian Fisheries, he draws special attention to the great development of the salmon and trout fisheries of Great Britain and Ireland, in consequence of the care and attention paid to them in this country.

UPSALA UNIVERSITY has just received a somewhat valuable present in the shape of a collection of Scandinavian, Icelandic, and Greenland eggs, specially remarkable for its completeness and excellent preparation. Among some of the rarest are eggs of *Tringa islandica*, *Phalaropus platyrhinchus*, and *Lestris pomerina*.

AN automatic bichromate battery has recently been produced by Messrs. Woodhouse and Rawson, the dimensions of which are only 7½″ × 1¾″ × 8½″, and weight 6 lbs. One charge will light a 5-candle power lamp for about two hours. The electrodes are attached to an ebonite plate supported in position over the liquid by the upper edge of the containing case, within which is placed a more shallow case, constituting the liquid reservoir. The reservoir itself is free to move up and down without any possibility of disarrangement, and rests upon a small roller connected with a lever at the bottom of the case. By moving this latter the liquid reservoir is raised, and its contents "immerse" the electrodes. A ratchet arrangement prevents disconnection being made until the battery is out of use. By this arrangement, requiring the use of one hand only, an accurate regulation of the electrodes can be obtained. Further, it is easy, when using ordinary bichromate solution, to raise or lower the liquid reservoir from time to time while the battery is in use, and so displace the gas which gathers upon the surface of the electrodes in consequence of their polarisation.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mrs. Cooper; an Erxleben's Monkey (*Cercopithecus erxlebeni*) from West Africa, presented by Miss Peers; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Lady Kensington; a Rendall's Guinea-fowl (*Numida rendalli*) from West Africa, presented by Mr. F. Le Sueur; three Razorbills (*Alca torda*), eight Puffins (*Fratercula arctica*) from Ireland, presented by the Rev. Ed. Weldon; a Long-eared Owl (*Asio otus*), European, presented by Mr. F. Allen; three Angulated Tortoises (*Chersina angulata*), an Areolated Tortoise (*Homopus areolatus*) from South Africa, a Black Sternothere (*Sternothærus niger*) from West Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two King Vultures (*Gypagus papa*) from Tropical America, deposited; an Axis Deer (*Cervus axis* ♂), a Duyker-bok (*Cephalophus mergens* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE ASTRONOMISCHE GESELLSCHAFT. — The first and second parts of the twentieth year of the *Vierteljahrschrift*, issued by this Society, have been published as a single number. It contains reports from some thirty of the Continental observatories, detailing the astronomical work accomplished during the year 1884, and a Report from the Bureau of Calculation at Berlin, on the part of the Transit of Venus Commission, describing the progress made in the reduction of the observations of the transit of 1882. Dr. B. A. Gould, with the authority of the Government of the Argentine Republic, has offered the stereotype plates of the Catalogue formed from the Cordoba zones, to the Society, the gift carrying with it the sanction of the Government to a new edition being printed therefrom at such time as may be desirable. All the errors detected up to the time of Dr. Gould's communication have been corrected on the plates. It is almost needless to add that this valuable gift has been accepted by the Society, who will preserve the collection of plates at Leipsic.—The death is announced of Dr. T. Clausen, late director of the Observatory of Dorpat; amongst many other important contributions to astronomical science, his masterly discussion of the observations of Lexell's comet of 1770 will be remembered; his prize-memoir thereupon published in the *Astronomische Nachrichten* elicited from Bessel the eulogising remark—"Welche herrliche, oder richtiger, meisterhafte Arbeit ist die von Clausen über den Cometen von 1770; sie ist eine Leistung unsere Zeit, welche unsere Nachkommen ihr anzurechnen nicht vergessen werden."

The next meeting of this Society will be held at Geneva, from August 19 to 22, under the presidency of Prof. Auwers.

THE NEW COMET.—Mr. Bainard of Nashville, U.S., having notified his discovery of a small telescopic comet, on July 7, to Prof. Pickering, it was observed at Harvard College on July 9, the resulting position being—

July 9, 12h 33m 0s M.T.; R.A. 17h 17m 48s·4; Decl. −6° 1′ 8″

Prof. Millosevich communicates the following observations made at the Collegio Romano, in Rome:—

July 12, 9h 56m 29s; Rome M.T.; R.A. 17h 12m 52s·35;

Decl. − 7° 32′ 15″·6.

He remarks that the comet had a nucleus 11m. in the preceding part of the small nebulosity.

The elements of the comet's orbit are yet uncertain, from the case not being a favourable one for calculation. The Dun Echt Circular of July 16 has an orbit computed by Mr. Chandler from observations between July 9 and 11; the resulting date of perihelion passage is May 16. But on combining the above observations on July 9 and 12 with one on July 15, made by Col. Tupman at Harrow, it would appear that the comet may not arrive at perihelion till September. In this uncertainty we defer printing elements till next week. In any case the comet can hardly be one possessing much interest. The theoretical intensity of light seems to be decreasing.

TUTTLE'S COMET.—At the time of writing, no ephemeris to facilitate the re-observation of this comet at its approaching perihelion passage has, to our knowledge, been published, beyond the few positions which have been given in this column, on the assumption that the perturbations during the actual revolution have not been very sensible. If it should prove that no computation of the perturbations has been effected, it will be desirable to make a close examination of the north-eastern heavens during the absence of the moon in August, and just before morning twilight. The period of revolution of this comet at its last perihelion passage in December 1871, was 5045 days, which, without perturbation, would indicate September 24 as near the date of next perihelion passage.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *JULY* 26 *TO AUGUST* 1

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 26

Sun rises, 4h. 17m.; souths, 12h. 6m. 14·3s.; sets, 19h. 55m.; decl. on meridian, 19° 22′ N.: Sidereal Time at Sunset, 16h. 14m.

Moon (Full on July 27) rises, 19h. 15m.; souths, 23h. 58m.; sets, 4h. 46m.*; decl. on meridian, 15° 30′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 39 ...	13 46 ...	20 53 ...	12 10 N.
Venus ...	6 18 ...	13 37 ...	20 56 ...	14 19 N.
Mars ...	1 8 ...	9 26 ...	17 44 ...	23 41 N.
Jupiter ...	7 25 ...	14 19 ...	21 13 ...	9 52 N.
Saturn ...	1 44 ...	9 54 ...	18 4 ...	22 31 N.

* Indicates that the setting is that of the following day.

Phenomena of Jupiter's Satellites

July	h. m.		July	h. m.	
29 ...	20 57	II. tr. ing.	31 ...	19 49	II. ecl. reap.
30 ...	20 9	I. occ. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

July	h.	
26 ...	7 ...	Mercury in conjunction with and 0° 12′ south of Regulus.

GEOGRAPHICAL NOTES

The Rev. G. Grenfell has recently explored the Mobangi, which enters the right bank of the Congo, forming a great delta, between 26′ and 42′ S. lat., nearly opposite Equator Station, and is probably its greatest tributary. Mr. Grenfell navigated the Mobangi in the little steamer *Peace*, on a mean course of north by east, from the equator to 4° 30′ N. lat., and left it still an open waterway. At 4° 23′ N., just below the second rapids, he found it 673 yards wide; at no point lower was it less in width. Its mean depth is 25 feet, and although the current runs not more than 80 to 100 feet per minute, it means an immense volume of water to find running south at a point, as Mr. Grenfell puts it, so near the supposed sources of the Binné, the great affluent of the Niger. Where does it all comes from? he asks. The "trumbashes" of the Chad Basin (Schweinfurth) are common, while they are not known on the Congo. The opinion of Mr. Grenfell and of his Congo colleagues, we believe, is that the Mobangi is probably the lower part of the Welle, a river whose course is one of the unsolved problems of African geography. This is certainly a more likely solution than to connect the Welle with the useless Aruwimi, as Stanley is inclined to do. From the notes sent home by Mr. Grenfell, it would seem that the Mobangi is navigable the whole way from the Congo to 4° 30′ N., a distance of probably 400 to 450 miles, taking account of the bends. A large map, in ten sheets, of the explored part of the river has just been received at the Royal Geographical Society. It is hoped that a full narrative of Mr. Grenfell's explorations will reach England in time to be read at the Aberdeen meeting of the British Association. The Mobangi, Mr. Grenfell writes, is far more populous than any equal length of the Congo, and to his mind the country is more promising. Whether the Mobangi is the Welle or not, it must form an important connecting link between the basin of the Congo and the basins of the Niger, the Shari, and the Nile. Mr. Stanley has always maintained that the region lying between the Congo and the Nile is probably the richest and most promising in Africa, and his belief seems likely to be amply confirmed. Besides the Mobangi, Mr. Grenfell has explored 300 miles of river courses debouching into the Congo, and, as he is a trained and careful surveyor, he will be able to plot them with precision. The most northerly point of the Congo bend he found to be 2° 11′ N. lat., near the mouth of the Ukere or Dujangi.

At the last meeting of the French Geographical Society, held on Friday night, M. Ferdinand de Lesseps gave an account of the recent success of the operations conducted with the object of finding water in the desert tracts of Southern Tunis. After the death of Col. Roudaire the French Minister of War authorised Commandant Landais to resign his duties at the Military School at Saint Cyr, in order that he might continue the schemes set on foot in the region of the Tunisian Shotts. At this time those who believed in the success of these undertakings directed their attention chiefly to the establishment of a harbour at Gabes. The necessity for a port where vessels could put in on the southern coast, and for a town through which the traffic of Tunis and Tripoli could be conducted, was apparent. It was determined to commence operations at the mouth of the Wady Melah, and to make the station established at this point the basis of future and more extensive operations. Two years ago M. de Lesseps, in company with M. Roudaire, visited the region of the Shotts. They observed there, on the banks of the Wady Melah, a lake in which the level of the water never sinks. This water was excellent. M. de Lesseps thought, although there was no visible confirmation of the fact, that this water might be in communication with a deep sheet of water. In consequence he requested the engineers to make borings, or to sink a well at that spot. They have succeeded admirably. At a depth of 91 metres they reached the sheet of water sought for. The flood rushed from the ground with such velocity that it raised with it stones weighing 12 kilogrammes, and threw them to a great height into the air. The well yields 8000 cubic metres of water a minute.

ANNUAL REPORT OF THE FISHERY BOARD FOR SCOTLAND, 1884

The third Report of the New Fishery Board for Scotland, which was recently presented to Parliament, contains, amongst other useful information, valuable statistics of the fish captured during 1884, and a record of the scientific work carried on under the direction of Prof. Ewart, the energetic convener of the Scientific Committee of the Board. From the Report it appears that the herring fishing of 1884 was the most abundant ever known. Unfortunately, it was largely composed of immature and small fish, and consequently it was of much less value than it would otherwise have been. Great shoals of young herrings were found far out at sea much earlier than usual, and heavy takes were made before they had time to mature. The curers were often unable to overtake the hauls of mature fish, and hence much good food was wasted. The haddock and sprat fishings were also successful, and large quantities of halibuts were taken off Shetland. The salmon fishing was not so productive as in 1883, which was a singularly good year. The most important fish taken and sold fresh is the haddock, of which the value is nearly three times as great as any of the others. The total estimated value of the white fish amounted to 716,295*l.*, and of the shell-fish, 80,939*l.* Beam trawling was carried on to a much greater extent than formerly, and with a fair amount of success. Telegraphic communication has been extended to the fishery stations at Castle Bay, Island of Barra, St. Mary's Burra, St. Margaret Hope, Orkney, Reawick, and Vaila Sound (Walls), Shetland, and this is much appreciated by the fishermen and other persons engaged in the fishing industry. Several harbours have also received grants to aid in construction or improvement. The Board, having recognised that great progress had been made in practical fish-culture in America, requested Prof. Cossar Ewart to visit Canada and the United States and report on the methods adopted there for improving the fisheries. Prof. Ewart accordingly visited first the fish-hatching stations in Canada, and afterwards the principal fishing-stations and laboratories of the United States Fish Commission. In addition to visiting the central station and the carp ponds in Washington, Prof. Ewart was able to study the appliances for carrying on hatching and other operations at Wood's Holl. He also visited the Bucksport and other stations for hatching salmon and trout, studied the arrangements for receiving and preserving fresh fish at Gloucester, Boston, and New York, and the methods of utilising the by-products of the fisheries. He likewise examined the boats and fishing appliances in use among the American fishermen and also the splendid vessel *Albatross*, recently constructed for the scientific work of the Fish Commission. It seems the Commission considers that "the best policy is to expend a small amount of public money in making fish so abundant by artificial means that they can be got without restriction and serve as cheap food for the people at large, rather than to expend a much larger amount in trying to prevent people from catching the few which remain after years of improvidence." In order to carry on investigations and hatching operations on the lines which have proved so successful in America, the Board will require to be provided with (1) a well-equipped laboratory with suitable hatching-tanks and at least one large sea-water pond; (2) a cruiser adapted for carrying on dredging and other operations; (3) two small steam tenders adapted for inshore work; (4) a sufficient annual sum of money to meet the working expenses of hatching and other operations and to provide the necessary apparatus. From information gained in America the Board feels that, if provided with sufficient funds and with increased powers, it might be able greatly to increase the number of useful food fishes in the firths, bays, and other waters around the coast. The marine station at St. Andrews is now in working order and an assistant naturalist has been sent to carry on investigations under the direction of Prof. McIntosh, F.R.S. A number of interesting inquiries have been instituted, especially on the nature of the eggs and rate of growth of fishes and the life-history of the common mussel. The Scientific Committee, who felt the assistance of an experienced naturalist devoting his whole time to the work of inquiry to be not merely expedient but necessary, have been so fortunate as to secure the services of Mr. Brook, F.L.S., of Huddersfield, who had been studying for some time the history and habits of fish, and gained considerable experience in organising and carrying on a marine laboratory. A temporary laboratory has been erected at East Tarbert, a convenient situation for studying the west coast fishing and from which it is possible to study not only the herring-fishing in Loch Fyne, but, with a good steamboat, to embrace the whole area of the Firth of Clyde. Mr. Brook is engaged in studying the development of the herring, and the result of his experiments will be described in detail in papers the first of which is now appended—the others to be presented to the Board in the autumn. Mr. Brook has also in hand a paper on the "Food of the Herring," to be completed in the autumn. The Directors of the Rothesay Aquarium have very kindly placed the tanks of their institution at the service of the Board, and this will be of great assistance in the study of the life-history of various food fishes, especially during the winter months. There is now at the service of the Board a small laboratory in the Cromarty Firth, and it is hoped that a marine laboratory may soon be established near the mouth of the Firth of Forth.

The most important paper in the scientific appendices contains "Observations on the Spawning of the Cod," by Prof. Cossar Ewart and Mr. George Brook. The authors say that it is now twenty years since G. O. Sars discovered, what our fishermen still decline to believe, that the eggs of the cod float on the surface of the sea, and only sink when dead. Sars's after-investigations showed that the eggs and the milt are of less specific gravity than the sea water, and consequently float, also that the micropyle lies near the lower portion of the egg. The experiments reported were carried on in Rothesay Aquarium on fish which had been in the tanks for four years. In February several cod appeared to be reaching maturity; early in March the fish refused food, and a few days afterwards eggs in an early stage of development were floating on the surface of the water, so abundantly that hundreds were collected in a few minutes by means of a piece of muslin placed over the overflow of the tanks. The temperature of the water was 43° F., and the specific gravity a little over 1·024. The eggs were usually found during the first few days in from the 2- to 8-cell stage at 8 a.m., so that they were most probably shed about daybreak. Later batches shed between 6 and 7.30 p.m. were found at the latter hour with the disk already forming. The great transparency of the living eggs makes it almost impossible to notice them as they rise through the water, whilst the dead eggs, being slightly opaque, are easily recognised as they are carried to and fro by the currents. For some time before the first eggs reach maturity, and during the early part of the spawning period, the fish not only refuse food, but give up their regular movements around the tank and swim about in small groups or rest together at the bottom, swimming and resting alternately. Sometimes a single female would swim leisurely about for a few minutes attended by a single male, and often settle down in a corner of the tank and rest till disturbed by her attendant. The activity of the males was specially evident at dusk and in the early morning, and it was apparently during these periods of activity that the eggs were shed and fertilised. One day, for example, there were no eggs visible on the surface of the water at 6 p.m., while a considerable number were obtained at 7.30, which, as the germinal disk was not completely formed, had in all probability been quite recently shed while the fish had been swimming about the tank in groups. From the observations made, it seems, as suggested by Sars, that the eggs and milt are shed while the fish are swimming freely about in the water. The males swim indiscriminately among the females, sometimes over, sometimes under them, fertilising the water through which the shed eggs are slowly rising to the surface. Eggs were pressed from a ripe female and fertilised artificially. They developed normally, but it was found that a few kept for some hours in a small glass cell in a warm room, for observation under the microscope, began to show similar abnormalities to those figured by Ryder ("Embryology of Osseous Fishes," Report U.S. Fish Commission, 1882). Too high a temperature has a similar effect on other eggs, but those which float on the surface are naturally more sensitive. The females, like the Salmonidæ, are capable of withholding the flow of ripe eggs to a certain extent. A limited number only are ripe at one time, and if the unripe be forced out they sink to the bottom and are incapable of being fertilised. The ripe unfertilised egg has a milky appearance and is moreover not so transparent as the fertilised one, so that by a little practice the two can be distinguished without the aid of a microscope. As soon as an egg begins to die or to develop abnormally, the milkiness returns and it sinks to the bottom. Whether fertilised or not, the eggs float immediately after extrusion, but in the latter case they die and sink to the bottom in twelve to fourteen hours. During this time no change was observed to take place in the unfertilised egg, the small oil-vesicles around the yolk remaining constantly in their primitive condition. In perfectly still water (sp. 1·024) the eggs float in a dense mass; when carried along by a strong current they become suspended at various depths, but none that are living lie at the bottom. At any rate all found there were either dead or dying. It seems that large numbers of the pelagic fish eggs have been dredged at the Fishery Board Station at Tarbet. With the sea perfectly calm, most eggs were obtained on the surface; with a slight ripple the net had to be kept just under the surface and in other states of the weather to be lowered two or three feet under the surface. The eggs having a specific gravity only slightly less than that of water, do not rise to the surface very rapidly. In one case noted it took an egg four minutes to rise through 1¼ inches of water. The milt also has less specific gravity than sea-water, and rises to the surface when shed. If forced down, it gradually rises again, disseminating as it does so. During the spawning process the water in the tank became slightly clouded by the spermatazoa, which were spread through it. The milt is, however, shed in such a thin stream under natural conditions that it is difficult to detect it. The eggs are capable of being fertilised a considerable time after the fish is dead, and also some time after they have been shed. Light appears to have considerable influence on the spawning process, and under natural conditions the eggs seem to be shed at daybreak or dusk, when the light is not strong. The observations made justify the conclusion that the spawn is shed while the fishes are swimming about freely in the water, and that the eggs are fertilised at, or as they rise to the surface, this being facilitated by the position of the micropyle, which is always found in the lower hemisphere of pelagic fish ova. To show the facility with which some fish ova are fertilised, an experiment on herring ova may be here mentioned. Three batches of ova secured from a living female were placed in tumblers, and water added from an adjoining tank. It was intended to fertilise each batch separately, and at fixed intervals, but it was found that though no milt had been intentionally added to the second or third tumblers, the water not being from the tank in which the herring were kept, spermatozoa must have been introduced with the water, as the second and third batch of eggs developed exactly like the first, and were ultimately hatched out. As Kupfer points out, it is necessary, in order to keep eggs unfertilised, to get a fresh supply of water direct from the sea.

Mr. Brook's first paper on the "Development of the Herring" gives a *résumé* of what is already known on the subject, as preliminary to the result of his own investigations. He also sends notes of rare and curious fishes sent to the Board. Dr. M'Intosh details the work done by himself and by his scientific visitors to the St. Andrew's Laboratory. Prof. Cossar Ewart reports on the progress of Fish-culture in America, and Mr. Young on the Northern and Western Salmon Rivers. The Report is both interesting and encouraging. It is difficult to form an adequate idea of the immense importance of their sea-fisheries to the people of Scotland. But it may be stated that about half a million of people, or about one-seventh of the entire population of Scotland, are connected with this industry, and more or less dependent upon it. Happily the country is now beginning to realise the importance of the matter, and when the Government places at the disposal of the Board sufficient money to carry on the necessary investigations, the produce of the Scottish fisheries, great as it now is, may be still largely increased.

RADIANT MATTER SPECTROSCOPY

THE following paper on this subject was read by Mr. Crookes at the Royal Society, June 18:—

In the concluding sentence of the Bakerian lecture which I had the honour to deliver before the Royal Society, May 31, 1883, I said that the new method of radiant matter spectroscopy there described had given me not only spectrum indications of the presence of yttrium as an almost invariabl:, though very minute, constituent of a large number of minerals, but had likewise revealed signs of another spectrum-yielding element. I stated that I had repeatedly seen indications of another very beautiful spectrum characterised by a strong red and a double orange band.

Elimination of Mercury Vapour from Vacuum Tubes.—It is much more difficult than is generally supposed to keep mercury vapour from diffusing into the experimental tubes.

The following plan answers perfectly so far as my experiments have yet gone:—Sulphur is first prepared by keeping it fused at a high temperature till bubbles cease to come off, so as to get rid of water and hydrogen compounds. It is then allowed to cool, and is pounded and sifted so as to get it in the form of granules averaging a millimetre in diameter. A glass tube, a centimetre in diameter and about 2 feet long, is lightly packed for half its length with this sulphur, and next about 2 inches of iodide of sulphur (I_2S_2) is added, and the rest of the tube is then filled up with sulphur. Ignited asbestos is packed in at each end to keep the sulphur from blowing out whilst the vacuum is being made, or from being sucked through when air is suddenly let in. This contrivance entirely keeps mercury vapour from passing through, since the iodide of sulphur holds its iodine very loosely, and fixes the mercury in the form of non-volatile red iodide. A glass tube containing finely-divided copper must follow in order to keep the sulphur out. With this blockade interposed between the pump and experimental tubes I have been unable to detect mercury vapour in any of the tubes, whether in the cold or on heating them.

The "Orange Band" Spectrum.—Since the date of my last paper I have devoted myself to the task of solving the problem presented by the double orange band first observed in 1881. With the yttrium experience as a guide it might be thought that this would not be a difficult task, but in truth it helped me little beyond increasing my confidence that the new, like the old spectrum, was characteristic of an element. The extreme sensitiveness of the test is a drawback rather than a help. To the in xperienced eye one part of "orange band" substance in ten thousand gives as good an indication as one part in ten, and by far the greater part of the chemical work undertaken in the hunt for the spectrum-forming element has been performed upon material which later knowledge shows does not contain sufficient to respond to any known chemical test.

Chemistry, except in few instances, as water-analysis and the detection of poisons, where necessity has stimulated minute research, takes little account of "traces;" and when an analysis adds up to 99·99, the odd 0·01 per cent. is conveniently put down to "impurities," "loss," or "errors of analysis." When, however, the 99·99 per cent. constitutes the impurity and this exiguous 0·01 is the precious material to be extracted, and when, moreover, its chemistry is absolutely unknown, the difficulties of the problem become enormously enhanced. Insolubility as ordinarily understood, is a fiction, and separation by precipitants is nearly impossible. A new chemistry has to be slowly built up, taking for data uncertain and deceptive indications, marred by the interfering power of mass in withdrawing soluble salts from a solution, and by the solubility of nearly all precipitates in water or in ammoniacal salts, when present in traces only. What is here meant by "traces" will be better understood if I give an instance. After six months' work I obtained the earth didymia in a state which most chemists would call absolutely pure, for it contained probably not more than one part of impurity in five hundred thousand parts of didymia. But this one part in half a million profoundly altered the character of didymia from a radiant matter spectroscopic point of view, and the persistence of this very minute quantity of interfering impurity entailed another six months' extra labour to eliminate these final "traces," and to ascertain the real reaction of didymia pure and simple.

Chemistry of the Orange Band-forming Substance.—At first it was necessary to take stock, as it were, of all the facts regarding the supposed new substance, provisionally termed *x*, which had turned up during the search for the orange band. In the first place *x* is almost as widely distributed as yttria, frequently occurring with the latter earth. It is almost certainly one of the earthy metals, as it occurs in the insoluble oxalates, in the insoluble double sulphates, and in the precipitate with ammonia. It is not precipitated by sodic thiosulphate, and moreover it must be present in very minute quantities, since the ammonia precipitate is always extremely small, and as a rule *x* is not found in the filtrate from this precipitate.

At this stage of the inquiry the chemical reactions of *x* were much more puzzling than with yttria. At the outset an anomaly presented itself. The orange band was prone to vanish in a puzzling manner. Frequently an accumulation of precipitates tolerably rich in *x* was worked up for purposes of concentration, when the spectrum reaction suddenly disappeared, showing itself neither in precipitate or filtrate; whilst on other occasions, when following apparently the same procedure, the orange band became intensified and concentrated with no apparent loss. The behaviour of the sulphate to water was also very contradictory; on some occasions it appeared to be almost insoluble, whilst occasionally it dissolved in water readily.

Is "x" a Mixture?—A very large series of experiments, which need not here be described in detail, resulted ultimately in establishing the remarkable fact that the *x* I sought was an earth which of itself could give no phosphorescent spectrum in the radiant matter tube, but became immediately endowed with this property by admixture with some other substance, which substance likewise by itself had no power of phosphorescing with a discontinuous spectrum.

"x" in Cerite.—In the corresponding yttrium research I was aided materially by the fact that the sought-for earth did not give an absorption spectrum. This enabled me to throw out a large number of obscurely known elements, and I therefore early endeavoured to ascertain whether the supposed new earth, *x*, did or did not give an absorption spectrum. Gradually it was noticed that whenever the didymium absorption bands were strong, the orange band spectrum was also particularly brilliant. Moreover, amongst the earths previously enumerated as mixed with lime in the quest for *x*, I have mentioned that some of them gave the orange band spectrum with increased intensity; the earths of the cerium group were the most noteworthy, and these considerations made it probable that here would be found the location of *x*.

Analysis of Cerite.—The cerium group consists of cerium, lanthanum, didymium, and samarium.

The first necessity was to get the earths ceria, lanthana, and the mixture hitherto called didymia, in a pure state; for my so-called pure earths of this group all showed the orange band in more or less degree.

The separation from each other of ceria, lanthana, didymia, and samaria is a most laborious process, and the amounts of these earths, obtainable in anything like a pure state, is small, compared with the mass of material worked up. Full particulars are given in the paper as to the method adopted to obtain each of them in a state of purity.

Ceria.—The ceric oxide obtained was almost pure white. A considerable thickness of a strong solution did not show a trace of absorption spectru n. The atomic weight of the metal was taken and yielded the number 141·1.

The ceric oxide gave no orange band spectrum in the radiant matter tube, either with or without the addition of lime.

Lanthana.—Lanthana is more difficult to purify than ceria. Long after the lanthana appeared pure it gave in the radiant matter tube a good orange band spectrum when mixed with lime and treated as usual, although without lime it gave no spectrum. Ultimately, however, a lanthana was obtained which, mixed with lime and treated in the usual manner, gave no orange band spectrum whatever. This lanthana was snow-white, and had an atomic weight of 138·3.

Didymia.—The earth formerly called didymia is now known to be a mixture of didymia and samaria, and systematic operations were now commenced with the object of obtaining the didymia and the samaria in a state of purity—that is to say, in such a condition that one of them should show no orange band spectrum at all, whilst the other should give the spectrum in its highest degree of intensity.

I commenced the purification of didymia in the latter part of the year 1883, and the operations have been going on since almost daily in my laboratory. At intervals of some weeks the didymia in the then stage of purification was tested in the radiant matter tube, a little lime having previously been added to bring out the discontinuous phosphorescence. During the first month or two the intensity of the orange band spectrum scarcely diminished. After this it began to fade, but the last traces of orange band were very stubborn, and not till the last few weeks could I obtain a didymia to show no trace of the orange band spectrum; and this result has not been accomplished without sacrifice. My 1000 grammes have dwindled away bit by bit, till now less than half a gramme represents all my store.

Samaria.—The foregoing experiments left little doubt that *x*, the orange-band-forming body, was samarium; the last problem was, therefore, to get this earth in a pure state. The general plan of operations was the same as I adopted in getting didymium free from samarium, only attention was now directed to the portions richest in samarium which had been formerly set aside. The colour of samaria, as pure as I have been able to prepare it, is white with the faintest possible tinge of yellow. The absorption spectrum of samarium salts is much more feeble than the spectrum of didymium.

The Phosphorescent Spectrum of Samarium.—Pure samaric sulphate by itself gives a very feeble phosphorescent spectrum. When, however, the samaria is mixed with lime before examination in the radiant matter tube, the spectrum is, if anything, more beautiful than that of yttrium. The bands are not so numerous, but the contrasts are sharper. Examined with a somewhat broad slit, and disregarding the fainter bands, which require care to bring them out, the spectrum is seen to consist of three bright bands—red, orange, and green—nearly equidistant, the orange being the brightest. With a narrower slit the orange and green bands are seen to be double, and on closer examination faint wings are seen, like shadows to the orange and green bands.

Preliminary experiments had shown me that lime was one of the best materials to mix with samaria in order to bring out its phosphorescent spectrum, but it was by no means the only body which would have the desired effect.

The samarium spectra, modified by other metals, may be divided into three groups. The first group comprises the spectra given when glucinum, magnesium, zinc, cadmium, lanthanum, bismuth, or antimony is mixed with the samarium. It consists simply of three coloured bands—red, orange, and green; as a typical illustration I will select the lanthanum-samarium spectra (Fig. 1).

The second type of spectrum gives a single red and orange and a double green band. This is produced when barium, strontium, thorium, or lead are mixed with samarium. The lead-samarium spectrum (Fig. 2) illustrates this type.

The third kind of spectrum is given by calcium mixed with samarium. Here the red and green are single, and the orange double. Aluminium would also fall into this class were it not that the broad, ill-defined green band is also doubled. The calcium-samarium spectrum (Fig. 3) is a good illustration of this type.

Mixed Samarium and Yttrium Spectra.—It was interesting to ascertain what spectrum a mixture of samarium and yttrium would give. A mixture of 90 parts of samaria to 10 of yttria was treated with sulphuric acid and then ignited, and afterwards examined in the radiant matter tube. The result was as remarkable as it was unexpected. Not a trace of the yttrium spectrum could be detected. The powder phosphoresced with moderate intensity, but the spectrum was almost the facsimile of that given by pure samaric sulphate, except that the sharp orange line, which in the spectrum of pure samaric sulphate is only just visible, had gained sufficiently in intensity to be measurable, and was found to lie at 2693, on the $\frac{1}{\lambda^2}$ scale. A large number of experiments were next tried on mixtures of samaria and yttria in different proportions, and the results are given in full in the paper.

Up to mixtures of 43 parts samaria and 57 parts yttria the spectrum nearly resembled the lead-samarium spectrum. Not a band of the yttria spectrum could be detected, and the brilliant orange line stood out sharply in the whole series. This spectrum is represented in Fig. 4.

After that proportion had been reached a change rapidly came over the spectra, and in the next trial mixture—samaria 35, yttria 65—the only indication of the samarium spectrum that could now be found was seen in the two faint green bands next to the citron line of yttria, and the new orange line, which shone out as brightly and sharply as ever.

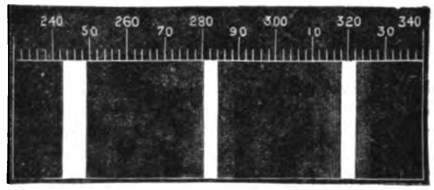


FIG. 1.

It will be remarked that a sudden change of spectrum occurs between very narrow limits of mixture.

The spectrum of a mixture of 44 parts samaria and 56 parts yttria, except for the orange line, is the pure samarium spectrum. The spectrum of 42 samaria and 58 yttria is built up of some of the component bands of the spectrum of each earth; whilst the

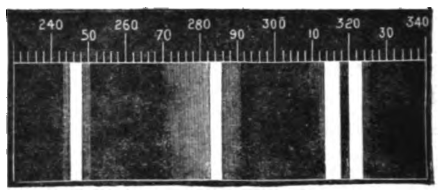


FIG. 2.

spectrum of 39 samaria and 61 yttria is almost a pure yttria spectrum, the sharp orange line running across them all.

The Delicacy of the Spectrum Test for Samarium.—Experiments were now commenced with the object of getting some approach to a quantitative estimate of how small a quantity of samarium could be detected.

A mixture was first made in the proportion of 1 part sama-

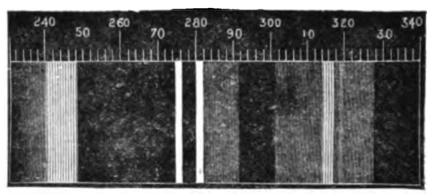


FIG. 3.

rium to 100 parts of calcium. The spectrum is very brilliant, and but little inferior in sharpness to the spectrum given by a 50 per cent. mixture.

A mixture was now prepared containing 1 part of samarium to 1000 parts of calcium. Very little difference can be detected between the spectrum of this mixture and that of the last. The bands are, however, a little less sharp.

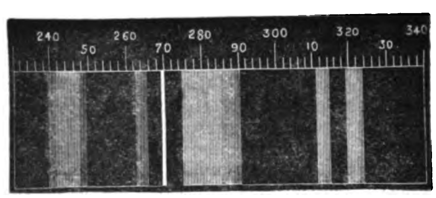


FIG. 4.

A mixture containing 1 part of samarium to 10,000 parts of calcium was now tested. The bands are now getting fainter, the second green band is fading out, and the continuous spectrum of calcic sulphate is getting brighter.

The next mixture tried contained one part of samarium in 100,000 parts of calcium. Here the green is almost gone, being overshadowed by the continuous spectrum of calcium which has spread over it. The red band has likewise almost disappeared in the greater brightness of the continuous red of the calcic spectrum. The double orange band is still very prominent, and the black space, 2942, between it and the green is very marked.

The next mixture, one part of samarium to 500,000 parts of calcium, gives a spectrum which is fainter than the last, but the orange bands are still distinctly visible. The blank space between the yellow and green is strongly marked, but narrower than before.

A mixture of one part of samarium in 1,000,000 parts of calcium was next subjected to experiment. In this the samarium spectrum is very feeble, and the orange bands are only to be seen with difficulty. Now the most striking characteristic of this spectrum is the black space which still cuts out the greater portion of the yellow.

A mixture of one of samarium in 2,500,000 parts of calcium was now taken. In the spectrum shown by this mixture the bands of samarium have entirely gone, and its presence now is apparent only by the darkening in the yellow portion of what otherwise would be a continuous spectrum.

The calcium phosphorescent spectrum by itself is continuous, with no break, lines, or bands in it.

The Anomalous Line $\frac{1}{\lambda^2}$ 2693.—On several occasions I have spoken of an orange line, 2693, which by its brilliancy and sharpness is a prominent object in most of the samarium-yttrium spectra. With pure samaric sulphate it is exceeding faint. With samaria containing 5 per cent. of yttria it is very little brighter; with 10 per cent of yttria it gains a little; with 15 per cent. it is brighter still, and with a mixture of 80 parts samaria and 20 parts yttria it is at its maximum intensity. It continues to be the most striking feature in the spectra of the various mixtures of samaria and yttria until the proportion becomes samaria 3, yttria 97, when it begins to get less bright, and only when pure yttria is reached does it altogether vanish.

It is noteworthy that so long as this bright line is a component of the spectrum, the other bands manifest decidedly less intensity, and many of them are suppressed. The profound modification in the spectra of samaria and yttria developed by their mixture is, I believe, without precedent in spectrum analysis. It is difficult to realise the character of the modification which converts somewhat faint diffused bands into one intensely sharp and brilliant line.

One important lesson taught by the many anomalies unearthed in these researches is that inferences drawn from spectrum analysis *per se* are liable to grave doubt, unless at every step the spectroscopist goes hand in hand with the chemist. Spectroscopy may give valuable indications, but chemistry must after all be the court of final appeal.

The following paper (reprinted from the *Chemical News*) is so intimately connected with Mr. Crookes's work, that it may be appropriately appended to his paper:—

AT the meeting of the Académie des Sciences on June 8, 1885, M. Lecoq de Boisbaudran requested that a sealed packet which he had deposited June 30, 1884, might be opened. The packet was opened by the Permanent Secretary during the meeting, and contained the following note:—

"When the electric spectrum of a solution *with a metallic base* is produced it is customary to make the outside platinum wire (whence the induction spark strikes) positive, the liquid consequently forming the negative pole.[1] If the direction of the current is reversed, the metallic rays (due to the free metal or to one of its compounds) are scarcely or not at all visible, at at all events so long as the exterior platinum wire now forming the negative pole is not coated with a deposit.

"Having again last year taken up my researches on the rare earths belonging to the didymium and yttrium family, I had occasion to observe with many of my preparations the formation of spectrum bands, nebulous, but sometimes tolerably brilliant, having their origin in a thin layer of a beautiful green colour, which was seen to appear at the surface of the liquid (a solution of a chloride) when it was rendered *positive*.

"These are the approximate positions of the principal bands:—

[1] This rule, hitherto general for *metallic* solutions, is not always applicable to liquids containing *metalloid* bodies, as I have already had occasion to notify (see my "Spectres Lumineux," p. 38).

Micrometer		λ	Observations
91¾	About the middle.	620½	A narrow band, somewhat hazy. Rather faint. About 1½ divisions wide. (Due to calcium??)
101	Approximately about the middle.	585¾	A nebulous band slightly connected with the following one. About 3 divisions wide. Slight intensity, but generally stronger than 91¾.
104 9/10	Approximately about the middle.	573	A nebulous band. Intensity varying with the state of the liquid and strength of spark. It seems to be fainter in the earths obtained from the sulphates which are very slightly soluble in potassic sulphate than in the earths obtained from the more soluble double sulphates. In some cases it has been seen as brilliant as *α* 115⅓, but it has almost always been seen *much* more feeble than 115⅓ in the earth obtained from the very slightly soluble double sulphate. It has, indeed, on several occasions been seen fainter than 101.
From 111½ to 112	About the beginning. Very indistinct.		A nebulous band, shading off from right to left. Rather strong, and generally much the most brilliant in the spectrum of the yellow earth whose double potassic sulphate is very slightly soluble.
115⅓	About the middle of maximum of light.	543⅓	
117	About the end. Very indistinct.		
About 141⅓	Apparent centre.	487	A very hazy band, appearing somewhat shaded from right to left when the spectrum is brilliant. About 4 or 4½ divisions wide. Somewhat joined to the following. Generally of very moderate intensity.
About 147⅓ to 147½	Apparent centre.	476½	Faint band, very hazy. About 6 divisions wide.

"On comparing in the different products the relative intensities of this new reversion spectrum and of the already known direct rays, I have come to the conclusion that the body producing the band *α* 115½ is very probably *not* one of the following:—

"Didymium, erbium, Y*α* (of M. de Marignac), lanthanum, samarium, zirconium, scandium, thulium, ytterbium, yttrium.

"Cerium and thorium are also excluded for chemical reasons.

"I have not yet obtained the new spectrum with a substance altogether free from holmium, but I have good reasons to think that this metal is not the cause of the observed phenomena.

"The treatment undergone by the earths which give most sharply the reversion spectrum hardly admits in my preparations of the presence of such bodies as phosphoric, boric, &c., acids.

"The band *α* 115⅓ (and most of the others which, except perhaps the band 104 9/10, follow in their intensities the same variations as *α* 115⅓) appears, therefore, only to be attributable to terbia, unless, indeed, it be due to some new analogous earth not hitherto defined.[1]

"The treatment of a yellow earth obtained from samarskite, and much resembling that which is now called *terbia*, has already

[1] There remains to be examined the earth decipia (of M. Delafontaine), the existence of which appears to be confirmed by the researches of M. Clève.

given me interesting results, which, however, it will be difficult to describe in this short preliminary note. I will only say that all the bands specified above (except sometimes $104\frac{9}{10}$) are especially very marked in the earth which is most easily precipitated by ammonia, which has a sulphate least soluble in potassic sulphate, and whose chloride, very soluble in pure water, is difficultly soluble in concentrated hydrochloric acid.

"Shall we find two earths respectively characterised by the bands $104\frac{9}{10}$ and α $115\frac{1}{5}$?

"The production of my reversion spectrum appears to be analogous physically with the formation of the phosphorescence spectra obtained by Mr. Crookes at the positive pole in his high vacuum tubes containing certain compounds of yttria. The conditions of the two experiments are, however, very different practically speaking.

"It is a singular fact that the positions of the phosphorescence bands observed by Mr. Crookes with very pure compounds of yttrium, are sufficiently near those which I, on my part, have obtained with hydrochloric solutions of the earths separated as widely as possible from yttria, chemically as well as spectroscopically. My reversion spectrum cannot, I think, be attributed to yttrium, for on the one hand it is seen *brilliantly* with products which give no trace of yttrium rays by the direct spark, and on the other hand I have found it impossible to obtain it sharply from certain earths extremely rich in yttria.

"As soon as my work is sufficiently advanced to enable me to arrive at some definite conclusion, I shall have the honour of informing the Academy of it."

M. Lecoq de Boisbaudran added the following additional note:—

I have not yet finished the very long work undertaken in the hope of determining the nature of the above described phosphorescence spectrum.

This spectrum is now recognised as being identical with that which is ascribed to pure yttria by Mr. Crookes, and which this *savant* obtained under experimental conditions very different to mine. Nevertheless my latest observations, as well as the older ones, lead to the conclusion that yttria is not the cause of the spectrum bands observed. In my fractionations the phosphorescence spectrum regularly gets weaker as I advance towards the yttria end. With almost pure yttria the phosphorescence bands show themselves faintly or not at all, whilst they are brilliant with the earths which do not give by the direct spark the rays of yttrium to an appreciable extent.

The prodigious sensibility of Mr. Crookes's reaction, which detects a millionth part of his purified yttria, makes very singular this divergence which I am obliged to point out between the conclusions of the eminent English chemist and myself. Mr. Crookes has willingly undertaken to examine some of my products in his high-vacuum tubes; and, on the other hand, he has promised to send me the earths prepared by himself, so that I can examine them by my process. A comparison of these cross experiments, it is hoped, will throw some light on the question of the origin of the phosphorescence spectrum.

Another conclusion from my researches, a conclusion which I publish with a certain reserve because my work is not yet finished, is that the bands 105 and 115 do not belong to the same element. On this hypothesis, based on the fact that some of my products give 105 notably stronger than 115, whilst others show 115 brightly and 105 faintly, I will provisionally call $Z\alpha$ the earth characterised by 105, and $Z\beta$ the earth giving 115.

Space does not allow me to describe to-day the principal experiments or observations undertaken to find out what are $Z\alpha$ and $Z\beta$; this will form the subject of another memoir.

I should acknowledge here that Mr. Crookes was the first to see the phosphorescence spectrum of samarium. During the past year only this spectrum was pointed out to me by my learned friend M. Demarçay, to whom I had confided the secret of my method for the production of phosphorescence spectra by the reversion of the induced current. I then made a drawing of it.—*Comptes Rendus*, vol. c. p. 1437, June 8, 1885.

SOCIETIES AND ACADEMIES

London

Chemical Society, June 18.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. Jos. F. Burnett and Harry M. Freear were formally admitted Fellows of the Society.—The following gentlemen were duly elected Fellows of the Society:—Messrs. Harry Haslett, Thomas Cradock Hepworth, Leonard de Koningh, Charles Langer, Arthur Richardson, James Sharp, James Pender Smith, James Spilsbury.—The following papers were read:—On the decomposition and genesis of hydrocarbons at high temperatures: I., the products of the manufacture of gas from petroleum, by Henry E. Armstrong and A. K. Miller, Ph.D. Having carried the examination of the various products of the decomposition of petroleum effected at high temperatures, in the manufacture of oil-gas (see paper in the *Journal* of the Society of Chemical Industry, September, 1884), as far as can usefully be done with the material originally dealt with, the authors now describe their methods and results; they remark, however, that these must be regarded as little more than preliminary, and that it will be necessary to repeat the investigation on a much larger scale, and to introduce new and improved methods. The products examined are (1) the portion of the compressed gas which combines with bromine; (2) the liquid deposited during compression of the gas to about ten atmospheres; (3) the portion of the tar which is volatile in steam. (1) By far the chief constituents of the mixture of bromides obtained by scrubbing the compressed gas by bromine are ethylene bromide and crotonylene tetrabromide, $C_4H_6Br_4$; propylene and butylene bromides have also been separated from it. The gas is practically free from hydrocarbons of the acetylene series capable of producing a precipitate in an ammoniacal cuprous solution. (2) The liquid deposited during compression of the gas is a complex mixture of olefines, of hydrocarbons of the C_nH_{2n-2} series, and of benzenes. The presence in it of *normal* amylene, hexylene, and heptylene has been demonstrated by the study of the products of oxidation of the various fractions. It is saturated with crotonylene, and contains a considerable quantity of the next homologue, C_5H_8; this latter hydrocarbon has not been previously described; it boils at 45°, and yields a tetrabromide which crystallises from alcohol in long flat prisms melting at 114°. All attempts to separate a hydrocarbon having the properties of Schorlemmer's hexoylene from the fraction boiling at 80°–82° have hitherto been unsuccessful, the statement previously made by one of the authors that this hydrocarbon was present having been based on determinations which have since been discovered to be faulty. The liquid deposited during compression of oil-gas is rich in benzene and toluene, but contains only traces of higher benzenes. (3) The steam distillate from the tar contains the less volatile hydrocarbons present in the liquid deposited during compression of the gas, together with a great variety of others. It is rich in hydrocarbons which are readily polymerised by sulphuric acid; these appear to be mainly members of the C_nH_{2n-2} series, such as Schorlemmer discovered in the light oils from cannel and boghead coal, and which yield no acid higher than acetic on oxidation. The three xylenes and mesitylene and pseudocumene are present in about the same relative proportions as in ordinary coal-tar; but in addition, the oil-gas tar contains certainly one—probably two—*higher* members of the benzene series: the amount obtained has not been sufficient, however, to permit of the precise determination of its nature. A very considerable amount of naphthalene may be separated from the tar; benzenoid hydrocarbons of higher boiling point than napthalene have also been obtained in small quantity. A certain, although relatively small, amount of a complex mixture of saturated hydrocarbons has also been separated from the tar: the quantity of material at their disposal has not enabled the authors to separate these to their satisfaction, and in a state sufficiently approaching purity; they are inclined to believe, however, that the mixture does not consist of paraffins, but of hydrocarbons of the C_nH_{2n} series—such as form the chief constituents of Russian petroleum. The hydrocarbons mentioned are by no means the sole constituents of the material examined, but merely those which have been proved to be present. The theoretical conclusions to be deduced from the results are in some respects interesting. It would appear that *only normal* olefines are present, and it is also remarkable that apparently this series is not represented by terms higher than heptylene. No true acetylenes have been detected; the crotonylene obtained is either *methylallene*, $CH_3{\cdot}CH{\cdot}C{\cdot}CH_2$, or *dimethylene-ethane*, $C_2H_2(CH_2)_2$, and from their behaviour on oxidation it is probable that the homologous hydrocarbons are closely related to it. Hence it may be inferred that in the formation of hydrocarbons of the C_nH_{2n-2} series at high temperatures from normal olefines of the formula $C_nH_{2n+1}{\cdot}CH{\cdot}CH_2$ two atoms of hydrogen are removed in such a way that the terminal $CH_2{\cdot}CH_2$ radicle in the formula becomes either

$CH_3 \cdot CH$ or $CH_3 \cdot CH$; although the production of acetic acid on oxidation of the hydrocarbons favours the former hypothesis, it is not safe to accept it until several of the hydrocarbons of the C_nH_{2n-2} series have been isolated and more completely studied. The possibility that *saturated* hydrocarbons of the C_nH_{2n} series are among the products is especially noteworthy, although it must not be forgotten that such hydrocarbons might have been original constituents of the petroleum used in making gas. To settle this and other questions, it is proposed to prepare oil-gas from *solid* paraffin on a sufficient scale to obtain the quantity of material required for the investigation.—On the non-crystallisable products of the action of diastase upon starch, by Horace T. Brown and G. H. Morris, Ph.D.—Decomposition of carbonic acid gas by the electric spark, by H. B. Dixon, M.A., and H. F. Lowe, B.A. Various chemists have investigated the decomposition of carbonic acid by the electric spark. Experiments having shown that no explosion is propagated by a spark in a mixture of carbonic oxide and oxygen dried by standing over anhydrous phosphoric acid, it seemed of interest to repeat the experiments on the decomposition of carbonic acid when dried in a similar manner. Carbonic acid dried over anhydrous phosphoric acid was submitted to a series of induction sparks in an eudiometer by means of a chain composed of short pieces of platinum fused into small glass bulbs. The amount of decomposition varied from time to time, approaching no fixed limit. Similar results were found on introducing a Leyden jar into the secondary circuit of the Ruhmkorff, but the amount of decomposition was less. On passing a series of induction sparks through a dried mixture of carbonic oxide and oxygen, partial combination gradually took place, but no fixed limit was reached. Two similar eudiometers were prepared and fitted with wires made of an alloy of platinum and iridium, each wire ending in a bulb about 2 mm. in diameter. The bulbs were brought to the same distance apart in the two tubes. On bringing an equal volume of dried carbonic acid into the two tubes, and sending a series of sparks from one Ruhmkorff coil through both tubes at the same time, the gases in the two vessels were found to be equally affected, their volumes varying exactly together so long as the pressure was kept the same in the two tubes. The more feeble the spark, the greater was the decomposition of the carbonic acid found to be. When 100 volumes of dried carbonic acid were brought into one tube, and 150 volumes of a dried mixture of carbonic oxide and oxygen were brought into the other, and a series of sparks were passed through both from the same coil, the volume of carbonic acid increased, and the volume of carbonic oxide and oxygen diminished, until after some hours they became equal. On a further prolonged passage of the spark the two volumes altered together, sometimes increasing and sometimes diminishing, as the nature of the spark varied. A coil of fine platinum wire was heated by an electric current to whiteness in dried carbonic acid. No permanent alteration of volume was produced. When a similar coil of platinum wire was heated in a mixture of dried carbonic oxide and oxygen, it glowed intensely for some minutes, and complete combustion was found to have taken place between the two gases. No flame was visible around the wires.—On the influence of silicon upon the properties of cast iron, by Thomas Turner, Assoc.R.S.M.—Eleven months' experience with toughened glass beakers, by R. J. Friswell.—Bromo-derivatives of diphenyl, tolylphenyl, and ditolyl, by Prof. Carnelley and Andrew Thomson.—Note on the influence of strain upon chemical action, by Prof. Carnelley and James Schlerschmann.—On the non-existence of gaseous nitrous anhydride, by William Ramsay, Ph.D.—On the causes of the decrepitations in samples of so-called explosive pyrites, by B. Blount.—On the specific action of a mixture of sulphuric and nitric acids upon zinc in the production of hydroxyamine, by E. Divers, M.D., F.R.S., and T. Shimidzu, M.E.—On the action of pyrosulphuric acid upon certain metals, by E. Divers, M.D., F.R.S., and T. Shimidzu, M.E.—On the constitution and reactions of liquid nitric peroxides, by E. Divers, M.D., F.R.S., and T. Schmidzu, M.E.—On the behaviour of stannous chloride towards nitric oxide and towards nitric acid, by E. Divers, M.D., F.R.S., and T. Haga.—Preliminary note on the reaction between mercurous nitrate and nitric oxide, and between mercurous nitrate and nitrites, by Edward Divers, M.D., F.R.S., and Tamemasa Haga.—On some derivatives of anthraquinones, by A. G. Perkin and Dr. W. H. Perkin, jun.

Royal Microscopical Society, June 10.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Suffolk exhibited a collecting bottle (made by Mr. Stanley) with flat sides, which had been worked to a true surface, through which an ordinary objective could be focussed with perfect definition.—Prof. Stewart called attention to a specimen he exhibited under the microscope, and a model showing the special eyes of Chitonidæ described by Prof. Moseley.—Mr. Wright's letter with reference to Dr. Anthony's criticism on his note on the structure of the tongue of the blow-fly was read, in which he gave all the credit of the discovery of the suctorial organs to Dr. Anthony, whose paper on the subject had been previously unknown to him. He also sent a slide of the blow-fly proboscis, mounted by Mr. Sharp, whose method of preparation and mounting in the biniodide of mercury solution was described.—Mr. Suffolk said he had examined Mr. Wright's first specimen, and he had also made a similar specimen of his own; but the conclusion he came to was that the appearances described were due to some sort of diffractive effect and that they were in fact out-of-focus appearances.—Mr. J. Mayall, jun., called attention to the fact that a Nobert 19-band test-plate had been successfully mounted in Prof. Hamilton Smith's medium, having a refractive index of 2·4, the results being to render the lines very much more visible than had been the case before The preparation was made by Dr. van Heurck, and was attended with considerable difficulty. He now thought it possible to improve upon the photomicrographs of the late Dr. Woodward of Washington, for, the lines being mounted in the highly refractive medium, could be illuminated by immersion means, so that an objective of higher aperture than any employed by Dr. Woodward could be used to resolve them. He hoped to try some experiments in photographing the test-plate by means of Powell and Lealand's new homogeneous immersion, 1/12th of 1·5 N.A.—Mr. Crisp said that they had received from Prof. W. A. Rogers, of Cambridge, U.S.A., a collection of upwards of 60 slides, showing the action of a diamond in ruling lines upon glass. The series was accompanied by a descriptive paper, which, when printed in the *Journal*, would enable the Fellows to compare it with the slides. The President said that Prof. Rogers had expressed the hope that some one might feel sufficiently interested in the subject to make a careful study of the slides. They had not yet had any opportunity either of examining the slides or reading the paper, but their best thanks were due to Prof. Rogers for his valuable donation.—Theiler's "Universal Pocket Microscope" was exhibited by Mr. Crisp.—Dr. Maddox said that since the last meeting he had continued his experiments on the feeding of insects with bacilli, and had fed both the wasp and the blow-fly with the Anthrax bacillus. They had lived on through the month until that very hot day when the thermometer rose to 136° in the sun, when they succumbed to what he believed was heat asphyxia, so that he was unable to attribute their deaths to any effect of the bacilli.—Mr. Waters read his paper on the use of the avicularian mandible in classification, the subject being illustrated by drawings.—Mr. Cheshire described a method of mounting in glycerine, which he had found of great advantage with the particular class of preparations (insect anatomy) with which he had lately been engaged; he further illustrated his meaning by drawings upon the blackboard and by the exhibition of specimens which were handed around for inspection.—Prof. M. N. Dutt's letter was read, accompanying some unknown powdery substance found near Delhi.

SYDNEY

Linnean Society of New South Wales, May 27.—Prof. W. J. Stephens, F.G.S., President, in the chair.—The following papers were read:—Note on the brain of *Halicore australis*, Owen, by N. de Miklouho-Maclay.—On a new species of *Haloragis* from New South Wales, by Baron F. von Müller, K.C.M.G., &c.—Two new Australian Lucanidæ, by William Macleay, F.L.S., &c.—A list of the *Cucujidæ* of Australia, with notes and descriptions of new species, by A. Sidney Olliff, Assistant-Zoologist, Australian Museum. In this paper, which is a preliminary contribution towards a monograph of the family, fourteen species are added to the Australian fauna. Ten new species are described, including five belonging to the genus *Læmophlœus*. A fine new *Brontes* from Port Darwin and the Richmond River, measuring 14 mm. in length, is characterised under the name of *B. macleayi*. It is distinguished from all the Australian species of the genus by its rather convex elytra, and in having the prothorax with the anterior angles very prominent and the sides feebly serrate. A table showing the geographical distribution of the species is added.—Description of some new fishes from Port Jackson, by J. Douglas-Ogilby, Assistant Zoologist, Australian Museum. Four fishes are here described—a new genus and species of Blenniidæ—*Petraites heptaolus*, also *Platycephalus macrodon*, *Percisnova-cambria*, and *Latris ramsayi*, the latter remarkable in its want of villiform teeth.—Note on *Neoanthias guntheri*, Cast, by J. Douglas-Ogilby, Assistant Zoologist, Australian Museum.—Notes on the geology and water supply of the interior of New South Wales, by the Rev. J. Milne Curran, F.G.S. The author points out the conditions under which the plains of the western interior have been formed, explains the river system or drainage of the level country, and indicates the sources of the subterranean waters which are met with in the gravel formations generally known as "drifts."—Some remarks on the fertilisation of the genus *Goodenia*, by E. Haviland.—Notes on a medusa from the tropical Pacific, by R. von Lendenfeld, Ph.D.—Contributions to the zoology of New Guinea; notes on birds from the Astrolabe Range, with descriptions of some new species, by E. P. Ramsay, F.R.S.E., &c. In this paper two new forms of Paradise birds, *Parotia lawesii* and *Lophorina superba minor*, are described, the former differing chiefly from its ally from Mount Arfak in the shape of the frontal crest and olive-coloured shield, the latter chiefly in size; measurements of specimens from both districts are given. The remaining portion of the paper gives a list of species hitherto only recorded from Mount Arfak.—Description of a new species of Collyriocincla, from Queensland, by E. P. Ramsay, F.R.S.E., &c.

PARIS

Academy of Sciences, July 13.—M. Bouley, President, in the chair.—A method of determining the absolute co-ordinates of the polar stars without the necessity of ascertaining the instrumental constants (declinations), by M. Lœwy.—Telluric spectra, by M. J. Janssen. The author reports the completion of the apparatus prepared in M. Ducretet's *ateliers* for the study of the gases in the terrestrial atmosphere and of the vapour of water.—Note in reference to M. Stieltjes' communication on a uniform function, by M. Hermite.—On the motion of a heavy revolving body attached by a point of its axis (continued), by M. G. Darboux.—On the theoretic aim of the late M. Henri Tresca's chief studies in the field of mechanics, by M. de Saint-Venant.—A study of the action of dust-particles left to themselves, by M. Chevreult. The particles in question came from a factory in Paris, where the hair of cows and calves is prepared for the spinning-mills of England. They have been left for a twelvemonth on a sheet of red paper in a cylindrical vessel, where they have presented certain mechanical, physical, and chemical phenomena studied and photographed by the author.—Fundamental principles of the new science of dynamic meteorology: reply to M. Mascart's note of June 29 (second part), by M. H. Faye.—Remarks on the same subject in reply to M. Faye, by M. Mascart.—Magnesia; its preparation from sea-water and application to various branches of industry, by M. Th. Schlœsing.—On the central nervous system of *Tethys leporina*, by M. H. de Lacaze-Duthiers.—Note on the homography of two infinitely-extended solids, by M. Sylvester.—On the nature of the transformations undergone by extenuated charbon virus cultivated in compressed oxygen, by M. A. Chauveau.—Remarks on Dr. Brouardel's report on his recent mission to Spain, by M. Pasteur. If Dr. Ferran has really discovered a remedy against cholera he will stand in no need of any Minister's signature; all mankind will welcome a guarantee of the moral and material value of his discovery. To persist in refusing to see this would justify all suspicions, as has become evident since the publication of the replies made to the French Mission in Spain. Dr. Ferran now wishes to withdraw from the position taken up by him, as appears from his fresh note addressed to the Academy. On this issue Dr. Brouardel will be the first to congratulate himself.—Remarks accompanying the presentation of the second edition of his work on the origin of the world, by M. H. Faye.—Protection against cholera by means of hypodermic injections of pure cultivations of the comma bacillus, by M. Jaime Ferran. The Spanish physician describes the results obtained from his method as quite astounding, and maintains that it offers an absolute remedy against cholera. The dangers of attack and death begin to disappear five days after vaccination, and the immunity from further attack increases with each successive injection. The period of immunity cannot yet be accurately determined, but a minimum of two months may already be confidently anticipated.—Observations of Barnard's new comet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On a law of reciprocity in the theory of displacement of a solid body, by M. A. Schœnflies.—On a uniform function in mathematical analysis, by M. Hermite.—Observation of a cloud of black particles which were seen to cross the solar disk with varying velocity on August 28, 1871, by M. E. L. Trouvelot.—Indices of refraction for some crystallised alums, by M. Ch. Soret.—On the spectra of absorption of some colouring matters, by MM. Ch. Girard and Pabst.—On the electric resistance of copper at a temperature of 200° C. below zero, and on the isolating point of liquid oxygen and nitrogen, by M. S. Wroblewski.—Heat of formation of the bromide and iodide of antimony, by M. Guntz.—On the double bromides of gold and phosphorus, and on a chlorobromide, by M. L. Lindet.—On a method of producing the alkaline earthy manganites, by M. G. Rousseau.—On the development of the Hematodes, and especially of *Ascaris megalocephala*, by M. de Lacaze-Duthiers.—On *Adamsia pallatia* and its association with *Eupagurus Prideauxi*; a hitherto unrecorded instance of symbiosis, by M. Faurot.—On the parasites of *Mæna vulgaris*, by M. R. Saint-Loup.—First traces of the presence of Permian rocks in Brittany, by M. Ed. Bureau.—On the Permian formations occurring in the departments of Aveyron and Hérault, by M. J. Bergeron.—On the distribution of luminous intensity and visual intensity in the solar spectrum, by M. Aug. Charpentier.—On a case of cebocephaly (atrophy of the nasal process), complicated with partial anencephaly, observed in a foal, by M. Dareste.—Attenuation of the cholera virus, by MM. Nicati and Reitsch. From a series of experiments made on the guinea-pig the authors conclude that the cultivated virus loses all efficacy after a few weeks.—Photographic experiments in a balloon, by M. G. Tissandier. During an ascent on June 19, 1885, in Paris, the author, aided by M. J. Ducom, obtained some excellent photographs at elevations ranging from 605 to 1100 metres. By the new processes of instantaneous photography these operations have been greatly facilitated, and may render effective service in time of war.—Remarks on a partial earthquake felt only on the surface of the ground in the Department du Nord, by M. Virlet d'Aoust.—Note on the microzymas of the Jequirity plant, by MM. J. Béchamp and A. Dujardin.

CONTENTS

THURSDAY, JULY 30, 1885

THE UNIVERSITY OF LONDON

CONVOCATION met on Tuesday to consider the report and draft scheme submitted to it by Lord Justice Fry's Committee. After a somewhat lengthened debate the House adjourned till November 3, when no doubt their consideration will be resumed.

We do not think much is lost by the delay. As we pointed out last week, the scheme has at first sight an aspect of complexity. But this arises in great measure from the technical form and language with which it is necessary to invest provisions intended to receive legislative effect. We do not think the underlying principles are difficult to disentangle, but it could hardly be expected that such a body as Convocation would grasp them without considerable opportunity for explanation and discussion.

The particular date which the accident of circumstance determined for the meeting was in some respects unfortunate. Many of the medical graduates who might be expected to support the scheme were drawn away by the meeting of the British Medical Association at Cardiff. In November all the medical schools will be in full activity, the leading teachers in every faculty will be in town, and the preliminary ventilation which the scheme has now received, followed, as it will be, by the discussion and reflection of the vacation, will prepare Convocation for a definitive decision in the autumn.

What that decision should be there can hardly be any doubt in the mind of any reasonable person. The remarkable attention bestowed by the leading journals on a purely academic question goes far to prove that the ear of the public is ready to entertain any reasonable proposals for the development of real university work in London. It is for the graduates in Burlington Gardens to decide whether they will approach the task or leave it to some new organisation which may be created for the purpose. That the thing sooner or later in some shape or other will be done we have not ourselves a shadow of a doubt.

The Association for promoting a Teaching University for London has suspended to some extent its own efforts, pending the action of Convocation, to which in its first report it has given its cordial support. The Association and the Committee of Convocation do not, however, seek to attain their objects quite on the same lines, and the identification by some of the speakers on Tuesday of the views put out on behalf of the two perfectly distinct bodies introduced a certain amount of confusion into the debate which no doubt the present opportunity for further consideration will go far to remove.

Of the debate itself little is to be said. Lord Justice Fry's speech explanatory of the scheme had the quality of lucidity which every one expected from him. But more than this, he exhibited a largeness of view in contemplating the possible future of the University which might have been expected to carry with it a more enthusiastic sympathy from Convocation than it obtained. The criticisms which followed were mostly on points of detail, and, on the whole Convocation, without being adverse, evidently felt that it should like more time for reflection.

THE EVOLUTION OF THE PHANEROGAMS

L'Evolution du Règne Végétal. Les Phanerogames. Par MM. Marion et Saporta. (Bibliothèque Scientifique Internationale, 1885.)

SINCE the appearance of the first volume of this important work the views of the authors have been subjected to more than one attack, and they have turned aside to vindicate the correctness of their interpretation of the often obscure fossils upon which our knowledge of the earliest forms of plants is based. The wisdom of the delay is unquestionable, for it would have been useless to continue a work whose foundations had been shaken by adverse criticism. It is not to be expected that their views will even yet be universally acceptable, for the difficulties attending the study of fossil plants are such that its most experienced professors are still scarcely agreed upon some of the fundamental questions. It is well known that Prof. Williamson is opposed to the French school as to the gymnospermous nature of several groups of Carboniferous plants, and in addressing the British Association in 1883 (NATURE, September 20, 1884) he criticised in advance some of the main facts dwelt upon in this work. In contrast to the divergent views of English investigators, the greatest workers in France, including the honoured names of the late Adolphe Brongniart, and of MM. Grand'-Eury, B. Renault, Marion, and de Saporta, are in complete accord. Their work presents for the first time a complete outline of the evolution of the vegetable kingdom, and its importance and novelty are such as to demand a critical as well as friendly examination.

In the former volume it will be remembered (NATURE, May 26, 1881) the authors endeavoured to trace the development of vegetable life from the protoplasmic body, differentiated from animal life in no way other than through the conversion of a portion of its protoplasm into chlorophyll, to the heterosporous cryptogams. The present volumes prove that there is an almost direct passage from the latter to the far higher phanerogams.

There is no need to argue at the present day that if phanerogams were differentiated from cryptogams this must have taken place in very remote times; and it is equally certain that evolutionists will be disposed to anticipate that the initial differences between them must at first have been relatively imperceptible. An heterosporous cryptogam in which the microspores penetrate to a solitary macrospore in order to effect fertilisation, and in which the prothallus is enclosed and germination takes place *in situ*, is well on the road to become a phanerogam and, moreover, a gymnospermous one, if the macrosporangium be not protected by any leaf modified into a tegumentum. The change in the reproductive organs was accompanied and preceded by modifications in the vegetative organs, and the transformation is actually found to have progressed through three distinct stages—the *progymnospermous*, the *gymnospermous*, and the *metagymnospermous*.

The Progymnosperms are among the earliest plants known, and already occupied an important position in Carboniferous floras. Though they are now completely extinct, the Cycads have to some extent preserved their characteristics. They retained many characteristics of the cryptogamic stock whence they originated, which are completely lost to remote descendants of the present day. As the earliest connecting links between Cryptogams and Phanerogams their morphology is peculiarly interesting, and the exquisite preservation of many of their silicified or calcareous stems permits the minutest details of this part of their structure to be studied.

That Cryptogams reached a far higher stage of development in the Palæozoic time than exists in any living representative is one of the few facts that has not been disputed. One of the best-known of these is Lepidodendron, a tree-like plant allied to the Lycopodiaceæ. Its structure has frequently been described, and presents nothing unusual to Cryptogams. But in Sigillaria, a plant strongly resembling it in nearly every other respect, we find a radiating vascular cylinder or woody zone in the cellular stem, with unmistakeable exogenous growth. It is richly supplied with medullary rays, and, Prof. Williamson allows, presents clear evidence of interruptions to growth, succeeded by periods of renewed vital activity. The same writer also describes the prosenchymatous and the parenchymatous structure investing the woody zone as a bark, and remarks that, although not divisible into three layers, the enormous development of the elongated prosenchymatous fibres or bast-tissue in the inner layers of the epidermis of the fossil stems is a manifest foreshadowing of the presence of that same tissue in the bark of living exogens, especially the Cycads. In Diploxylon there is a further development, the woody zone being made up of an inner or medullary vascular cylinder, either interrupted or continuous, composed of large scalariform vessels without definite order, and an outer cylinder of scalariform vessels of smaller size arranged in radiating fasciculi. There is no difference of opinion as to the exogenous nature of the woody zone, which bears a relatively small proportion to the diameter of the stem, and as to the presence of medulla or pith and bark; but while Adolphe Brongniart and our authors class Sigillaria in consequence as a low form of exogen, a progymnosperm, Prof. Williamson and some of the German authors prefer to regard it as a highly-developed Cryptogam. He possesses specimens which conclusively prove to him that the exogenous wood is undeveloped in the young stages, and that young stems of Sigillaria are indistinguishable from Lepidodendrons; but though there is a gradual passage from one to another, the typical Lepidodendron never produced a ligneous zone. Sir J. W. Dawson, who has done much to elucidate this subject, believes that even some Lepidodendrons are exogenous, and that all Sigillarias are so. The evidence goes to prove that unquestionable Lepidodendrons in youth gradually acquire the internal features, notably the exogenous ring, characteristic of Brongniart's gymnospermous family of Sigillariæ. So far as its bearing on evolution is concerned, the differences of opinion scarcely affect the question. Whether they are looked upon as Cryptogams with exogenous growth, or exogens with cryptogamic characters, they are equally valuable as connecting-links, and if we agree with Prof. Williamson that they pass direct into true Lycopodiaceæ, the chain only becomes so much the more direct and complete. During growth the woody or exogenous zone increased for a certain period, but this was quickly arrested by the absorption or destruction in some way of the Cambium layer. The subsequent increase in diameter took place mainly in the cortical system, and to it the growth and solidity of the stem was principally due. The exogenous element in the oldest known trees is thus seen to have been transitory and subordinate, for had it persisted indefinitely, the continued generation of fresh layers or new rings of growth would have produced true dicotyledonous stems. It is suggested that until seasons, or alternations of activity and repose, replaced the earlier uniformity of climate, an exogenous growth would have been of relatively little use to the plant.

Sir J. W. Dawson has observed specimens of Sigillarian stems possessing still more definite exogenous characters, and in Poroxylon M. Rénault finds that the wood is dotted with areolated punctæ similar to those distinguishing the spiral vessels of Cycads and Araucariæ. Still the structure of their stems agree in so many respects with those of the highest heterosporous Cryptogams, the Lepidodendrons, that the difference between them remains almost insensible. Moreover, the Sigillarias are not supposed to be in the direct line of the evolution of Gymnosperms, but an offshoot which was quickly extinguished, and even in the Carboniferous time exogenous trunks were growing side by side with them. The construction of their stems was greatly varied, and it is evident that their plan of growth was susceptible of very considerable modification and development. It is now universally acknowledged that some Stigmarias are the roots of Sigillaria, yet here again we find a remarkable divergence of opinion, for while our authors regard them as rhizomes capable of bearing leaves as well as roots, Prof. Williamson contends that they are merely roots with rootlets. The Stigmarian rhizomes were procumbent and vegetated in the soft mud, Sigillarian stems budding from them occasionally, erect and cylindric, and crowned with a mass of long and linear leaves whose scars, impressed upon the bark, give rise to complex and beautiful tesselated designs. To how great an extent their fruiting organs preserved their cryptogamic attributes is unfortunately even yet imperfectly known.

The next type of progymnospermous stems, that of Calamodendron, is more remarkable because more abnormal, for it possessed a hollow fistular stem with verticillate leaves, closely resembling in appearance a gigantic Equisetum. Here again there is an irreconcilable divergence between the views of the French authors and those of Prof. Williamson. The former separate Calamites from Camalodendron, believing them to have been confounded simply because the casts of the interior of the hollow stems of both accidentally present the same grooved and articulate aspect, though morphologically they completely differ. Calamites they maintain to be a Cryptogam whose thin walls presented within and without the same structure as those of Equisetum. Prof. Williamson urges that no such Calamite has ever been found, but that, however thin the walls of a specimen may be, they always show the Calamodendron structure if any is preserved, and that the points of agreement are too remarkable to be a mere case of mimicry between a cryptogam and a gymnosperm. Our authors, however, lay stress on the fact that there are two very distinct types of articulated root, belonging respectively to the two genera in question, but although Prof. Williamson recognises them both, he does not specially comment on the fact. As to matters of fact relating to the structure of the Calamodendron stem, opinion does not differ, but the Professor, as in the case of Sigillaria, views them as Cryptogams of exogenous growth, without, however, admitting the close relationship to the Equisetaceæ advocated by Mr. Carruthers.

The stems of Calamodendron were filled in solid with pith or cellular parenchyma when young, but became hollow with age, the fistular interior of the stem consisting then of a linear series of oblong chambers, making an entire internode and separated from each other by transverse medullary diaphragms. The exogenous zone consisted of numerous woody wedges separated from each other by peculiar prolongations of the pith, to which Prof. Williamson assigns the name of primary medullary rays, while secondary medullary rays separated the constituent vascular laminæ of each wedge as in recent Exogens. These extended vertically from node to node, when they underwent a change. The apex or inner face of each wedge originates in a duct or canal. Investing this woody zone was a thick cellular cortical layer without vessels. The bark is very rarely preserved and is not exogenous in character, the tripartite division of existing Coniferæ not being present. The outer surface appears to have been smooth, and not fluted longitudinally, at the same time masking the articulations. Camalodendron thus possessed exogenous wood playing exactly the same *rôle* as in Sigillaria, surrounding the pith, and closely resembling the first year's shoot of a recent conifer; but it differed in the verticellate arrangement of its appendicular organs. The structure of the root hardly differs from that of the stem, this indicating, according to the authors, a peculiarly primitive type, and the rootlets grew from the nodes and were branching. Prof. Williamson states, on the other hand, that the root is adventitious and not a prolongation of the main axis. The leaves or branchlets were distributed on the trunk at regular distances on the line of the nodes, which were pretty close together, alternating regularly from one to another, so that the appearance resulting was that of a quincuncial arrangement, the more obvious on account of the concealment of the nodes by the bark. There is no direct proof, but the authors believe that the foliage known as Archæocolamites and Bornia, consisting of repeatedly dichotomosing acicular leaves arranged in verticels around nodes on slightly striated stems, really belongs to Calamodendron, in which case the male inflorescence was born in catkins something like those of the Taxeæ. Sir J. Dawson, however, states that he has found leaves like those of Asterophyllites attached to stems of Calamodendron. The fruiting organs are still very imperfectly known, but Prof. Williamson believes them to have been a heterosporous Strobilus like those of Lepidodendron. The authors, in conclusion, remark upon the resemblance between leaves of Bornia and those of Trichopitys and Bryon, which are true Salisburieæ, for, though the one is verticellate and the other spiral in disposition, the possibility of an easy transition from one to the other is exemplified in Calamodendron, and both modes occur together in existing Cupressineæ and the young Abietineæ.

Prof. Williamson believes that Calamites and Camalodendron are one and the same plant, and this a cryptogam. Against the exogenous wood he sets the cryptogamic bark, the Strobilus with Calamite structure full of spores, the adventitious roots and the verticellate arrangement of the leaves. It seems hardly possible, however, that such observers as A. Brongniart, M. Grand'-Eury, M. Rénault, and our authors can all be mistaken. In the former volume a graphic description was given of the growth of the Equisetum-like Calamites as they occur at St. Etienne. Prof. Williamson has not come across an undoubted Calamite, and very prudently disbelieves in their existence, but his evidence seems negative rather than positive, and we have already seen in several instances that coal-plants may have flourished in great numbers in one country and yet be exceedingly rare in another. The Carboniferous lasted over an immense period of time, and there appears less reason, as their plants become more completely known, to suppose that the forests were then composed of few types universally distributed. Development was proceeding actively, and it is quite conceivable that a gigantic primæval Cryptogam might take on phanerogamous characters without greatly modifying its external appearance.

Another remarkable cryptogam with exogenous wood is described by Prof. Williamson as Astromyelon. The stem was hollow, and except that it was not articulated, resembled that of Camalodendron. It appears that the stem and branches grew together under exactly the same relation as those observable in an ordinary exogenous tree, the latter not differing materially in their outward appearance from those of an ordinary pine. He appears to have felt hesitation in classing it, as he uses the expression "I am inclined to place" it among Cryptogams. Its affinities he considers to be with Marsilea, and we have thus—perhaps—in the coal-measures arborescent representatives of the Lycopodiaceæ in Lepidodendron, of Equisetaceæ in Camalodendron, and of Marsiliaceæ in Astromyelon, all of them having possessed rudimentary exogenous trunks.

J. STARKIE GARDNER

HARBOURS AND DOCKS

Harbours and Docks. By L. F. Vernon-Harcourt, M.A. (Oxford: Clarendon Press, 1885.)

IN the author's previous work on "Rivers and Canals" the science of hydraulic engineering received a valuable addition and the subject was treated, as far as it was necessary for inland works, in a masterly manner, fully upholding the author's high standing in his profession. We have now another work by the same author, in which the sequel to "Rivers and Canals" is given. In "Harbours and Docks," sea-works and kindred engineering subjects receive full consideration, the two books containing together an excellent collection of data on hydraulic engineering generally.

Of all the many branches of the engineering profession, that of hydraulic engineering pertaining to sea works and similar constructions trusts less to theory and more by far to practice than any other. The hydraulic engineer for sea works has no convenient formulæ to guide him, but only previous experience and precedent. This is evident from the volume before us, for most of the sea works described are improvements on previous constructions.

The author commences with a description of the natural laws which govern the general movements of the sea, the causes and action of its waves, tides, currents, and consequent changes in the coast line, the knowledge of which is all important when any new works are projected; indeed, it is not too much to say that many sea-works have proved very expensive in their maintenance owing to ignorance of the above conditions when they were designed.

The author divides the various types of harbours into five classes—(1) estuary harbours; (2) harbours with back-water; (3) harbours partly sheltered by nature; (4) harbours protected solely by break-waters; (5) peculiar types of harbours with detached break-waters. After having given long and clear descriptions, with excellent illustrations of the several types, the author remarks with reference to the first three classes and their shelter from the sea:—"Some natural shelter exists in all the harbours referred to above, but it will be noticed that the amount of shelter varies considerably. Thus whilst at Cherbourg, Plymouth, Wick, Genoa, and Barcelona the entrance alone of a complete bay requires protection; at Holyhead, Table Bay, and Alexandria only a portion of the extensive bays in which the harbours are situated can be utilised, though the existence of the bay diminishes considerably the exposure; and lastly, at Dover, Newhaven, and Colombo projecting points of the coast, rather than regular bays, are taken advantage of for the site of a harbour." After discussing the last two classes of harbours, we have the conditions which govern the size and position of the entrances to harbours explained. We commend these chapters to the careful perusal of those who take an interest in the proposed harbours of refuge, for here will be found considerable information concerning the advantages of the several sites proposed.

Chapter V., and those following, until the end of Part I. of the book is reached, deal with perhaps the most important of all sea-works—viz. break-waters. The author classifies their several modes of construction into three classes—(1) mound of rubble and concrete blocks; (2) mound with superstructure; (3) upright wall. Under these heads we find all the principal break-waters, each being well described, the construction explained, and reason given for any special work.

It is interesting to follow the gradual increased use of Portland cement concrete in the place of natural stone, and, as the latest break-water, we may take the one at Newhaven now in construction. This break-water is practically one solid mass of cement concrete. It is built on the upright wall system, with concrete in bags deposited from hopper barges on the chalk bottom up to low-water, and concrete-in-mass above. The bags each contain about 104 tons of concrete, the concrete being mixed by a special machine consisting of a screw working in an inclined cylinder, the materials being added at one end, water being added during the transit, thoroughly mixed concrete coming out at the other end.

In Part I. of the volume is to be found every information with regard to sea-works generally; the descriptions and details of the construction of the Manora break-water, Madras harbour, and Alderney break-water among the many others, are extremely interesting, being as well written as they are good. Of the American break-waters described, those constructed in the large lakes, are, as may be expected, principally constructed of wood, some being bound together by means of iron ties. The form taken is generally crib-work, floated out to the site in sections, and filled with stone. Before leaving the subject of break-waters we will quote the author's opinion on floating break-waters; this is interesting at the present time on account of the late experiments at Eastbourne and other places. He says:—"Various schemes have been suggested from time to time for arresting waves by means of floating break-waters moored in position. It has been imagined that the undulation being on the surface might be stopped or reduced considerably by an obstacle at or near the surface, and thus the cost of building up a break-water from the bottom could be saved; though, in the case of large waves, the undulatory motion is not simply superficial, yet, undoubtedly, the power of the waves would greatly diminish if the upper portions could be arrested in their progress; and the gain in dispensing with a solid structure founded on the bottom of the sea would be very great." He then tells us of several forms tried which were not successful in reducing the waves, and in conclusion says:—"The force of waves is so great, as indicated by its effects in moving huge masses, that no fragile floating moored construction could possibly oppose an adequate resistance. The accumulated power of the wind, acting through the medium of the waves, cannot be evaded, but must be met; and this can only be effectually accomplished by a solid break-water." This part of the book concludes with a chapter on lighthouses, beacons, and buoys; the construction and cost of all the important lighthouses is given and admirably illustrated.

In Part II. "docks" receive very full consideration, Chapters XIX. and XX. dealing with sites, preliminary works for docks and dock walls; suffice it to say that all these are treated in such a way as to render it evident that the author is thoroughly master of his subject. In Chapters XXI. and XXII. the usual fittings pertaining to docks are discussed, their entrances and locks, dock-gates and caissons of all kinds thoroughly described, and their varied construction under different conditions explained. All the following chapters, which occupy the last 150 pages of the book, are taken up with a general, and in some cases a detailed, description of some of the more important English and foreign docks; it is needless to say that they are all thoroughly well treated, and the trade statistics are carefully given and useful comparative distinctions drawn.

As a work on hydraulic engineering we can confidently recommend it to all those who are interested in the subject, feeling convinced that it will be found a most useful book. The author has produced, and students will profit by, a book well written, sound, and most useful in forwarding the science. Both volumes do credit to the publishers, the plates are good and well executed. These volumes ought to find a place in every technical library in the country.

OUR BOOK SHELF

Lehrbuch der vergleichenden Mikroskopischen Anatomie. Von Dr. Herman Fol. Erste Lieferung. (Leipzig, 1884.)

THE present volume is the first of a work which promises to be in many respects an important addition to the literature of microscopic anatomy. It describes in clear and concise language most of the commendable methods used by the author himself for examining and preparing microscopic specimens of animal tissues.

The methods of injecting vessels and cavities, the nature and preparation of the various materials and apparatus useful for injection, the theory and practice of the microscope and practice of the auxiliary apparatus are treated thoroughly, the theory and practice of drawing microscopic objects, the methods most useful for making micro-photographs, and for showing stereoscopically small objects, are fully described and illustrated, and will be found most useful and instructive reading. Next, the methods for examining living tissues, for fixing and hardening them, then the various ways for embedding and making sections, are minutely described. The last or seventh section is one of the most important ones, giving an excellent *résumé* of micro-chemical reactions, including the osmic acid gold and silver methods, and the methods of staining tissues with carmine, hæmatoxylin, and the various aniline dyes.

To each section is added a useful bibliographical summary. On the whole the book is an excellent guide for microscopists, both teachers and original workers.

E. KLEIN

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Unconscious Bias in Walking

THE results of some experiments recently made to ascertain the cause of the well-known phenomena of "unconscious bias in walking" will perhaps be of interest to your readers in connection with the various theories presented in the discussion of this subject in NATURE (vol. xxix. pp. 262, 286, 310, 356, 384, 452).

Within the past six months over 2500 anthropometric measurements have been made of students in the three higher classes of the Massachusetts Agricultural College, including the relative length and strength, muscular development, &c., of the limbs, and the bias in walking of forty-nine individuals has been carefully determined, with results as given in the following summary statement.

In making these measurements I have been assisted by Dr. F. Tuckerman, of this place, who will collate the data obtained in their relations to bilateral symmetry.

The tests to determine the bias in walking were made in the drill-hall of the College, a room with a hard smooth cement floor, well adapted to this purpose.

For convenience in recording the curves of divergence a meridian or base line was drawn through the middle of the floor lengthwise of the hall, and on each side of it lines of departure were marked 1 metre apart, while the latitude was indicated by transverse parallel lines every 2 metres.

In trials to determine the bias, the individual was placed on the meridian line 2 metres back of the first parallel, and after he had well fixed the bearings of the line, he was blindfolded and started at a rapid, but not hurried pace. If he crossed the first parallel of latitude on the meridian line, he was allowed to proceed, but if a marked divergence from this line was made he was stopped, and a new start was made in the right direction. Small sticks were laid down on each parallel of latitude at the point of crossing, by assistants conveniently placed for this purpose, and at the end of the course the line of march could be readily seen. In some cases irregularities in the curve indicated either a hesitating or constrained effort in walking, or errors in marking the precise point of transit.

In these cases the trials were repeated, until a reasonably true curve was obtained. A record was then made of the distance from the meridian line, to the right or the left of the point of crossing on each parallel of latitude.

From this record the curves made were plotted on a diagram, so that they could be readily compared and their peculiarities noted.

That the relative length and strength of the legs has no direct relation to the bias in walking will be readily seen from the following tabular statement:—

TABLE I.

No bias in 5 cases	In 2 the right leg is longest ... (One of these presented the greatest difference in length of legs, and the other more than the average of those with right leg longest)	In 1 the right leg is strongest In 1 strength of legs not tested
	In 3 the legs of equal length ...	In 1 the right leg is strongest In 2 the left leg is strongest (*a*)

Four are right-handed.

One uses right and left with equal dexterity (*a*). In pointing at a distant object with both eyes open, in three the right eye is dominant, in one the left eye is dominant, and in one both eyes are apparently used to determine the range.

TABLE II.

Bias to right in 14 cases	In 5 the right leg is longest ...	In 2 the right leg is strongest In 2 the left leg is strongest In 1 the strength of legs not tested
	In 4 the left leg is longest ...	In 3 the right leg is strongest (*a*) In 1 the left leg is strongest
	In 5 the legs are of equal length	In 2 the right leg is strongest (*a*) In 3 the left leg is strongest

All are right-handed.

In pointing at a distant object with both eyes open, in 12 the right eye is dominant, and in 2 the left eye is dominant, the latter in the groups marked (*a*).

TABLE III.

Bias to left in 30 cases	In 8 the right leg is longest ...	In 5 the right leg is strongest (*a*) (*b*) In 2 the left leg is strongest In 1 the legs of equal strength
	In 10 the left leg is longest ...	In 5 the right leg is strongest (*b*) In 4 the left leg is strongest (*b*) In 1 the legs of equal strength
	In 12 the legs of equal length ...	In 5 the right leg is strongest In 5 the left leg is strongest (*b*) In 2 the strength of legs not tested

One is left-handed (*a*). Twenty-five are right-handed. Four use right and left with nearly equal dexterity (*b*). In pointing with the finger at a distant object, with both eyes open, in 22 the right eye is dominant, in six the left eye is dominant, and in 2 both eyes are apparently used to determine the range.

The relative dexterity of the legs was tested in a number of cases, but a press of other duties prevented further experiments in this direction. From the tests made, however, it is obvious that there is no direct relation of the relative dexterity of the legs to the bias in walking.

From these experiments it is evident that the cause of the observed unconscious bias in walking is not to be found in the mechanical proportions, or relative strength, or dexterity (?) of the legs.

The application of well-established physiological principles will, however, furnish a ready explanation of the phenomena in question.

The co-ordination of the voluntary muscles is the exclusive prerogative of the nervous system and the senses are important factors in all movements involving a definite direction. The muscles of locomotion when called into action under ordinary conditions, as when walking in a straight line, are co-ordinated or brought into an orderly correlation, by impulses conveyed to the nervous centres through the afferent or sensory nerves, but when in the dark, or in a mist, or when one is blindfolded, the senses are not available as a guide to direction, the co-ordinating nervous mechanism is dormant, and a divergence from a right line is made to the right, or the left, from a lack of equilibrium in the action of the efferent or motor nerves.

In several of the trials, to determine the bias in walking, interruptions occurred before the course was completed, by the opening of the door at the side of the hall and the talking, in a low tone, of the visitors, which served as a guide in orientation, and the curve made before the interruption was suddenly corrected to a line parallel to the meridian.

In all of the trials the greatest care was taken to prevent the senses from gaining clues to the right direction.

Unconscious bias in walking is obviously the result of vital activities involving complex actions and reactions in the nervous system, which may be clearly defined in general terms, while the details of the obscure changes taking place in the nervous mechanism cannot, in the present state of our knowledge, be fully traced. Moreover, it is evident that the phenomena in question must be studied from the same stand-point of other biological processes which cannot be explained or expressed by purely physical or chemical conditions. MANLY MILES

Massachusetts Agricultural College, Amherst, Mass., April 7

The Flora of Canada

THE review by Mr. J. G. Baker in your last number (p. 242) of the second part of Prof. Macoun's "Catalogue of Canadian Plants" prompts me to send you a few notes on some of the features of the flora of Canada, which I had an unusual opportunity of observing last autumn under the guidance of Prof. Macoun in the neighbourhood of Ottawa, and again in the magnificent railway trip given to members of the British Association by the Canadian Pacific Railway Company from Lake Superior to Kicking-Horse Pass in the Rocky Mountains.

Throughout Eastern Canada and the Eastern United States the European botanist is struck with the strange intermingling, in the wayside flora, of forms new and strange with those familiar by every roadside and in every hedge-bank in England. Away from human habitations the flora is almost altogether novel, but near houses, introduced purposely or accidentally, the English weeds are rivalling and even supplanting the native. I was particularly struck with noticing the vegetation of the grass lawn by the hotel on the Catskill Mountains at an elevation of about 3000 feet. It consisted almost entirely of the same species as you would expect to find in similar situations at a lower altitude in the old country: *Achillæa Millefolium*, *Daucus Carota*, *Plantago major*, *Chenopodium album*, *Cnicus lanceolatus*, &c., most or all of them importations. Elsewhere, in the east, you find docks, milfoil, thistles, shepherd's purse, jostling *Asters*, *Asclepiases*, *Amaranthuses*, *Solidagos*, and other peculiarly American weeds. Exactly the same thing is taking place with introduced animals. I was staying at a farmhouse in Ontario, not far from Niagara, and was told that the English house-sparrow made his appearance there about three years since, and is already as abundant as in England, and a terrible nuisance. Some English plants, however, like our daisy and primrose, seem to refuse to naturalise themselves to the American soil and climate.

Everywhere the lines of the railways are marked by the advent of the foreigner. As Prof. Asa Gray said at Montreal, even English weeds now travel by express train. It is most interesting, in travelling westwards over the vast continent, to note the gradual disappearance of European and the unrivalled supremacy of American types. But it is not only westwards that the tide of floral conquest makes its way. A fellow-traveller of our party had the good fortune to gather, near Port Arthur on Lake Superior, where we were detained twenty-four hours by stress of weather, a grass, *Beckmannia erucæformis*, 300 miles east of any locality previously recorded

Although in the main the indigenous American flora is altogether different specifically from ours, yet there are exceptions. I am not now speaking of the Alpine flora of the Rocky Mountains, which agrees to a wonderful extent generically, and even specifically, with the flora of the Alps, Pyrenees, or Grampians. Covering the vast extent of ground from the eastern sea-board to the Rockies are a few species undoubtedly indigenous and absolutely identical with European and even English forms. I may mention three illustrations taken from widely-separated natural orders—*Potentilla fruticosa*, *Campanula rotundifolia*, and *Linaria vulgaris*. How to reconcile these facts with any theory accounting for the geographical distribution of species on the face of the earth it is difficult to say.

Even more interesting are those cases where American and European plants are regarded as belonging to the same species, but where there is a certain difference difficult to define, but recognisable at a glance. To take, again, three examples:—Among the most cosmopolitan of ferns are *Osmunda regalis* and *Pteris aquilina*. Abundant throughout Canada, there is yet, in both cases, a general habit by which they are at once distinguished from the English forms. Again, the American *Plantago major* is all but indistinguishable from the English wayside weed. And yet, it is said, American horses know the difference. Prof. Macoun is contemplating a visit to Europe next year, when one of his special objects will be to compile an account of these closely-allied but yet distinct eastern and western forms. It is possible that such a comparative list—and it could not be in better hands—may throw some light on some of the many still unsolved problems connected with the evolution and distribution of species. ALFRED W. BENNETT

The Fauna of the Seashore

IN addition to the instances from the Molluscan class mentioned in the interesting letter from Mr. Arthur R. Hunt (NATURE, pp. 243-4), as illustrating—after Prof. Moseley's most valuable contribution—"the variety of method exhibited by the littoral fauna in resisting wave-currents," may be mentioned one of a higher class among the fishes—viz., the common smooth blenny (*Blennius pholis*).

No one who has hunted for this pretty little fish in rock-pools, or who has kept it in an aquarium, can have failed to notice its remarkable adaptation to the ever-varying environment of the littoral zone. The angular form of the head and smooth, mucous-covered body enable it readily to burrow within the smallest crevices of the rocks, to prevent its being washed ashore when the tide is coming in, and to prevent its being carried into deep water when the tide is going out, where it would readily fall a prey to rapacious fishes, as it has apparently little power to swim freely to a distance, not needing to do so in shallow water. Its peculiarly modified ventral fins, forming almost anterior limbs, enable it to cling securely not only to weeds and rocks, but even to perpendicular surfaces, for similar purposes to those above stated, while its beautifully-marked body—of splashed dark and light greens—seems to be a case of mimicry of the sea-weeds which afford it protection from its natural enemies among its own class and those of the higher Crustacea. An allied deep-sea genus (*Anharricas*, the wolf-fish), whose ancestor was probably a littoral blenny, has the ventral fin entirely wanting, and the head is round, for the obvious reasons that it does not need to cling to surfaces nor to burrow in crevices. This fish is, however, compensated by a formidable array of sharp teeth to protect it from its natural enemies. In the aquarium no fish, in my experience, is so readily tamed as the smooth blenny, so as to allow it to be handled, or exhibits such a high degree of piscine intelligence, arising doubtless from long education, both inherited and acquired; in the varying environment which is its habitat. A specimen now in my aquarium daily avails itself of the advantage of the dry ledge of the slope-backed tank "to get a mouthful of fresh air," while at other times it usually takes refuge in an untenanted old shell of the common whelk (*Buccinum undatum*), where it is secure from the gobies and other fishes in the tank, and where it watches—as one can see its fellows do so at any time on the sea-coast in the middle of a rock-pool—expecting the return of the tide and prepared to adapt itself thereto. In "A Year at the Shore," pp. 215–16, Mr. P. H. Gosse, F.R.S., mentions, on the authority of Mr. Ross, of Topsham, the case of a blenny which for five months proved "a regular and correct tide-indicator," spending a portion of its time on the rock-work, and going back to the tank at the time of the return of the tide.

I quite agree with Mr. Arthur R. Hunt's idea that it would be a great gain if we could copy Nature a little closer, and have "working-models of the sea in some of our new aquariums."

Birmingham, July 22 W. R. HUGHES

Artificial Earthquakes

PROF. MILNE'S experiments with artificial earthquakes in Japan, noticed in NATURE of June 4 (p. 114), show that the vertical free surface-wave had the quickest rate of transit, and this was taken to account for the preliminary tremors of an earthquake. The normal wave travelled with a less velocity, and the transverse wave slowest of all. In the earthquakes which occur here from time to time there are generally, if not always, two distinct shocks felt, and it is possible that the second is the transverse wave following on after the swifter normal vibration. I have not heard that there are any seismographs in the Punjab, and in the alarm of the moment it is not easy to notice the direction of the motion without apparatus; fortunately our earthquakes do not leave any automatic record in the shape of fissures or fallen buildings. But Prof. Milne's experimental results are curiously confirmed by observations in Kashmir during the earthquakes of this month, which do not appear yet to have quite subsided. The Kashmir correspondent of the Lahore *Civil and Military Gazette* of to-day's date writes as follows:—"The more severe shocks seemed to be followed by others in a different direction, like cross waves. I noticed this in a boat which quivered all over during a severe earthquake, but rolled somewhat afterwards." T. C. LEWIS

Government College, Lahore, June 29

The Recent Earthquake in Switzerland

THE following is a table of events of the earthquake in Switzerland of June 20 last, compiled from numerous and interesting observations of the phenomenon, obligingly forwarded to me from all parts of the country.

The earthquake consisted of a series of shocks:—

1. *Preparatory Shocks.*—Very weak and ill-defined from midnight to 3 a.m.; at Neuchâtel and Chaud-de-Fonds.
2. *Great Shock*—At 5.16 on the morning of June 20; at the centre of the earthquake.
3. *Consecutive Shocks.*—At 7.26 a.m. June 22 at Neuchâtel; at 8.30 a.m. of June 22 at Yverdun, Payerne, Estavayer, Concise, Boudry, Neuchâtel; at 11 a.m. of June 23 at St. Imier; at 2.30 p.m. of June 23 at Neuchâtel; at 9.20 a.m. of June 24 at Yverdun (?)

The great shock had its centre near Yvonand and the central area may be defined by the triangle formed by Yverdun, Neuchâtel and Payerne. The shock was strong enough to alarm the inhabitants, to displace some articles of furniture and even to throw down a chimney at Payerne. I assign to the shock the strength of number 6 on the scale of intensity, of which number 10 would stand for the highest degree. The shock was felt more feebly in a vast territory extending as far at least as Geneva, Le Brassus, Le Locle, Bâle, Glaris, Thun, Saxon: that is, it traversed the whole plain of Western Switzerland from the Jura Alps. A subterranean noise was heard very distinctly in the whole central area and even a little beyond it.

The shock had very markedly the character of successive oscillations, horizontal or vertical, their direction differing according to the locality. Such is, indeed, the usual type of earthquakes, as has been shown by the study of them with registering instruments, and it is interesting to notice that the various observations of the earthquake of June 20 all perfectly concur in ascribing to it this character. F. A. FOREL

Morges

THE PITCHER PLANT

THE variety of the Pitcher Plant (*Sarracenia variolaris*) found in North America is carnivorous, being a feeder on various animal substances.

Mrs. Mary Treat, an American naturalist, made, a few years ago, several experiments upon the plants of this species to be found in Florida; and to the labours of this lady the writer has been indebted, in some measure, in the preparation of this paper.

The *Sarracenia* derives its name of "Pitcher Plant" from the fact of its possessing the following curious characteristics. The median nerve is prolonged beyond the leaves in the manner of a tendril, and terminates in a species of cup or urn. This cup is ordinarily three or four inches in depth, and one to one and a half inches in width. The orifice of the cup is covered with a lid, which opens and shuts at certain periods. At sunrise the cup is found filled with sweet, limpid water, at which time the lid is down. In the course of the day the lid opens, when nearly half the water is evaporated; but during the night this loss is made up, and the next morning the cup is again quite full, and the lid is shut.

About the middle of March the plants put forth their leaves, which are from six to twelve inches long, hollow, and shaped something like a trumpet, whilst the aperture at the apex is formed almost precisely in the same manner as those of the plants previously described. A broad wing extends along one side of the leaf, from the base to the opening at the top; this wing is bound, or edged with a purple cord, which extends likewise around the cup. This cord secretes a sweet fluid, and not only flying insects, but those also that crawl upon the ground, are attracted by it to the plants. Ants, especially, are very fond of this fluid, so that a line of aphides, extending from the base to the summit of a leaf, may frequently be observed slowly advancing towards the orifice of the cup, down which they disappear, never to return. Flying insects of every kind are equally drawn to the plant; and directly they taste the fluid they act very curiously. After feeding upon the secretions for two or three minutes they become quite stupid, unsteady on their feet, and whilst trying to pass their legs over their wings to clear them, they fall down.

It is of no use to liberate any of the smaller insects, every fly, removed from the leaf upon which it had been feeding, returned immediately it was at liberty to do so, and walked down the fatal cup as though drawn to it by a species of irresistible fascination.

It is not alone that flies and other small insects are overpowered by the fluid which exudes from the cord in question. Even large insects succumb to it, although of course not so quickly. Mrs. Treat says:—"A large cockroach was feeding on the secretion of a fresh leaf, which had caught but little or no prey. After feeding a short time the insect went down the tube so tight that I could not dislodge it, even when turning the leaf upside down and knocking it quite hard. It was late in the evening when I observed it enter; the next morning I cut the tube open; the cockroach was still alive, but it was covered with a secretion produced from the inner surface of the tube, and its legs fell off as I extricated it. From all appearance the terrible *Sarracenia* was eating its victim alive. And yet, perhaps, I should not say 'terrible,' for the plant seems to supply its victims with a Lethe-like draught before devouring them."

If only a few insects alight upon a leaf no unpleasant smell is perceptible during, or after, the process of digestion; but if a large number of them be caught, which is commonly the case, a most offensive odour emanates from the cup, although the putrid matter does not appear to injure in any manner the inner surface of the tube, food, even in this condition, being readily absorbed, and going to nourish the plant. In fact, it would seem tha the *Sarracenia*, like some animals, can feed upon carrion and thrive upon it.

In instances in which experiments have been made with fresh, raw beef or mutton, the meat has been covered in a few hours with the secretions of the leaves, and the blood extracted from it. There is, however, one difference between the digesting powers of the leaves when exercised upon insects or upon meat. Even if the bodies of insects have become putrid, the plant, as has already been stated, has no difficulty in assimilating them; but as regards meat, it is only when it is perfectly sweet that the secretions of the leaves will act upon it.

The Pitcher plant undoubtedly derives its principal nourishment from the insects it eats. It, too—unlike most other carnivorous plants, which, when the quantity of food with which they have to deal is in excess of their powers of digestion, succumb to the effort and die—appears to find it easy to devour any number of insects, small or large, the operation being with it simply a question of time. Flies, beetles, or even cockroaches, at the expiration of three or four days at most, disappear, nothing being left of them save their wings and other hard parts of their bodies.

The *Sarracenia* is, indeed, not only the most voracious of all known species of carnivorous plants, but the least fastidious as to the nature of the food upon which it feeds. W. C. M.

THE ECLIPSES OF AUGUST, 1886

IT has been before stated in NATURE that the total solar eclipse of August 28-29 next year can be most favourably observed on the west coast of Africa near Benguela. In a recent number of *Science* Mr. Skinner supplies a valuable account of the local conditions, which we here reprint:—

"Benguela is about 400 miles south of the mouth of the Kongo, and about 200 miles south of the mouth of the Koanza. The climate of the lowlands bordering the coast near Benguela is fatally unhealthy for strangers, making it compulsory, on the score of prudence, for an observing party to penetrate the interior sufficiently to attain the mountainous highlands which lie not far inland.

"The American Board of Commissioners for Foreign Missions has for some three years occupied two mission stations in this region—viz. Bailundu, about 133 miles eastward from Benguela, and Bihe, about 70 miles southeast from Bailundu. Through the courtesy of Rev. Judson Smith, D.D., secretary of the American Board, and Mr. Frederick A. Walter, secretary of this west-central African Mission, I have received definite statements of some of the precautions necessary, and some of the difficulties to be encountered by an observing party locating in this region. I will give in brief the points with which Mr. Walter favours us.

"Dangers to the person from savages are not to be apprehended. The climate of Bailundu and vicinity is exceedingly salubrious. During a residence of nearly three years, Mr. Walter and his family have experienced no illness to be ascribed directly to the climate, but in every case to overwork, over-exposure to the sun, or want of proper food.

"The difficulties in reference to transportation are considerable. Transportation is done entirely by men; waggons and animals cannot be used. The gross weight for a carrier is from 65 to 70 lbs.; commonly it does not exceed 58 lbs. Packages, either bales or boxes, should be of about the following dimensions:—14 inches by 9 inches by 30 inches, or, if more convenient, 16 inches by 10 inches by 24 inches. No single package should exceed 18 inches in width by 10 inches in depth. Pieces not exceeding 60 lbs. in weight, though 8 or 10 feet long, can be carried by a single carrier.

"As to means of subsistence, an observing party must bring *all their supplies with them*, as it is essential to the health of newcomers that they should live on food to which they are accustomed. The time required for a round trip of a caravan from Bailundu to Benguela may be stated as one month to six weeks.

"Mr. Walter states that the chances for clear sky at the time of the eclipse are very favourable.

"It may be stated that the land rises very abruptly as one leaves the coast from Benguela, and in a few miles attains a very considerable altitude, and throughout these highlands the climate is very healthful."

INTERNATIONAL INVENTIONS EXHIBITION

SELF-ACTING or automatic machinery has made wonderful strides of late years, and its progress in the special department of watch-making cannot be more advantageously studied than in the beautiful display of machine tools now exhibited by the American Waltham Watch Company at South Kensington. We think that a few remarks with reference to the functions of these tools may be of service to the readers of NATURE when viewing the collection. The machine tools are all labelled, and can readily be identified.

(1) A screw-making machine.—This machine is engaged in producing watch jewel screws; the size of the screws may be appreciated when we state that it takes more than 8500 to weigh one ounce troy. Lengths of wire are transformed into these tiny screws in the following manner. The machine is fed with the wire through a hollow mandrel, the wire is seized and rotated rapidly, a movable cutter is brought against it, and immediately the body of the screw is turned. Two dies are at hand which attach themselves, and they cut the thread; on reaching the limit of their cut, they pull out the wire a distance, the thickness of the screw head, for hitherto the wire has only projected the length of the body of the screw through the mandrel head. The dies disengage themselves, and a second cutter cuts off the screw at its junction with the mandrel head. There is an alternating arm, the most conspicuous part of the machine: this takes possession of the screw as it is cut off, and, carrying it to a different part of the machine, holds the head against a small circular mill, where the notch is cut. The screw is now finished, and is discharged into a magazine by a kind of ramrod. The machine turns out 4000 screws a day, and indeed the successive operations go on with so much rapidity, that it requires some practice to follow them. It is to be noticed that when the dies are cutting, the wire is stationary, and the machine then quickens its motion to save time. When the dies pull forwards, the chuck holding the wire opens simultaneously. Copious streams of oil are supplied to wash away the shavings, and the oil after being used once, escapes into reservoirs from whence it is automatically pumped up again. The different parts of the machine are regulated almost entirely by cams, the dies by a very elegant arrangement of opposing toothed sectors.

(2) A machine for cutting off dial feet—*i.e.* attachments. If this machine stood alone it would be interesting, but it is overshadowed by its neighbours.

(3) A machine for roughing out staves or pinions.—This is similar in some respects to the screw-making machine. Lengths of wire are fed through the mandrel, and a cutter shapes one end of the staff or pinion, giving it a male centre. It is then cut off, but the other end has to be shaped with its male centre too. Again we have an alternating arm, which carries the pinion away and places it in a very similar mandrel on the other side. So soon as it is gripped it begins to rotate; a cutter comes and shapes the unfinished end with its male centre. When done it is discharged into a magazine, as the tiny screws were.

(4) This is a machine for trueing down the staves or

pinions roughed out in (3). Like (2) this is a simpler machine, but worthy of attention. The roughed-out pinions are here turned true upon their own centres. Notice that when the tool has turned off the necessary amount it stops of itself, till started for a fresh piece.

(5) A pinion-polishing machine.—The polisher is driven to and fro by crank motion. After a sufficient number of rubs have been given the pinion turns automatically and presents a fresh face to the polisher, till all the leaves are done. The other side of the stand shows us a lathe requiring no special explanation.

(6) An automatic machine for cutting pinions.—In this is exhibited an elegant arrangement for bringing a succession of cutters into play. The principle, however, is very much better illustrated in the scape-wheel engine that follows; we therefore defer explanation.

Alongside of this machine is another for cutting the bevelled wheel teeth for keyless work.

(7) A scape wheel tooth-cutting engine. The scape wheels to the number of sixty are threaded upon a kind of split spindle, which passes through the spaces around their arms, and holds them firmly. The spindle with the wheels around it looks like a solid rod of brass, and the cutter acts transversely so as to scoop a groove through all the sixty at once. Owing to the peculiar shape of tooth and the degree of finish necessary, seven different cutters are required. The actions are as follow:—The spindle being placed in position, the first cutter operates. When it has made one groove the spindle turns; it makes another, and another, in all 15, which corresponds to the number of teeth. A sudden change now happens—the first cutter is diverted, and a second takes its place This cutter works through all the fifteen spaces, and then the next supersedes it, until all have had their turn and the wheel is finished. We understand that the whole sixty wheels are cut in about twenty minutes.

(8) Another polishing machine, of somewhat similar design to (5).

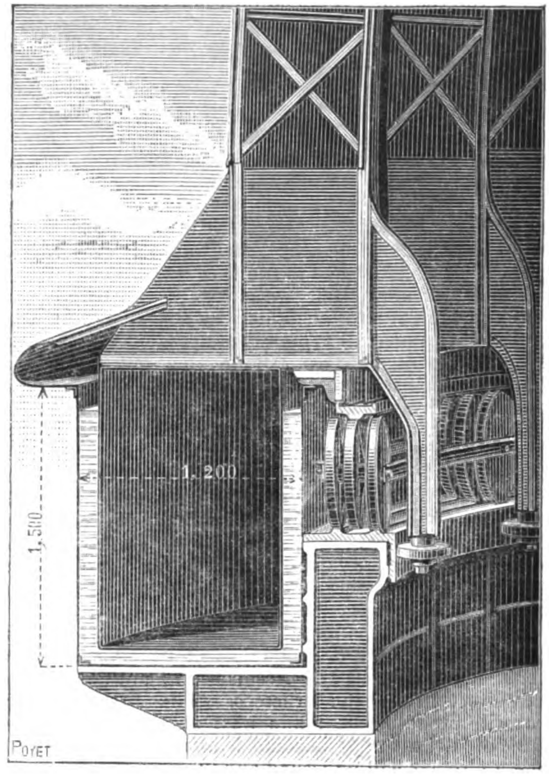
(9) On a counter opposite to the main stand is shown an interesting instrument for determining the strength of watch-balance springs. In this the differential principle is employed, the spring to be tested being measured against one of known force, and the number of degrees the latter is deflected registered. The springs are sorted into compartments corresponding to these numbers.

There are two other tools not working at present, but still of considerable interest. The first is supplementary to (9), which only gives the strength of the spring within certain limits. There is a normal balance with spring attached, and the balance and spring to be tested are mounted on an arm alongside of it. A lever sets both balances vibrating simultaneously, and it is easy to perceive in a few seconds whether their vibrations are synchronous or not. The other tool is automatic, and is for the purpose of drilling and tapping the screw-holes in compensation-balances. These holes are placed at irregular distances, as experience has suggested. By means of a divided plate the machine automatically finds these intervals. A very pretty feature will be noticed when the machine is drilling—viz. that the drill is withdrawn occasionally by the machine to free the cuttings, just as would be done by a workman.

HENRY DENT GARDNER

THE NICE FLOATING DOME

WE have already (NATURE, vol. xxxii. p. 62) referred to the floating dome for the great equatorial of the Nice Observatory of M. Bischoffsheim. We give now an illustration from *La Nature*, which shows the details of the annular floater. The entire dome is supported on the annular floater situated at its base. The floater, of hollow metal, swims in a circular caisson containing water holding saline matter in solution. When the dome is in the position of normal buoyancy, the only friction which opposes its movement of rotation is the friction inside a liquid body, and consequently is extremely feeble, notwithstanding the great weight of the moving mass. Experiments prove that one man can easily set the dome in motion with his hand. The floater of the dome is open above like an undecked boat; it has a rectangular section of 1·50 m. in height by 0·95 m. in breadth. Its walls are bound together by rivets of steel.



The annular caisson, which receives the floater and the liquid, has a rectangular transverse section; its height is 1·50 m., and breadth 1·20 m. The latter dimension thus exceeds the breadth of the floater by 0·25 m., which gives a lateral play of 0·125 m. in the inside and 0·125 m. at outside between the floater and the caisson. Finally, the caisson rests on thirty-six strong cast-iron supports, distributed at equal distances over the upper part of the mason-work of the tower.

A NEW ENDOWMENT FOR RESEARCH

IT is usually the case that private endowments for public purposes are made subject to narrowing restrictions, and then it too often ensues that with the lapse of time the very object of the gift is defeated by the restrictions—the letter kills the spirit. It must therefore be a matter of congratulation when a great public donation is left as free as compatible with the general object for which it is made. This is remarkably the case with a noble and munificent endowment established by Mrs. Elizabeth Thompson, of Stamford, Connecticut—an American lady well known for her public benefactions. Her long experience with churches and various charitable enterprises had led her to question whether the money spent in them achieves the greatest possible good. She finally reached the conviction that knowledge is the real source, the impelling power, of human progress, and it became her desire, from motives of the highest philantropy, to contribute to the promotion of science.

When the plan for the establishment of an International Scientific Association was brought forward at Montreal, and again at Philadelphia before the great National Associations, Mrs. Thompson considered that the proposed International Society would be the fittest body to assume the trust she wished to establish. Accordingly, she placed in my hands the sum of 5000 dollars (1500*l.*) as the nucleus of a fund to be controlled by the International Association when organised.

Not long since Mrs. Thompson communicated to me her desire to transfer the above-mentioned sum to a board of trustees and to add to it at once 20,000 dollars more, making a total permanent fund of 25,000 dollars. Mrs. Thompson has been as liberal in the conditions she has established as in the amount she has given. According to her letter of conveyance, "the income of the fund is to be devoted to the advancement and prosecution of scientific research in its broadest sense, it being understood that to provide for and assist in the maintenance of an International Scientific Association is a method of application which seems to me very desirable."

The trustees are left with very great discretionary powers, which are to be guided by certain general directions. It is above all expressly understood that the prime object is to contribute from the income towards defraying the cost of scientific researches. The Board of Trustees consists of five members: Chairman, Dr. Henry P. Bowditch, Professor of Physiology and Dean of the Harvard Medical School; Treasurers, Wm. Minot, jun.; Prof. Edward C. Pickering, Director of the Harvard Astronomical Observatory; General Francis A. Walker, President of the Massachusetts Institute of Technology; and the Secretary, Dr. Charles S. Minot. It was considered important to have as great a variety of interests represented as possible, and this is accomplished by the association of these gentlemen.

When the International Association is organised the income of the fund presumably will be expended under the direction of that new Association; until then, under the direction of the trustees. The first appropriation will probably be made next autumn, when several hundred dollars will become available. At the proper time a circular will be issued announcing the manner in which applications may be made. As it is desired to give the fund an international character, it is hoped that foreign journals will copy this notice.

In conclusion I wish to express my admiration for the wisdom shown by Mrs. Thompson. It is certainly very remarkable that a person not specially versed in science, nor directly interested in any of its branches of investigation should be induced by a desire to benefit her fellows, not to give for some temporary need, but, with exceptional insight, to give for the development of the very sources of progress. The same sound judgment governed her decision as to the conditions of her gift, for it is difficult to foresee any probability which will render this endowment futile. Very often a public gift has its object determined by the donor's personal interests. I believe Mrs. Thompson was governed solely by her convictions as to the application of her money which would do most good.

At their first meeting the trustees voted unanimously to call their trust "The Elizabeth Thompson Science Fund."

CHARLES SEDGWICK MINOT

Boston, Mass., U.S.A.

NOTES

WE are informed by Dr. Armstrong that arrangements have been made for two discussions in the chemical section over which he will preside at the meeting of the British Association at Aberdeen. The one will be on the Determination of the Molecular Weights of Liquid and Solid Bodies, the other on Electrolysis. It is proposed to have a series of critical papers read which shall embody, as far as possible and desirable on such an occasion our knowledge of these subjects, and also indicate the directions in which investigation is specially required and may be most usefully carried on. These subjects have been chosen as being of general interest and of special importance to the chemist, and in the hope of inducing chemists and physicians to cooperate in attacking the many problems which await solution. Capt. Abney will open the first discussion with a paper on the spectroscopic method. Profs. Guthrie, Reinold, and Dilden, Mr. S. U. Pickering, Dr. Russell and Dr. Armstrong will also contribute papers. Professor Lodge will open the discussion on Electrolysis, and Prof. Schuster, Capt. Abney, and Mr. Shelford Bidwell have already consented to contribute papers on portions of this subject. Dr. Armstrong will be glad to hear from any other gentlemen who may wish to aid in forwarding what promises to be a useful departure.

A TELEPHONE has just been brought to this country from America which is absolutely independent of electricity, so that batteries, coils, and cells are quite dispensed with. This obviously greatly simplifies the working of the instrument, and in the "mechanical telephone," which was recently subjected to a severe test, simplicity and distinctness are claimed as its chief characteristics. The instrument consists of a diaphragm, or sounding-board made of strips of willow wood, which has been found by experiment to possess a remarkable sensitiveness to sound vibrations. These strips of wood are closely woven together and varnished. In the centre of the diaphragm a small disc of metal is placed, from which the wire proceeds to any point desired up to two miles. In recent trials the instrument freely answered to all demands upon it, the ticking of a watch, musical sounds, whispering, &c., being heard with great distinctness.

WE understand the Fishery Board for Scotland, in order to learn further what has been done in other countries for increasing the fish supply, has requested Prof. Cossar Ewart, when on the Continent during the autumn, to visit some of the principal fishing stations in Norway and Sweden. It will be remembered that Prof. Ewart, by visiting at his own expense Canada and the United States last autumn, was able to present to his Board a valuable report on the "Progress of Fish Culture in America." An equally interesting report on the Norwegian fisheries may be expected.

IN accordance with previous announcements the summer meeting of the Institution of Mechanical Engineers will be held at Lincoln on Tuesday, Aug. 4, and the following days of the week. The following papers have been offered for reading and discussion after the address of the President, Mr. Jeremiah Head:—Description of Dunbar and Ruston's steam navvy, by Mr. Joseph Ruston, M.P., of Lincoln; on recent adaptations of the Robey semi-portable engine, by Mr. John Richardson, of Lincoln; description of the Tripier spherical eccentric, by M. Louis Poillon, of Paris; on private installations of electric lighting, by Mr. Ralph H. C. Nevile, of Wellingore; on the iron industry of Frodingham, by Mr. George Dove, of Frodingham; description of an autographic test-recording apparatus, by Mr. J. Hartley Wicksteed, of Leeds. A formidable programme of excursions and visits to various works has been arranged.

WE referred a short time back to a proposed excursion by the Geologists' Association to Belgium, under the direction of MM. Dupont, Gosselet, Purves, and Renard. The monthly circular, giving full details of the arrangements, is now before us, from which we learn that during the six days of the excursion (August 10 to 15) visits will be made to the typical sections of Cambrian, Devonian, and Carboniferous rocks, including the altered rocks of the Ardennes; the Devonian limestones of Roly, &c., which M. Dupont regards as true coral atolls; the grand section of Devonian and Carboniferous limestone along the Meuse; the Grotto of Han, and the Devonian limestones, &c., near Rochefort. The circular contains nine maps and cuts illustrating the geology of Southern Belgium, a table of geological formations, and a list of maps and books relating to the district. There are also full particulars as to routes, fares, &c. A pamphlet on "The Geology of Belgium and the French Ardennes," containing papers by Gosselet, Bonney, Rutot, Van den Broeck, and Topley, has also been prepared by the Association, and is published by Stanford. This gives a fuller account of the literature, and is illustrated by three maps and thirteen cuts.

ON Saturday, July 25, a whole day meeting of the Essex Field Club was held at Witham and neighbourhood. The party, about sixty-five in number, was met at Witham Station by the Vicar, Canon Snell, and after being conducted over the church, an inspection was made of the ancient earthwork surrounding the railway station. A paper on this camp, which is believed to have been constructed by Edward I., was communicated by Mr. F. C. J. Spurrel, who had prepared for distribution a number of printed copies showing the plan of the entrenchments. After lunch at the "Spread Eagle," Witham, an ordinary meeting of the Club was held for the election and proposal of new members, Prof. R. Meldola, in the absence of the President, taking the chair. At the conclusion of the meeting brakes were in attendance, and the party proceeded to Black Notley, passing *en route* through the village of Cressing, where in former times the Knight Templars had a preceptory. The remains of the Temple, now a farmhouse, were inspected by the permission of the present owner, Mr. J. H. Shoolbridge, who had had excavations made in various parts of the grounds in order to expose some of the old brickwork foundations. In the churchyard of Black Notley, by the tomb of John Ray, Prof. G. S. Boulger gave an excellent account of the "Domestic Life of John Ray at Black Notley." Mr. E. A. Fitch followed with an equally interesting account of Ray's labours as an entomologist. The Rector of Black Notley, the Rev. J. Overton, was in attendance in order to conduct the party over the church. In the neighbouring school-room the Rev. F. W. Kenworthy, Vicar of Braintree, had arranged for exhibition a fine collection of flint implements, many of which had been found in the neighbourhood, and some of the palæolithic specimens being of special interest as having been found beneath the chalky boulder clay. After leaving the school-room a visit was paid to "Dewlands," the home of John Ray at Black Notley, by the permission of Mr. Mortier, the present occupier. Proceeding to Faulkbourn, the rector, the Rev. F. Spurrel, conducted the party over the church, and, by the invitation of Capt. Talbot, Faulkbourn Hall was next visited, although the length of the day's programme prevented the club from taking advantage of the hospitality of the owner. After a short ramble through the grounds and an inspection of the hall from the exterior, the party proceeded to Terling Place, where a most hospitable reception was given by Lord and Lady Rayleigh. In the course of the evening Lord Rayleigh addressed the meeting on some mechanical questions involved in the flight of birds, and some of the party were then conducted to the laboratory, where a number of experiments bearing upon his lordship's researches on sound, hydrodynamics, &c., had been arranged for exhibition. Amongst those present at the meeting were Mr. G. J. Symons, F.R.S., Prof. S. P. Thompson, Mr. E. B. Knobel, Sec. R.A.S., Dr. T. Taylor, &c. In carrying out the local arrangements much assistance had been rendered by Mr. W. D. Cansdale.

THE British Medical Association is holding its annual meeting this week at Cardiff.

THE annual meeting of the Belgian Royal Society of Public Medicine, to be held at Antwerp on August 26-30, will this year assume a somewhat international character. The Committee issue a special invitation to its foreign corresponding members, with a view to their taking part in the discussion of the main topic to be submitted to the meeting. That topic is thus formulated:—"What are, in the present state of epidemological science, the most practical international prophylactic measures to be taken, especially in Belgium, against pestilential malaria?'

THE annual meeting of the National Fish Culture Association will take place on Thursday next under the presidency of the Marquis of Exeter, when reference will be made to the Indian and Colonial Exhibition to be held next year, at which the Association is to represent the Fisheries Department, in accordance with the request of the Royal Commissioners.

AT the last meeting of the Seismological Society of Japan (reprinted in the *Japan Gazette*) Dr. Knott read a paper on earthquake frequencies. The writer's aim was to discover, if possible, some satisfactory reason for the winter maximum of frequency. Earthquake statistics show that, wherever there is a marked winter season there is a corresponding increase in seismic action. In searching for possible causes for this periodicity Dr. Knott left out of account purely terrestrial actions, due to the earth's cooling and shrinking, or to the unequal distribution of surface matter as displayed in the arrangement of continents and oceans, for, although these no doubt produce earthquakes, they cannot cause periodicity. This restricts us to such periodic stresses as may result from the tidal actions of the sun and moon, or from the meteorological changes which accompany the sequence of the season. The writer discusses each of these possible causes in turn. Earthquake statistics do not afford us any clear evidence of fortnightly or monthly periods, and on the whole he discards the tidal action of the sun and moon as incapable of explaining the annual period in earthquake frequency. Coming to meteorological causes, the seasonal changes of temperature cannot have any direct effect, as they are inappreciable at a depth of from 20 to 30 feet; storm depressions and wind generally may be left out of account, as the earth is sluggish in responding to short-lived stresses. The attempts that have from time to time been made to connect earthquakes with the indications of the barometer *at the locality* could hardly be expected to lead to any definite result, for we have no right to assume that the earthquake is caused by an external stress applied directly at the origin of the disturbance. We must consider the stresses over a large area inclosing the locality in question. Are there, then, any meteorological phenomena of the necessary period and sufficiently long-continued in their different phases to give rise to stresses to which the earth's crust could reasonably be expected to yield? There seems, Dr. Knott says, to be such a possible cause in the annual oscillations of barometric pressure over land and sea. In cold weather this pressure is high over the land and low over the sea; in warm weather this relation is just reversed. This gives rise to steep gradients, which of course are steepest just where land and sea meet. Japan, for instance, between Siberia and the Pacific, is under one of these steep gradients. This semi-annual see-saw of pressure is very marked in all temperate regions, the steepest gradients always occurring in the winter months. Then, so far as regards the winter excess of pressure, a much more powerful cause than barometric changes is to be found in the snow-fall. If we consider the great winter accumulation of snow in the higher latitudes, especially over continental areas, such as Siberia, we see that the magnitude of the shearing stresses along the region where the snow accumulations cease—that is, along the littoral districts—must be considerable. In lower latitudes, however, this explanation fails us, and the effect of rainfall on account of its non-persistency can hardly be taken into account. Thus there seem only two possible meteorological phenomena which can be regarded as causing the annual periodicity of earthquakes—the snow-fall gradient and the barometric gradient. Of these the accumulations of winter snow over the land surfaces must be regarded as vastly the most potent. It must not be forgotten that in the case of a rigid mass like the earth a slight steady stress may be more effective than a short-lived shock.

ON Thursday the 16th inst. the first annual meeting of the Manchester and District Association of Science and Art Teachers was held in the Manchester Technical School, Mr. W. Gee, agent of the Union of the Lancashire and Cheshire Institutes, presiding. The report showed that "the Committee have endeavoured to diffuse information regarding methods of teaching and apparatus used by good teachers, and that some of the meetings have been very successful." The principal papers of the year had been "On the Science Department's List of Apparatus," "The Honours Examination in Machine Drawing and Building Construction," "Diagram Making," "The Magic Lantern as applied to Science Teaching," and "The True Purposes and Right Pursuit of Art." Visits had also been made to inspect scientific works at the Cheetham College Library and the Manchester Free Reference Library, and also to the Manchester Telephonic Exchange. The officers were appointed for the new year, including the re-election of Prof. Sir Henry Roscoe as President. The chairman drew attention to the subordinate position still occupied by science at several of the public examinations, and it was understood that this subject would be considered by the executive.

AT the half-yearly general meeting of the Scottish Meteorological Society on Monday the following business was transacted:—Report from the Council of the Society; the proposed earthquake observations on Ben Nevis, by Prof. Ewing, Dundee; methods of observing the temperature and humidity of the air (with experiments), by H. N. Dickson, Scottish Marine Station; Prof. Crum Brown exhibited an anemometer for maximum wind-pressure.

A TELEGRAM from Calcutta, July 25, states that three shocks of earthquake have occurred in Runpur, Bengal Presidency, causing serious damage. A village near Nattore has sunk completely into the earth.

A TELEGRAM from Teneriffe announces that a shock of earthquake was felt there on the morning of July 22. No details have yet been received.

MR. C. G. ROOKWOOD prints some notes on American earthquakes in the June number of the *American Journal of Science*, the earthquakes being those which occurred in the preceding year in North and South America. The list contains fifty-four items, not counting the one of Nov. 13. They may be geographically classified thus:—

Canadian Provinces	5
New England	9
Atlantic States	5
Mississippi Valley	7
Pacific Coast	21
West Indies	2
Central America and Columbia	3
Peru	2
Uruguay	1
	55
Deduct for Aug. 10, counted twice ...	1
	54

By seasons they are classified thus:—Winter, 12 (Dec., 2; Jan., 8; Feb., 2); Spring, 15 (March, 8; April, 7; May, 0); Summer, 8 (June, 4; July, 0; Aug., 4); Autumn, 19 (Sept. 4; Oct., 5; Nov., 10; Spring and Summer together, 23, Autumn and Winter together, 31. The following localities were shaken on two or more days:—Los Angeles, Cal., Jan. 4, Jan. 16, Oct. 22; San Francisco, Jan. 25, March 15, 25, July 15, Nov. 12; Oakland, Cal., March 25, April 17, 20; Eureka, Cal., Jan. 27, April 6, 8, 11; Concord, N.H., Aug. 10, Nov. 12, 23. The only shocks causing much damage were Nov. 5, Panama; Nov. 6, Colombia; Nov. 22, Lima, and Aug. 10, Middle States.

WE have received from Stonyhurst College Observatory the "Results of Meteorological and Magnetical Observations for 1884," by the Rev. S. J. Perry, F.R.S. The work done at this observatory becomes more and more valuable every year. Of the solar surface 281 drawings were made during the year and 88 complete measures of the chromosphere. The spectra of sun-spots have been measured on 30 days, and the widening of 200 lines between B and D accurately measured.

A MEETING of the Washington Philosophical Society not long ince took the form of a symposium, in which various members gave answers to the question: "What is a glacier?" The following are the various definitions given; but it should be mentioned that there are explanations and suggestions in most cases which we have not space to reproduce in full. "An ice-body, originating from the consolidation of snow in regions where the secular accumulation exceeds the loss by melting and evaporation—*i.e.* above the snow-line—and flowing to regions where the loss exceeds supply—*i.e.* below the snow-line" (*Mr. Russell*); "A river of ice, possessed, like the aqueous river, of movement and plasticity" (*Mr. Emmons*); "A mass of ice with definite lateral limits, with motion in a different direction, and originating from the compacting of snow by pressure" (*Mr. W. H. Dall*); other members did not attempt such precision of expression. Mr. Chamberlin pointed out that hard-and-fast lines of demarcation do not prevail in nature, but rather gradations of character. The terms névé and glacier were probably used by guides and travellers for convenience. "There is an area of growth and an area of waste to every glacier; superficially the area of growth coincides with the névé; the area of waste is that of the glacier proper." Mr. McGee said that as glacier ice and névé ice belonged to a graduating series, the two phases can only be arbitrarily discriminated. "Perhaps the most satisfactory line of demarcation detectable is the snow-line, above which the superficial *débris* is buried by precipitation, and below which it is exposed by ablation."

WE have to acknowledge the receipt of the third Biennial Report of the Central Station of the Java Weather Service, as well as of various quarterly reports and monthly bulletins issued by Dr. Hinrichs, the director. The appropriation for the work is very small, but there appears to be a large number of volunteer observers all over the State. In a foot-note to a list of these the director notices the death of one of his volunteers with the following epitaph:—"Died, June 10, 1882. He was a most painstaking observer, furnishing good reports in fine handwriting."

A FEW days ago a salmon weighing 28 lbs. was netted at Jomfruland, in the Christiania Fjord, which was marked under the left fin with a straight line and a Latin A. Probably the line was meant for an I, making the marking I A.

MR. JOHN WHELDON, of Great Queen Street, has sent us Part I. of his Catalogue of Botanical Works. It extends to 84 pages and contains 1306 entries.

In a paper read before the last meeting of the French Academy of Medicine M. Lagneau described his researches into the anæsthetics employed in Europe by physicians in the Middle Ages. That such were known is beyond any doubt. Abelard, speaking of the creation of Eve from a rib of Adam, speaks of the deep sleep which fell upon the latter as similar to that which physicians produce in patients upon whom they wish to operate. Pliny speaks of a stone of Memphis which, when crushed and treated with vinegar, renders any part to which it is applied insensible to pain; and many old authors speak of surgeons producing sleep in their patients before an operation by mixing with their food a decoction of the leaves or root of the mandragora, or some grains of the plant called "morion." Preparations of these two plants, as well as of other narcotics, were employed by surgeons down to the thirteenth and fourteenth centuries, but much less in subsequent times. Opium was also used for a similar purpose, while in the East the anæsthetic properties of hemp have been known from the earliest times. These were all taken into the stomach; but anæsthesia by inhalation was also known. Two different preparations were discovered in the thirteenth century: one by a Dominican of Rome, the other by a surgeon named Theodoric, who was also a preaching friar, and subsequently a bishop. Both of these were prepared from opium, henbane, mandragora, hemlock, and many other plants, and were inhaled from a sponge. It is, however, difficult to believe that preparations so little volatile could produce anæsthesia by simple inhalation. M. Perrin, who has studied ancient anæsthetics, has given the composition of a liquid which contains all the ingredients required for chloroform, and it is said that this was applied to witnesses or prisoners who were about to be tortured in the judicial tribunals of the Middle Ages. After inhaling it the unfortunate subject was plunged into a semi-comatose state, which diminished in a certain degree the pain of the torture. This liquid was always kept in a place adjoining the torture-chamber.

The additions to the Zoological Society's Gardens during the past week include a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. H. Grant; two Great Eagle Owls (*Bubo maximus*), European, presented by Mr. E. G. Carpenter; a Common Peafowl (*Pavo cristatus*) from India, presented by Miss Rowland; an Indian Shama (*Copsychus macrurus*) from India, deposited; an Axis Deer (*Cervus axis*), two Squirrel-like Phalangers (*Belideus sciureus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

Tuttle's Comet.—In No. 2674 of the *Astronomische Nachrichten*, published during the last week, are elements and an ephemeris of this comet, by Herr Johannes Rahts of Königsberg. The orbit has been deduced from the observations of 1858 and 1871–2, with perturbations by Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and Uranus to July 11, 1885. Under such conditions it may be anticipated that Herr Rahts' ephemeris will closely represent the track of the comet. His elements are as follows:—

Perihelion passage, 1885, September 11·14265 G.M.T.

Longitude of perihelion	116 28 58·8	M. Eq. 1890·0
,, ascending node ...	269 42 1·5	
Inclination	54 19 45·5	
Angle of eccentricity	55 14 22·6	
Mean daily motion	257″·8648	
Log. semi-axis major	0·7590765	

Motion—direct.

Hence we have—

Eccentricity	0·8215436	Semi-axis major ...	5·7422
Perihelion distance	1·02475	,, minor ...	3·2739
Aphelion distance...	10·4596	Semi-parameter ...	1·8666

Period of revolution, 13·76 years.

Tuttle's comet was first seen by Méchain at Paris on January 9, 1790, and was observed there till February 1. Parabolic elements calculated by Méchain did not lead to any suspicion of ellipticity of orbit. On January 4, 1858, Mr. Tuttle, of Cambridge, U.S., discovered a comet, which was independently detected by the late Prof. Bruhns a week afterwards, and its orbit was found to present so close a resemblance to that of the second comet of 1790 as to immediately lead to the comets being considered identical, the identity being established by Bruhns, who found that five revolutions had been completed between 1790 and 1858. The dates of perihelion passage in this interval were thus determined by Clausen after taking into account the perturbations produced by the planet Jupiter—

	G.M.T.		G.M.T.
1790, January	30·87	1830, December... ...	6·64
1803, November ...	7·27	1844, June	28·96
1817, May	18·76	1858, February	23·52

The comet was not recognised at any one of the four intermediate returns.

From Herr Rahts's ephemeris we have the following positions during the absence of moonlight in August:—

At Greenwich Midnight

1885	R.A. h. m. s.	Decl. ° ′	Log. Dist. from earth	Intensity of light
August 6	7 13 27	+29 48·1	0·2853	0·39
7	7 16 51	29 12·7		
8	7 20 14	28 36·6	0·2816	
9	7 23 36	27 59·9		
10	7 26 56	27 22·7	0·2780	0·42
11	7 30 16	26 44·7		
12	7 33 35	26 6·3	0·2744	
13	7 36 54	25 27·3		
14	7 40 12	24 47·7	0·2708	0·46
15	7 43 28	24 7·4		
16	7 46 43	23 26·6	0·2674	
17	7 49 59	22 45·3		
18	7 53 13	22 3·5	0·2640	0·49
19	7 56 27	21 21·1		
20	7 59 40	20 38·0	0·2607	
21	8 2 53	19 54·5		
22	8 6 5	19 10·5	0·2575	0·52
23	8 9 16	18 25·9		
24	8 12 27	+17 40·8	0·2544	

The intensity of light when the comet was first observed at Marseilles at its last appearance, October 12, 1871, is taken as unity. On September 10 it will be 0·55, the comet rising two hours before the sun. It must always be faint at its present return, so much so probably as to render observation difficult.

The New Comet (Barnard, July 7).—From observations on July 9, 12, and 15 the following elements result:—

Perihelion passage, 1885, September, 20·6740 G.M.T.

Longitude of perihelion	290 10·5
,, ascending node	93 27·1
Inclination	76 6·1
Log. perihelion distance...	0·36549

Motion—direct

An orbit calculated by Dr. Holetschek, of Vienna, much resembles the above.

It would appear that the perihelion distance of this comet may prove to be greater than in the case of any other comet hitherto computed, excepting the extraordinary one of 1729, which did not approach the sun within four times the earth's mean distance.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *AUGUST* 2–8

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 2

Sun rises, 4h. 27m.; souths, 12h. 5m. 58·2s.; sets, 19h. 45m.; decl. on meridian, 17° 40′ N.: Sidereal Time at Sunset, 16h. 31m.

Moon (at Last Quarter on August 3) rises, 21h. 56m.*; souths, 4h. 29m.; sets, 11h. 13m.; decl. on meridian, 5° 34′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 6 ...	13 50 ...	20 34 ...	7 56 N.
Venus ...	6 41 ...	13 42 ...	20 44 ...	11 14 N.
Mars ...	0 59 ...	9 19 ...	17 39 ...	23 50 N.
Jupiter ...	7 5 ...	13 57 ...	20 49 ...	9 21 N.
Saturn ...	1 20 ...	9 30 ...	17 40 ...	22 30 N.

* Indicates that the rising is that of the preceding day.

Occultation of Star by the Moon

August	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
6 ...	B.A.C. 1526 ...	6 ...	3 32 ...	3 56 ...	129 174

August	h.	
4 ...	21 ...	Mercury in conjunction with and 2° 32′ south of Jupiter.
5 ...	17 ...	Saturn in conjunction with and 0° 4′ south of μ Geminorum.
6 ...	3 ..	Mercury at greatest elongation from the Sun, 27° East.
6 ...	7 ...	Venus in conjunction with and 0° 26′ north of Jupiter.
6 ...	20 .	Mars in conjunction with and 1° 20′ north of Saturn.
7 ...	8 ...	Mercury at greatest distance from the Sun.
7 ...	14 ...	Saturn in conjunction with and 4° 13′ north of the Moon.
7 ...	15 ...	Mars in conjunction with and 5° 33′ north of the Moon.
8 ...	17 ...	Mercury in conjunction with and 3° 42′ south of Venus.

GEOGRAPHICAL NOTES

LIEUTENANT PALAT, of the French Cavalry, has been despatched by the Ministers of Public Instruction and of Commerce on a mission to the Sahara, his point of departure being Senegal and his terminus Algeria. The advanced posts recently occupied by the French in the Senegal, and the presence of a gunboat on the Niger, are believed to render the present a favourable moment for such an expedition. At Timbuctoo Lieutenant Palat will appear as a French officer, but from this place to Algeria he will travel as a Moslem doctor. His mission, though of geographical interest, appears to be undertaken chiefly with the object of leading the trade of the Sahara to Senegal on one side and to Algeria on the other.

AT the meeting of the Paris Geographical Society on the 3rd inst. M. Lostalot, French Consul at Jeddah, described in detail the circumstances attending the murder of M. Huber; a letter was read from M. Teisserenc de Bort continuing his account of his expedition in the Sahara; M. Jules Girard discussed the changes of level on the coasts of Scandinavia, and M. Demanche read a paper on the half-breeds of Canada, with especial reference to the recent revolt.

THE Spanish Government has appointed a geological commission, of which Señor Abella y Casariego is the president, to investigate the Philippines. The commission will not confine itself to geology, but will also study the geography and topography of the archipelago; and it is instructed to prepare a map which will complete and correct existing ones.

THE last *Bulletin* of the Royal Geographical Society of Antwerp (June IX. 6th fascicule) contains a report of the proceedings at the reception of Mr. Revoil on his return from the Somali country, and an interesting reprint of the diary of a journey from Antwerp to Vienna and back in 1724, made by representatives of a commercial corporation at Ostend to obtain certain alterations in the letters patent granted by the Emperor Charles VI.

A CORRESPONDENT writes:—In your note on Mr. Grenfell's recent explorations in the Congo Basin you state that the northern bend of the Congo is found by him to be in 2° 11′ N. This had already been found by Stanley; *vide* the map in his recently-published book. You also note that the Mbangi River has been traced by him to a point in 4° 30′ N. lat., lying north-by-east (magnetic?) of its mouth in 0° 26′ to 0° 42′ S. lat. At this ultimate point its breadth is stated to be 673 yards. Now the breadth of the River Thames at Gravesend is considerably greater, and its source in a direct line from Gravesend westward is about 105 miles, the drainage area being, in round figures, 5000 square miles. Arguing from this we should conclude that the source of the Mbangi does not lie east of 20° E. long., and, applying the measurements to Stanley's map, the water parting falls just on the line thereon suggested. The distance in a direct line from the ultimate point reached by Mr. Grenfell to the last known point on the Welle is 540 miles, and to the source of the Welle some 900 miles. Judging, then, from this preliminary note, it appears to be practically impossible for this river, of less than the third of a mile in breadth, to carry off the water of the Welle Basin; and Mr. Stanley's suggestion that the Biyere (wrongly called the Aruwimi) is the outlet of the Welle is rather strengthened than otherwise by this latest, and certainly not least important, contribution to our knowledge of the mighty Congo.

A SOMEWHAT amusing quarrel has arisen between the parishes of Kjelvik and Maasö about a point of considerable geographical interest—viz. the proprietorship of the North Cape. It is caused by the establishment on the celebrated promontory of a *restaurant*, the taxes of which are claimed by both parishes. The Cape has always been considered to form the boundary between the two, without it being stipulated to whom it actually belonged.

The Deutsche Seewarte has issued a chart of the ice in the Atlantic Ocean this spring, which, as it may be remembered, penetrated very far south and east in consequence of continuous northerly and north-westerly winds. Several icebergs appear even to have been found in the Gulf Stream. It seems from experience that, first towards the end of June the ice recedes northwards, while between the banks and the east coast of Newfoundland it remains longest, even after it has disappeared south and south-east of the banks.

FROM recent observations it would appear that during the last thirty years or so the elevation of the shores around the Baltic and the Gulf of Bothnia has gone on with greater rapidity than during the previous period of observation. The shore-marks by which the fact of the elevation has been ascertained were made about the year 1750, at the time of the dispute between Celsius, the celebrated Swedish astronomer, and a German man of science as to whether the level of the Baltic was rising or sinking, Celsius maintaining the latter view. Since the shore-marks were made it has been shown that a movement of elevation of the land has been going on around the island of Bornholm, the level of which remains constant. The rate of emergence is most rapid in the north. In the neighbourhood of the frontier of Finland it amounts to two metres, while in the south it is only a foot. The increased rate of emergence in recent times is clearly shown on the rock known as Stora Reppen, not far from Piteå. That rock in 1851 had emerged 94 cm. above its former level since the commencement of the observations, while in August, 1884, it had risen 50 cm. further.

THE Geographical Society of Australasia has, it is stated, completed arrangements for the exploration of New Guinea, and a fully-equipped expedition has started under the leadership of Capt. Everill.

THE HIGHER MATHEMATICS

PROF. G. MITTAG-LEFFLER, principal editor of the *Acta Mathematica*, forwards us the following communication, which will shortly appear in that journal:—

His Majesty Oscar II., wishing to give a fresh proof of his interest in the advancement of mathematical science, an interest already manifested by his graciously encouraging the publication of the journal *Acta Mathematica*, which is placed under his august protection, has resolved to award a prize, on January 21, 1889, the sixtieth anniversary of his birthday, to an important discovery in the field of higher mathematical analysis. This prize will consist of a gold medal of the eighteenth size bearing his Majesty's image and having a value of a thousand francs, together with a sum of two thousand five hundred crowns (1 crown = about 1 franc 40 centimes).

His Majesty has been pleased to entrust the task of carrying out his intentions to a commission of three members, Mr. Carl Weierstrass in Berlin, Mr. Charles Hermite in Paris, and the chief editor of this journal, Mr. Gösta Mittag-Leffler in Stockholm. The commissioners having presented a report of their work to his Majesty, he has graciously signified his approval of the following final propositions of theirs.

Having taken into consideration the questions which from different points of view equally engage the attention of analysts, and the solution of which would be of the greatest interest for the progress of science, the commission respectfully proposes to his Majesty to award the prize to the best memoir on one of the following subjects:—

1. A system being given of a number whatever of particles attracting one another mutually according to Newton's law, it is proposed, on the assumption that there never takes place an impact of two particles, to expand the coordinates of each particle in a series proceeding according to some known functions of time and converging uniformly for any space of time.

It seems that this problem, the solution of which will considerably enlarge our knowledge with regard to the system of the universe, might be solved by means of the analytical resources at our present disposition; this may at least be fairly supposed, because shortly before his death Lejeune-Dirichlet communicated to a friend of his, a mathematician, that he had discovered a method of integrating the differential equations of mechanics, and that he had succeeded, by applying this method, to demonstrate the stability of our planetary system in an absolutely strict manner. Unfortunately we know nothing about this method except that the starting-point for its discovery seems to have been the theory of infinitely small oscillations.[1] It may, however, be supposed almost with certainty that this method was not based on long and complicated calculations, but on the development of a simple fundamental idea, which one may reasonably hope to find again by means of earnest and persevering study.

However, in case no one should succeed in solving the proposed problem within the period of the competition, the prize might be awarded to a work in which some other problem of mechanics is treated in the indicated manner and completely solved.

(2) Mr. Fuchs has demonstrated in several of his memoirs[2] that there exist uniform functions of two variables which, by their mode of generation, are connected with the ultra-elliptical functions, but are more general than these, and which would probably acquire great importance for analysis, if their theory were further developed.

It is proposed to obtain in an explicit form those functions whose existence has been proved by Mr. Fuchs, in a sufficiently general case, so as to allow of an insight into and study of their most essential properties.

(3) A study of the functions defined by a sufficiently general differential equation of the first order, the first member of which is a rational integral function with respect to the variable, the function, and its first differential coefficient.

Mr. Briot and Mr. Bouquet have opened the way for such a study by their memoir on this subject (*Journal* de l'École polytechnique, cahier 36, pp. 133-198). But mathematicians acquainted with the results attained by these authors know also that their work has not by any means exhausted the difficult and important subject which they have first treated. It seems probable that, if fresh inquiries were to be undertaken in the same direction, they might lead to theorems of high interest for analysis.

(4) It is well known how much light has been thrown on the general theory of algebraic equations by the study of the special functions to which the division of the circle into equal parts and the division of the argument of the elliptic functions by a whole number lead up. That remarkable transcendant which is obtained by expressing the module of an elliptic function by the quotient of the periods leads likewise to the modulary equations, that have been the origin of entirely new notions and highly important results, as the solution of equations of the fifth degree.

[1] See p. 35 of the Panegyric on Lejeune-Dirichlet by Kummer, "Abhandlungen der K. Akademie der Wissenschaften zu Berlin," 1860.

[2] These memoirs are to be found in—(1) "Nachrichten von der K. Gesellschaft der Wissenschaften zu Göttingen," February, 1880, p. 170; (2) Borchardt's "Journal," Bd. 89, p. 251 (a translation of this memoir is to be found in the "Bulletin" of Mr. Darboux, 2me. série, t. iv.); (3) "Nachrichten von der K. Gesellschaft der Wissenschaften zu Göttingen," June, 1880, p. 445 (translated into French in the "Bulletin" of Mr. Darboux. 2me série, t. iv.); (4) Borchardt's "Journal," Bd. 90, p. 71 (also in the "Bulletin" of Mr. Darboux, 2me série, t. iv.); (5) "Abhandlungen der K. Gesellschaft der Wissenschaften zu Gottingen," 1881 ("Bulletin" of Mr. Darboux, t. v.); (6) "Sitzungsberichte der K. Akademie der Wissenschaften zu Berlin," 1883, i. p. 507; (7) The memoir of M. Fuchs published in Borchardt's "Journal," Bd. 76, p. 177, has also some bearings on the memoirs quoted.

But this transcendant is but the first term, a particular case and that the simplest one of an infinite series of new functions introduced into science by Mr. Poincaré under the name of "fonctions fuchsiennes," and *successfully* applied by him to the integration of lineary differential equations of any order. These functions, which accordingly have a *rôle* of manifest importance in analysis, have not as yet been considered from an algebraical point of view as the transcendant of the theory of elliptic functions of which they are the generalisation.

It is proposed to fill up this gap and to arrive at new equations analogous to the modulary equations by studying, though it were only in a particular case, the formation and properties of the algebraic relations that connect two "fonctions fuchsiennes" when they have a group in common.

In case none of the memoirs tendered for competition on any of the subjects proposed above should be deemed worthy of the prize, this may be adjudged to a memoir sent in for competition that contains a complete solution of an important question of the theory of functions other than those proposed by the Commission.

The memoirs offered for competition should be furnished with an epigraph and, besides, with the author's name and place of residence in a sealed cover, and directed to the chief editor of the *Acta Mathematica* before June 1, 1888.

The memoir to which his Majesty shall be pleased to award the prize as well as that or those memoirs which may be considered by the Commission worthy of an honorary mention, will be inserted in the *Acta Mathematica*, nor can any of them be previously published.

The memoirs may be written in any language that the author chooses, but as the members of the Commission belong to three different nations the author ought to subjoin a French translation to his original memoir, in case it is not written in French. If such a translation is not subjoined the author must allow the Commission to have one made for their own use.

THE EDITORS OF THE "ACTA MATHEMATICA"

DR. PERKIN ON THE COAL-TAR COLOURS[1]

TAKING a precedent from some of those who have occupied this chair before me, I have selected for my few remarks to-day the subject in relation to Technical Chemistry, with which I have been personally connected—namely, the colouring matters produced from coal-tar products, with some of the lessons its development appears to me to teach is in connection with industrial chemistry. Sir Frederick Abel, in his address in 1883, when speaking of the history of gunpowder, said that "It is one of the most remarkable features connected with the history of gunpowder, that until the last quarter of a century no radical changes should have been introduced into the manufacture and modes of applying this, the first known practically useful explosive agent." It appears to me that this is more or less true of all the older industries, which resulted simply from experiment and observation without any other basis to work from. They have had long histories in which little progress has been made, but of late years, owing to our advanced and rapidly increasing scientific knowledge, they are undergoing great, and in many cases radical, changes.

The coal-tar colour industry stands in a very different position to our older ones. It has a sharply-defined origin, and a very short history dating back only to 1856, and it is not yet twenty-nine years since the date of the first patent. It is an industry which has been founded on scientific discovery, and has developed side by side with it, being in fact a most important handmaid to research, which in its turn has repaid it by new discoveries. At the date of its introduction very little was known of the chemistry of colouring matters; they were always found difficult bodies to investigate, and when produced in reaction were generally regarded as secondary products, and every endeavour was made to get rid of them so that the other products associated with them might be examined; but now, owing to the very extended study which has been made of these bodies, on account of this industry, and the relationships which have been found to exist between the colour of the compounds and the chemical constitution, it is possible with more or less certainty to predict the colour a compound will have before it is produced, and the means which can be used to modify it.

[1] The President's address, Institute of Chemistry.

It will be impossible for me to give you but a very brief sketch of the history of this industry in the time at my disposal; anything like a complete account would fill volumes. On account of this I shall not be able to refer except casually to the coal-tar industry itself, the development of which is nearly entirely due to the one under consideration. Nor can I give a consecutive account of the coal-tar colours themselves, because the discovery of new series of colouring matters, and the progress of old ones, necessarily produce overlapping as it were, and renders such a course difficult and confusing. I therefore propose to take them according to the groups we now know them to belong to. I will therefore commence with that which contains the first colouring matter connected with this industry—mauvein and safranine group of compounds.

As I already mentioned, the coal-tar colour industry dates from 1856, the discovery of the aniline purple or mauve dye being made during the Easter vacation of that year, and the patent for its production taken out on the 26th of the following August. From the accounts I have already given elsewhere, I have mentioned how the discovery of this colouring matter was made during the prosecution of scientific research, which had for its object the artificial production of quinine, a subject which of late has very much occupied the attention of chemists, though it has not as yet been accomplished.

When commencing this industry, which was looked upon by many with considerable doubt as to its practicability, the difficulties encountered were very numerous on account of its unique character, but few of the processes having their representatives in other industries, the products were also very valuable, so that great care had to be employed with them. The success of the product tinctorially had not been proved on the large scale, so that it was necessary to proceed tentatively and not launch out too rapidly.

Aniline, as is well known, was at this period a rare body, originally obtained from indigo by Unverdorben in 1826, but for its production from benzene we are first indebted to the discovery of nitrobenzenein 1834 by Mitcherlich, and then to Zineri, who found that this substance when submitted to certain reducing agents produced a base which was eventually identified as aniline. It was not long before the date of this industry that a method of producing this base from nitrobenzene, with greater ease than by the process of Zinin, was discovered; and it is to Beauchaump we are indebted for this, who found that the reduction might be easily accomplished by means of iron filings and acetic acid. Had this discovery not been made, aniline could not have been produced sufficiently cheap to be used for the production of colouring matters. And it is interesting to note that this process of Beauchaump, slightly modified, is the one used to-day for the production not only of this base, but its homologues and analogous compounds.

It was not long before the difficulties of producing nitrobenzene were to a great extent overcome. Messrs. Simpson, Maule & Nicholson also began to experiment on the production of nitrobenzene, and after a time were able to produce it at a sufficiently low cost to be able to supply us with part of our requirements. I mention this in passing because it was the starting point of the history of the connection of this firm with artificial production of colouring matter, which they carried on so successfully afterwards.

After the mauve was discovered it was necessary to teach dyers how to use it. Being an organic base, it is opposite in properties to the vegetable colouring matter, and therefore the ordinary methods of application were not generally useful, and much time had to be spent in dyehouses and printworks in the early days of this product in reference to this subject, and at that time the question of fastness to light soap and bleaching liquor was much insisted on. Fortunately for the future of the coal-tar colour industry, although the mauve would not resist bleaching liquor well, it proved to be a very fast colour—the fastest purple yet produced, I believe—and thus its introduction became rapid. After this the love of brilliancy of colour which it had induced caused less attention to be given to the subject of fastness. I quite think that had this, the first coal-tar colouring matter, yielded colours as fugitive as some which have since been used, this industry would probably have been, to say the least, much delayed in its progress; so that it will be seen the mauve had to bear all the burdens of the difficulties incident on the inauguration of this industry, the future products being free from these impediments. The importance of this colouring matter after its success was established was quickly recognised in France, and its manufacture commenced there. This soon resulted in its importation into this country irrespective of patent rights. As, however, the foreign manufacturer employed responsible agents in this country, the law was without difficulty put into operation successfully—unfortunately, however, only to teach Continental manufacturers the lesson not to employ responsible agents in this country any longer, but, by means of correspondence or travellers, to deal directly with the consumers, and this *modus operandi* (practically, though perhaps not theoretically) enabled them to ignore the existence of patents, and import their products freely into this country. On this point I shall have to speak again further on. The mauve was first employed in silk dyeing in London, Mr. Thomas Keith & Sons, of Bethnal Green, being the first to use it. The second application was calico printing, Messrs. James Black & Co., of Glasgow, being the first to employ it largely for this purpose. It afterwards was extended to other trades.

With reference to the chemical history of this dye, although it had been submitted to analysis very soon after its discovery, its formula, or rather the formula of its principal constituent "mauvein," was not established until some time after it had become a commercial product, and was prepared in a crystalline condition. It was then shown to have the composition $C_{27}H_{24}N_4$ (*Proc. R. S.* xiii. 170).

It was found to be a very powerful base, decomposing ammonia salts with evolution of ammonia, and combining with carbonic acid to form a carbonate. Its ordinary salts are produced by its combination with one molecule of a mono-basic acid, its hydrochloride being $C_{27}H_{24}N_4HCl$.

In concentrated sulphuric acid it dissolves with a dirty green colour, changing to blue on slight dilution, and back to purple when thoroughly diluted; this is a distinctive reaction of this class of substance. Further researches have shown (*J. Chem. Soc.* xxxv. 717-732) that in the ordinary colouring matter there are two other compounds, one which is remarkable for its solubility, and from analysis appears to have the composition $C_{24}H_{20}N_4$; and the third, which has not been fully examined, possesses a redder shade of purple than the other.

The first product, or mauvein, is evidently a derivative of paratoluidine and aniline. The third of orthotoluidine and aniline, and the second of pure aniline. This has been called pseudo-mauvein. It might perhaps be better called phenol-mauvein.

When boiled with aniline mauvein yields an indigo-blue product, difficultly soluble in alcohol. This change takes place without formation of ammonia, and shows how different mauvein is in its character to rosaniline.

Runge found that aniline, when treated with dilute chloride of lime, yielded a blue- or violet- coloured solution, which soon underwent change. Some experiments on this, made in 1868 (*J. Chem. Soc.* xxii. 25-27), showed that the product which I termed "Runge's blue," was a peculiar compound, the salt of an organic base, which itself dissolved in alcohol with a reddish brown colour, the salts being blue. It is quite different from mauvein, and of no practical value; but what is interesting is that when exposed to heat, as by boiling a solution of one of its salts, it decomposes with formation of mauvein.

A beautiful colouring matter was obtained from mauvein by treating it with ethylic iodide. It gives shades of colour of a very red purple tint, and it was therefore called dahlia. It was mostly used in calico and delaine and other kinds of printing, but being costly, the production was never very large. This substance is a mono-ethylic derivative of mauvein, and all attempts to further ethylate this compound have proved fruitless. In properties it appears to be more like an ammonium compound than a replacement product.

Safranines.—In the preparation of mauvein, a colouring matter was obtained from the liquors, from which it was precipitated, producing beautiful crimson-red shades of colour on silk. The amount produced in this way was so small, however, that we are even not able to introduce it as a dye. But it was found that it could be produced by the oxidation of the mauve dye itself, and was then manufactured under the name of "aniline pink," but afterwards "safranine." This substance is evidently closely related to mauvein, as it gives the characteristic reaction with sulphuric acid I have already referred to.

The preparation of this from the mauve dye was, however, too costly to allow of its being brought into general use. However, new processes have been since discovered, by which this or other colouring matters of its class can be produced cheaply.

The first of these processes consisted in passing nitrous acid into commercial aniline, and then heating the mixture with arsenic acid, and then extracting the colouring matter produced. Hofmann examined this, and showed that it had the formula $C_{21}H_{20}N_4$ (*Ber.* vi. 526, 1872).

The examination of the product which was obtained by oxidising the mauve dye, I found to have the composition, $C_{20}H_{18}N_4$ (*J. Chem. Soc.* xxxv. 731), results which correspond with analyses published by Dale and Schorlemmer (*J. Chem. Soc.* xxxv. 682), obtained from the examination of a similar product. This substance, I found, was associated with that examined by Hofmann in a product prepared by Messrs. Guinon & Co., of Lyons.

Methods of a more synthetical nature have since then been discovered. O. Witt found that safranine could be obtained from orthoazotoluene and hydrochloride of toluene at 150-200° (*Ber.* x., 874, 1877). He then found that by oxidising a mixture of one part of paraphenylenediamine, and two parts of aniline, on the application of heat a safranine could be obtained which has the formula, $C_{18}H_{16}N_4$, and which is called phenosafranine.

The formation of this colouring matter by this and other processes has been studied by Nietzki (*Ber.* xvi. 464). He finds that the aniline in the reaction, in which paraphenylenediamine takes part, may be substituted by other primary monamines, or a mixture of these with dimethylaniline, and thus a large number of these dyes can be obtained.

Phenosafranine is now produced very largely, and in a pure crystallised condition, and is a very useful dyeing agent.

If we assume that all the safranines are strictly homologous compounds, the formula that Nietzki gives for phenosafranine would make the formula of that examined by Hofmann, and that examined by myself and Dale and Schorlemmer, to be incorrect, and that they should contain two hydrogens more than are assigned to them. This I cannot think is possible from all the analytical results we obtained.

The constitution of mauvein has not yet been established, and I have still experiments on this subject in hand. This may also be said of safranine, I think, although Nietzki has proposed a formula for it, in which nitrogen occupies a similar position to the metharacarbon in the rosaniline series.

Triphenylmethane Derivatives.—We must now go back again to the early days of this industry to consider the next class of compounds—viz., triphenylmethane derivatives.

The industrial success of the mauve dye caused aniline to become a very favourite body to experiment with, and the result was that in 1859, the discovery of that important colouring matter first known as fuchsine or magenta took place. Hofmann had observed in his experiments on the action of carbon tetrachloride on aniline in 1858, the formation of a red colouring matter, which consisted of this substance as a secondary product of the reaction, but it was M. Verquin who first discovered a process for the transformation of aniline into a red colouring matter of tinctorial value. This discovery of the compound marks a most important fresh departure in the history of coal-tar colours. As I mentioned, the mauve had paved the way for future colouring matters, and this new substance, which could be applied to fabrics by the same methods as the mauve, was most eagerly sought after owing to the brilliancy of its colour; and probably its manufacture was one of the most successful financially of all the aniline colours.

M. Verquin's process, which consisted in treating tin tetrachloride with commercial aniline, was soon superseded by better processes. The number of patents taken out for the production of this dye was very large, and all imaginable products were claimed as capable of producing it from aniline. The two most important, however, were those in which mercury nitrate and arsenic acid were used. The first of these processes, with which I had some experience, required much care to regulate the reaction and prevent deflagration. The next process with arsenic acid, known as medlocks, was by far the best, and was used very extensively until the last few years, the use of nitrobenzene as the oxidising agent being now mostly used in the place of arsenic aicd.

The manufacture of magenta, which at this period was often called roseine, was carried on chiefly in this country by Messrs. Sampson, Maule, & Nicholson, by the arsenic acid process. Mr. E. C. Nicholson and Dr. A. P. Price, of this firm, worked out the process with great success, and were the first to produce this colouring matter in a pure state. The beautiful display of the crystallised acetate, shown at the Exhibition of 1862, illustrated this fully.

It was with products supplied by Mr. Nicholson that Dr. Hofmann made his first researches on this colouring matter. He changed its name from roseine to *rosaniline*, and found that the base, when in combination with acids, had the formula $C_{20}H_{19}N_3$.

The important observation of Nicholson, and the critical experiments of Hofmann, on the necessity of using, not pure aniline, but a mixture of aniline and toluidine for the production of this substance, was made about this period.[1]

The next important step in this industry was the use of rosaniline itself as a source of new colouring matters. For this we are indebted to the experiments of two French chemists—viz., MM. Gerard and Delaire, who discovered that rosaniline salts, when heated with aniline, gave violet and blue colouring matters, which they called Violet Imperial and Bleu de Lyon. It is, however, to Mr. Nicholson that the credit of producing these bodies, in a practically pure state, belongs. This especially refers to the blue, the product known as opal blue, used by Dr. Hofmann in his investigations on the subject, being of great purity. Dr. Hofmann showed that these products were phenylated rosanilines, as is now well known, ammonia being given off in the reaction. And I may mention in passing that the manufacture of these blues is now carried on to such a large extent that the ammonia produced in this reaction is collected for the production of its sulphate or other salt.

One of the difficulties in the way of the new blue was its insolubility in water. Mr. Nicholson, however (in 1862), probably thinking of the method used to render indigo soluble, experimented upon the action of sulphuric acid in this compound, and he found that it was possible to obtain sulphonic acids from it. One of these, the sodium salt of which is known as "Nicholson's" or "alkali blue," is the monosulphonic acid, which is itself insoluble in water, but forms soluble salts, which can be applied to the goods, and then decomposed by acids. This compound has had much to do with the successful introduction of this colouring matter. The other product known as soluble blue is the sodium salt of trisulpho acid.

In the early part of 1864 the Hofmann violets were introduced. These, as is well known, are the ethylated rosanilines produced by acting upon rosaniline with ethyliodide. These colouring matters are more brilliant, though much more fugitive than mauvein; but by this time the desire for permanency was giving way very much to that of brilliancy; and these colouring matters were quickly taken up by dyers and calico printers.

About this time some colouring matters derived from phenol were introduced, and which, curiously, are found to belong to the class of substances now under consideration. These were brought forward by Messrs. Guinon, Marnas, and Bonnet, of Lyons. The first product was aurine, prepared from phenol by means of oxalic and sulphuric acid (Kolbe and Schavtt's process). The next was polvuine, obtained by acting upon aurine with ammonia. The third was azuline, prepared by heating aurine with aniline. This last was a blue dye, which has since been shown to consist chiefly of triphenylrosaniline.

Purple and violet derivatives were also obtained from rosaniline by a process of my own, in which brominated turpentine was employed. These were known as Britannia violets, and were much used.

Other coloured derivatives were also discovered; for example, by the action of aldehyde and sulphuric acid, a blue product was obtained, which, when treated with sodium hyposulphite or sulphuretted hydrogen water, yielded the well-known aldehyde green.

On examining the action of acetylchloride on Britannia violet, I obtained a peculiar green, which was used principally by calico printers, and very considerable quantities of acetylchloride were prepared for this purpose. The process was not published. This green was of a blue shade, and was obtained in a crystallised condition in combination with picric acid. The crystals had a golden metallic reflection.

Soon after this it was noticed that a green compound was produced in the preparation of the Hofmann violets, though generally only in small quantities. It was afterwards found that by making rosaniline react with an excess of methylic iodide that it could be produced practically. It was called iodine green; but the product now manufactured is a chloride. This colouring matter gave good candle-light greens. One of

[1] In my original patent it was shown that colouring matters could be obtained, not only from aniline, but also from toluidine xylidine and cumidine.

its peculiarities is that when heated it is converted into violet methyl-rosaniline, with loss of methyl-chloride.

A new method of producing rosaniline violet was proposed by Lauth, and patented by MM. Porrier and Chappat, in June, 1866. The process consisted in taking aniline, in which hydrogen had been replaced by an alcohol radical, and oxidising this instead of first preparing rosaniline, and then replacing the hydrogen in the colouring matter by the radical. The product proposed for this purpose was methyl-aniline.

Owing to the improved method of methylating aniline, which, I believe, was first proposed by Messrs. Gerard and Delaire (*Bull. Chem. Soc.* [2] vii. 360), this process has become a very important one, and large quantities of dimethyl-aniline are now used, the oxidation being effected by copper salts. The product, according to the reseaches of Otto Fischer, consists chiefly of pentamethylpararosaniline.

The most important advance in the production of green colouring matters of the triphenyl-methane series was the discovery of the benzaldehyde, Victoria or malachite green.

In 1877, Otto Fischer, whilst investigating the condensation products of tertiary aromatic bases (*Ber.* x$_2$, 1625), obtained by the action of benzaldehyde on dimethyl-aniline in presence of chloride of zinc, a colourless base of the formula $C_{23}H_{26}N_2$, the salts of which, when exposed to the air, rapidly oxidised to a fair blue-green dyestuff, which, he thought, would prove to be of complicated constitution. A little later (*Ber.* xi$_1$, 950) he showed that by oxidising this colourless base with some of the ordinary oxidising agents, this green could be more easily produced, and that it stood to the colourless compound in the same way as rosaniline does to leucaniline. Emil and Otto Fischer afterwards say (*Ber.* xii. 796) that the first experiments for the production of this green were made by the Badische Aniline und Soda Fabrik, in March, 1878. About this time Oscar Doebner (*Ber.* xi. 950) found that a green colouring matter was produced by heating benzaldehyde with benzyl trichloride and zinc chloride. This product has been found to be identical with that of Fischer's. This green colouring matter is now largely made from benzaldehyde, as this process is found to be the best. A similar compound is also prepared from diethyl-aniline, and is known as brilliant green. It is a beautifully crystalline body. It is rather curious that this produces shades of colour somewhat yellower than the green from dimethyl-aniline, whereas, being of a higher molecular weight, we should have expected it to be blue.

The principal difficulty which had to be contended with in the production of these colouring matters was the need of a supply of benzaldehyde The usual method of obtaining it from bitter almonds, which was the only one in use, was quite out of the question, so that other sources had to be looked for. The Badisches Aniline und Soda Fabrik, however, successfully overcame this difficulty. At first they experimented with the process of Lauth and Grimaux, which consists in the oxidation of benzyl-chloride, with an aqueous solution of lead nitrate; but the product made by this process was too dear. But they found that the decomposition of benzylidene-dichloride, by means of water, as observed by Cahours (*Ann. Chem. Suppl.* 2306) and Limprecht (*Ann. Chem.* 139, 316) gave them a means of producing this compound successfully, the reaction being as follows:—

$$C_6H_5CHCl_2 + OH_2 = C_6H_5.CHO + 2HCl.$$

This process, which they have successfully employed since March, 1878, consists in the preparation of benzylidenedichloride from pure toluene, and in the subsequent treatment of this chlorinated body with milk of lime, at 100° C.

I have stated that the group of colouring matters under consideration are called triphenylmethane derivatives, and to show how this has been proved to be the case, I must now refer very briefly to some of the theoretical work which has led to this knowledge. The most important of this refers to rosaniline. I have already drawn attention to the work of Hofmann, which gave us the first knowledge of the composition of this colouring matter, and the further information that it contained hydrogen, which could be displaced by phenyl and alcohol radicals; but as to the matter of constitution, I think the experiments of Caro and Wanklyn were the first, as they showed the relation which existed between rosaniline and aurine, or rosolic acid, and, in fact, produced rosolic acid from rosaniline; but it is to the beautiful researches of Emil and Otto Fischer that we are indebted for a clear knowledge of the constitution of this class of colouring matter.

But to clear the ground before proceeding further, I must remind you that ordinary commercial rosaniline, or magenta, prepared from aniline and toluidines, is a mixture of colouring matters. This was first known by Mr. Nicholson, who found that for the production of the finest blues it was necessary to purify the base and separate one of these before phenylating; but it is only of later years that the difference between these bodies has been carefully studied and explained. The base examined by Hofmann contained C_{20}, and is the chief constituent of commercial rosaniline. The other contains C_{19}, and is now called pararosaniline, because it is produced from aniline and paratoluidine. Similarly, in commercial aurine, two compounds are found, one containing C_{20}, now called rosolic acid, and one containing C_{19}, now called aurine; and these latter can be produced from the corresponding rosanilines; and Dale and Schorlemmer have also shown that aurine can be also converted into pararosaniline, by the action of ammonia (*J. Chem. Soc.*, xxxii. 121).

Emil and Otto Fischer, however, by submitting the leuco compound of commercial rosaniline to the diazo reaction, obtained the hydrocarbon $C_{20}H_{18}$, and from rosaniline prepared from paratoluidine and aniline, the hydrocarbon $C_{19}H_{16}$.

And this latter hydrocarbon was found to be identical with Kekule's triphenylmethane—

$$\begin{matrix} C_6H_5 & & C_6H_5 \\ & C & \\ C_6H_5 & & H \end{matrix}$$

Triphenylmethane.

On nitrating this hydrocarbon they obtained a trinitro derivative, which, when reduced, gave the tri-amido body,

$$\begin{matrix} NH_2C_6H_4 & & C_6H_4NH_2 \\ & C & \\ NH_2C_6H_4 & & H \end{matrix}$$

Leucaniline.

which is paraleucaniline, and by carefully heating its hydrochloride to 150–160°, it was converted into pararosaniline.

Also they found that by oxidising trinitrotriphenylmethane they obtained trinitrotriphenylcarbinol, and this when reduced gave pararosaniline direct.

From these results the constitution of the base is evidently—

$$\begin{matrix} NH_2C_6H_4 & & C_6H_4NH_2 \\ & C & \\ NH_2C_6H_4 & & OH \end{matrix}$$

Pararosaniline.

The salts– the hydrochloride, for example—being

$$\begin{matrix} NH_2C_6H_4 & & C_6H_4NH.HCl \\ & C & \\ NH_2C_6H_4 & & \end{matrix}$$

Pararosanilinehydrochloride.

Similar results were obtained from the hydrocarbon from rosaniline; it is tolyldiphenylmethane:—

$$\begin{matrix} C_6H_4(CH_3) & & C_6H_5 \\ & C & \\ C_6H_5 & & H_6 \end{matrix}$$

The rosolic acid and aurine corresponding to the rosanilines are constituted in an analogous manner:—

$$\begin{matrix} HOC_6H_4 & & C_6H_4O \\ & C & \\ HOC_6H_4 & & \end{matrix} \quad \text{and} \quad \begin{matrix} HO \\ CH_3 \end{matrix} \Big\} C_6H_3 \begin{matrix} & & C_6H_4O \\ & C & \\ HOC_6H_4 & & \end{matrix}$$

Aurin. Rosolic Acid.

From these results we see the beautiful relationships of the various colouring matters of this series to each other, and by it obtain information which is of practical value, as well as theoretical. From the following formulæ of a few of these products their relationships are seen:—

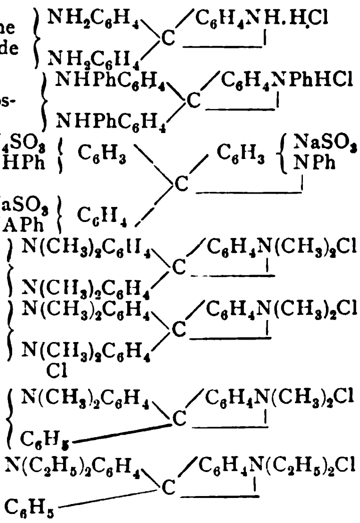
Marsh gas
$$\begin{matrix} H & & H \\ & C & \\ H & & H \end{matrix}$$

Triphenylmethane
$$\begin{matrix} C_6H_5 & & C_6H_5 \\ & C & \\ C_6H_5 & & H \end{matrix}$$

Leucopararosaniline
$$\begin{matrix} NH_2C_6H_4 & & C_6H_4NH_2 \\ & C & \\ NH_2C_6H_4 & & H \end{matrix}$$

Pararosaniline
$$\begin{matrix} NH_2C_6H_4 & & C_6H_4NH_2 \\ & C & \\ NH_2C_6H_4 & & OH \end{matrix}$$

Pararosaniline Hydrochloride
Aniline blue Triphenylpararosaniline.
Soluble blue
Methyl violet Hexamethylpararosaniline.
Methyl green Heptamethylrosaniline
Victoria, or Benzaldeyhde green.
Brilliant green



The effect of replacing hydrogen by hydrocarbon radicals in rosaniline is seen to result in the shade of colour becoming blue for each hydrogen replaced—the effects of those of high molecular weight, such as phenyl, being to produce the bluest shades; thus triphenylrosaniline is blue, whilst hexamethylrosaniline is blue-violet, notwithstanding it contains six hydrogens replaced.

After all the replacements possible have been effected, as in hexamethylrosaniline, the result of the combination of the products with halogen compounds of methyl is very interesting. The particular group to which this is attached becomes of the nature of an ammonium, and the colour changes to green—*i.e.*, methyl green—and this, like other ammonium compounds, when heated, dissociates, with loss of the halogen compound of methyl, and then hexamethylrosaniline is reproduced. Again, if this ammonium group be replaced by phenyl, we also get a green—*i.e.*, Victoria green.

The structure of some of these bodies has been proved by another most beautiful synthetical process, which has lately come into use—a process which enables us now not only to say that we employ the volatile products of the distillation of coal, but also the coke itself; as carbonic oxide, in combination with chlorine, is one of the important agents—*i.e.*, phosgene or carbonoxychloride is used. This product was discovered in 1812 by J. Davey.

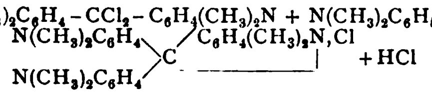
In 1876 W. Michler gave an account of his researches on the synthesis of aromatic ketones by means of phosgene (*Ber.* ix. 716), in which he showed by the action of this substance on dimethylaniline that a tetramethylised diamidobenzophenone was contained. This substance has, therefore, the constitution—

$$N(CH_3)_2C_6H_4 - CO - C_6H_4(CH_3)_2N.$$

The formation of this product takes place in two phases, but I need not enter into that now.

The first experiments to turn Michler's synthetically prepared tetramethylated diamidobenzophene to practical account were made by Dr. A. Kern, in the works of Bindschedler, at Basle. Dr. Kern proved that an agent like phosgene might be produced on a larger scale, and he invented a process to convert Michler's ketone base into methyl purple. This process was derived from the ketone synthesis of triphenylmethane from benzhydrol and benzene, and consisted in preparing the tetramethyldiamidobenzhydrol, and condensing the latter with dimethylaniline; thus the leuco base of hexamethylrosaniline was obtained, and then oxidised with lead peroxide. This process, which was too costly for practical purposes, has been superseded by one discovered by Dr. Caro, who has found that this ketone base can be made to form condensation products with dimethylaniline and other products directly, by the use of phosphorus trichloride—this substance converting it first into a chloride, which then reacts on the dimethylaniline, thus—

$$N(CH_3)_2C_6H_4 - CCl_2 - C_6H_4(CH_3)_2N + N(CH_3)_2C_6H_5 =$$



And this reaction takes place quantitatively, the body being so pure that it readily crystallises from water in prisms, like potassium permanganate, only with very much more brilliant lustre. These contain water of crystallisation. The condensation can also be effected with phosgene gas. The colouring matter obtained by this means is bluer than that obtained from dimethylaniline by oxidation, which consists chiefly of the pentamethyl compound.[1]

Diethylene can also be made into a ketone with phosgene or carbon oxychloride, and this product condensed with diethylaniline yields hexaethylpararosaniline.

Instead of dimethylaniline, dimethyl-α-naphthylamine can be used, and in this case a beautiful blue colouring matter is obtained, and if α-phenylnaphthylamine, the Victoria blue is produced, and by varying the reaction in this kind of way a great variety of colouring matter can be synthetically prepared.

With ammonias this ketone condenses to form the new yellow colouring matter, auramine, with aniline phenylauramine. With quinoline it produces a green very similar to Victoria or benzaldehyde green. I must not, however, spend any more time over this interesting part of the subject, but may say here again we have pure scientific research, conducted for its own sake, bearing fruit. The discovery of W. Michler, which remained for seven years a matter of theoretical interest, now comes forward as a matter of practical value.

(*To be continued.*)

THE DEVONIAN SYSTEM OF RUSSIA

M. P. VENUKOFF has recently given a general sketch of the Devonian rocks of Russia. As is well known, these rocks, so largely developed in Russia, contain such a peculiar fauna that geologists have been puzzled to establish a parallel between them and the different subdivisions of the Devonian system of Western Europe. Two great areas of Devonian strata are known in Russia: that of the north-west and that of the central basin. From Esthonia and Livonia the former extends north-eastwards to Lake Onega and perhaps even to the White Sea, and southwards through Pskor and Vitebsk to Moghiber. In Smolensk only traces of Devonian rocks have been found; but further south-east a great tract of these rocks runs through Tula, Orel, Voronesh, Ryazan, and Tamboff.

Prof. Grewinck, in his "Geologie von Livonia und Kurland" in 1861, and again in 1879, and Prof. Barbot de Marny, in the Russian *Mining Journal* of 1878, attempted to classify the Russian Devonian deposits; not to mention the earlier English work of Murchison, followed by those of Pander, Pacht, Helmersen, and Kutorga, and recently by those of MM. Stuckenberg, Inostrantseff, and Romanovsky. The mixed characters of the fauna have thus always presented great difficulties in the way of satisfactory correlation.

The recent monograph by M. Tschernyskev (*Mem.* Geol. Committee, i., 3) shows how rich a field remains to be explored before our knowledge of the Devonian fauna of Russia in any measure approaches completion.

M. Venukoff, in his *résumé* of the present condition of the problem, gives a brief account of all that is known as to the Russian Devonian system in each separate government, followed with an analysis of the work done by previous geologists. He then presents a detailed exposition of his own observations and conclusions in North-West and Central Russia; giving long lists of fossils which comprise the rich collections recently made by M. Antonowitsch. In the north-western basin three stratigraphical series have long been known: the lower sandstones, the middle limestones and dolomites, and the upper sandstones. The lower member contains only fishes and small *Lingulæ*, though on the Oyat the ichthyolites are accompanied with *Rhynchonella livonica*, *Streptorhynchus crenistria*, *Avicula rostrata*, *Isocardia*, and numerous *Algæ*. The fauna of the limestones is mostly that of deeper water, but even among these strata there occur occasionally—as at Lake Ilmen—beds of sandstone with shallow-water forms (the fishes *Coccosteus*, *Asterolepis*, *Osteolepis*, and the little *Lingula bicarinata*, Kut.). On the whole the middle limestones of Pskov and Novgorod may be sub-divided into four stages or zones characterised, the first, by *Rhynchonella Meyendorfii*, *Rh. livonica*, *Spirifera muralis*, *Atrypa reticularis*, *Orthis striatula*, and *Strophalosia product-*

[1] See Patents, Caro, 4428, September, 1883; 4850, March 13, 1884; and 5038, March 18, 1884.

oides; the second, by the same fossils, but without *Rh. Meyendorfii*, and with two additional species of *Spirifera* (*S. disjuncta* and *S. lenticula*); the third has yielded only these two Spirifers, and *Str. productoides*, while the fourth contains also *Atrypa reticularis* and *Orthis striatula*. Among the Devonian rocks of Central Russia, which consist only of limestones, M. Venukoff tries to establish the following four subdivisions: the Voronesh marls and limestones characterised by the presence of *Spirifera Anosoffi*, together with *Atrypa reticularis*, *Strophalosia productoides*, several Orthoceratites and Corals, the Elets beds, where *Sp. disjuncta*, and a variety of *Sp. Archiaci* replace *Sp. Aanosoffi*, the other leading fossils being: *Rhynchonella livonica*, *Athyris concentrica*, *Productus subaculeatus*, *P. membranus*, *Strophalosia productoides*, *Streptorhynchus crenistria* (*umbraculum*), *Pleurotomaria*, *Euomphalus*, &c. The intermediate beds between these two groups are especially rich in corals (*Aulopora serpens*, *Cyathophyllum ceratites*, *Syringopora abdita*, *S. tabulata*, species of *Stromatopora*, &c.). The Elets beds are covered with a series of limestones characterised by the presence of *Arca oreliana*, and these last are followed by the well-known group of Muraevuya (in Ryazan) which constitutes a passage between the Devonian and Carboniferous systems. The correlation of the subdivisions of the deposits of the Devonian groups of North-Western with those of Central Russia, and of both with those of Western Europe, is beset with difficulties. Still it appears that the limestones of Elets and Voronesh, as also those of the Duna (especially since M. Antonowitsch's researches), are comparable with the *Stringocephalus* group of the Eifel and Nassau; some resemblance may also be traced between the Elets and Voronesh limestones and the higher parts of the Middle and Lower members of the Upper Devonian system of England. They may likewise represent the "Frasnien" subdivision of the Upper Devonian series of the Boulonnais. Regarding the Lower Devonian Sandstones of Russia, Murchison's correlation of them with the [Lower] Old Red Sandstone of Caithness and Elgin remains unshaken. The break between these sandstones and the Silurian deposits which they cover seems also to be confirmed. As to the Devonian rocks of Poland, it appears from M. Mikhalsky's researches (*Izvestia* of the Geol. Committee, 1883) that the Lower, Middle, and Upper Devonian divisions of Western Europe are found there, the Upper being akin to the *Rhynchonella cuboides* group of the Eifel. Again, on the other side of the country the discovery on the eastern slope of the Ural of a *Clymenia* closely akin to the *C. annulata* and the *C. spinosa* (*Izvestia*, 1884, 4) is a fresh confirmation of the likeness of the Ural Devonian rocks to those of Western Europe. According to M. Tschernyshev the limestones of the western slope of the Middle Ural chain belong to the Lower Devonian, those of the Byelaya River (*Izvestia*, 1885, 3) belonging to its lower subdivisions.

SCIENCE IN BOHEMIA

THE Royal Bohemian Society of Sciences celebrated, on December 6 of last year, the hundredth year of its public existence. Occasion has been taken to issue some special publications, comprising a historical sketch of the Society and a *résumé* of the principal researches, a list of all papers, and another of members, since the commencement. The Society originated in a private one for study of science and history started in 1770 under the presidency of Ignaz von Born, who was not only an able scientist of the time, but an ardent freemason (as were many of his fellows). It is a curious fact, throwing light on the aims of this Society, that its publications were all in German, not in Latin, the usual scientific medium in Bohemia at that time. No one thought of using Bohemian for science. *Now* a considerable portion of papers appear in Bohemian, not always accompanied by a German *résumé*, through which some are rendered more accessible to the average linguist here.

Of the various scientific work recorded in the *Abhandlungen* and *Sitzungsberichte* for 1883–84 we may first notice that on fossil forms. The sponges of the Bohemian chalk formation, as represented in the Prague Museum, are being gone through by M. Pocta. In the new method of studying such remains, special weight is attached to inner structure, the outer form being regarded as of secondary importance; and following this course M. Pocta contributes the first two portions of a careful and finely-illustrated monograph dealing with the *Hexactinellidæ* and *Lithistidæ*, two of the seven orders of Zittel's classification. M. Pocta describes elsewhere the varieties of isolated sponge spicules met with in the chalk. Some sponge remains from the Lower Silurian strata of Bohemia resemble (according to M. Feistmantel) the species *Acanthospongia Siluriensis*, described by MacCoy in 1846, and found at Cong, near Galway. We further notice accounts of fossil flora of the anthracite formation in Central Bohemia (M. Kusta), and of remarkable stem remains of *Araucaroxylon* from the same (M. Feistmantel), &c. M. Novak shows from Bohemian trilobites how the form and markings of the hypostome offer good generic characters which may be taken as decisive where the other parts of the body agree.

Among interesting fossils brought before the Society is a scorpion from the "Moravia" coal-pit at Rakonitz. This is one of the little known order of *Pedopalpi*, and is the first fossil representative of a still living genus, *Thelyphonus*, and probably of the order. Its great similarity to present forms is noteworthy, showing persistence of type in this genus from the Carboniferous period. The same pit has yielded four new spiders, and the number of known Palæozoic arachnida is now (according to M. Kusta) 34. A fossil cockchafer was found in a mass of Tertiary quartz received from France at a millstone manufactory in Prague. The body stood nearly free in an oval hollow of the stone, doubtless corresponding to the cocoon. M. Fric has sent it to the Jardin des Plantes, Paris.

From a chemical examination of the dark colouring matter of ebony, M. Belohoubek concludes that it is to be regarded as coal, and the case is a striking one, as being that of carbonisation of plant material occurring physiologically in a living plant. The author not having sufficient young ebony could not exactly determine the mother-substance. M. Celakovosky finds in certain anamorphoses of the ovulum of *Raphanus sativus*, L., and in abnormal leaves of *Croton*, evidence in support of the foliolar theory of the ovulum. M. Palacky furnishes two instalments of his valuable, though necessarily incomplete and tentative sketch of the geographical distribution of plants. The formation of serial buds is studied by M. Velenovsky. M. Hansgirg extends the knowledge of Bohemian algæ (imperfectly studied hitherto), and there are yearly reports on the additions to Bohemian botany.

The organs of excretion of *Hirudineæ* are to be regarded (according to M. Vijdovsky) as modified "segmental organs" of the *Oligochæta*; as the former worms may be considered as Oligochæta degenerate through parasitism. The same author furnishes an account of the freshwater sponges of Bohemia; he finds five well-characterised species with some varieties belonging to the three sub-genera, *Euspongilla*, *Ephydatia*, and *Trochospongilla*. Of freshwater Bryozoa M. Kafka finds in Bohemia thirteen species, two of them new. M. Bayer shows how widely apart *Pelobates* and *Bombinator* are in the structure of their skeleton, and offers a new classification of the Anoura.

Considering the nature of steel-hardening from the electrical standpoint, in connection with the corresponding behaviour of some silver alloys, MM. Strouhal and Barus arrive at the result that neither the mechanical nor the chemical hypothesis as to steel hardening suffices alone to explain the phenomena, and, while the proportion of carbon is the principal factor for determining the behaviour of steel, this behaviour must be explained by a combination of chemical and mechanical influences. The authors offer a definition of steel on the basis of the electrical behaviour of iron with increasing proportion of carbon. M. Kolacek makes a contribution to the theory of the Gramme machine. M. Seydler investigates the application of the principle of energy to the pondero-motive and electro-motive actions of the electric current, also the theory of tension of electrostatic phenomena from the standpoint of the theory of elasticity. There are various papers in mathematics, crystallography, &c., which we must not stop to notice. Tables of rainfall at different stations of Bohemia are furnished by M. Stodnicka.

To this brief account, indicating some directions of recent Bohemian science, we will add a word about the great work of Barrande. That eminent geologist, who died on October 5, 1883, left his collections, &c., to the Bohemian Museum; he also left directions and funds for the completion of his "Système Silurien du Centre de la Bohème," of which twenty-two volumes had appeared between 1852 and 1881. Drs. Waagen and Novak now undertake, at Barrande's request, the further work required. The text and plates relating to the Gasteropods and Echinoderms were found in a nearly finished state, but the Polyps, Graptoliths, and Bryozoa have still to be worked out for the most part. Four volumes will thus be added to this remarkable work, making in all twenty-six, with 2000 plates of illustrations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Bristol Merchant Venturers' School of Science, Technology, and Commerce, erected at a cost of nearly 50,000*l.*, to replace the old Trade and Mining School, was formally dedicated by the merchants to the city on Saturday, when their handsome gift, including the complete charge of the school, estimated at 1000*l.* a year, was received by the Mayor on behalf of the citizens. After the Trade and Mining School was handed over to the Colston Trust by the Endowed Schools Commissioners, this science school, which had already won a very distinguished position in the country, made such rapid progress that the building was soon found inadequate for the 500 scholars attending it, and the Merchant Venturers, who constituted the chief part of the governing body known as the Colston Trust, determined to build a new school on the plan of the newest and best equipped English and foreign school, with the best-known methods and appliances for science and art instruction. Finding that the Colston Trust funds assigned for the purpose were inadequate to the demand of such a large building, they undertook the entire charge, so that the scholastic institution will henceforth be known as the Bristol Merchant Venturers' School. Sir Frederick Bramwell, C.E., Chairman of the Council of the City Guilds Institution for the Advancement of Technical Education, the Mayor and High Sheriff of Bristol, the Bishop of Gloucester and Bristol, Mr. Samuel Morley, M.P., Mr. Lewis Fry, M.P., Col. Donnelly, Capt. Abney, and others took part in the inaugural ceremony, which was prefaced by a luncheon given by the master of the Society, Mr. R. W. Butterworth, at the Merchant Venturers' Hall. After the luncheon the party repaired to the new schools, and the opening ceremony took place in the examination hall. The Master (Mr. Butterworth) presided, and in opening the proceedings gave a history of the growth of the old Trade School and its development into the present great establishment. The Master then called upon Sir Frederick Bramwell to declare the building open. Sir Frederick Bramwell said he thought that he might safely say that almost by universal agreement the training to be given in schools such as that was held to be a training that ought to be given, and was a national benefit and blessing. That meeting, he said, was not to initiate something new, for, as had been said, the work had gone on for thirty years; it was not to mark a birth, but to mark progress; not the full development, or anything like it, but a stage—for they would hope that not many years would elapse before an audience as numerous and as earnest as that he saw before him would meet in Bristol to celebrate some further marked step in the development of technical education in the city. What was the object in giving this technical education? The primary object was to enable men and women to earn their living better than they could otherwise do. The primary object of such education was to teach men engaged in industrial pursuits to conduct them in a manner which would redound to their happiness and material prosperity, and this would redound to the prosperity and welfare of the whole nation. A man instructed as he would be there would be enabled to carry on his industry in a totally different manner from those who had to begin the battle of life fifty years ago. At that time they had to profit by what could be taught them derived from experience, but without understanding the principle on which the things depended. They should remember the great things which for the first sixty years of this century were done by men who had not the advantage of technical education. But when a man had that advantage he was enabled to look at the experience of the past in a totally different manner, because he knew the principles on which that experience was based, and knew when it was applicable or inapplicable. Whatever his determination, the Englishman was badly weighted in his struggle with his foreign competitor if the latter had the means of applying science to his industry when the former had not. In London they were doing good work of this sort, one of the branches being technological examination, and during the past three years the number of those that came up more than doubled—from 1900 to 3900. That increase did not arise from the governing body relaxing the examination; on the contrary, they thought it right to add to he stringency of the examination. So the best judges of all, the very men whom they wished to instruct, themselves proved that they valued this instruction. It could not be said that this was a question where they were endeavouring to force on an unwilling people the advantages of education the value of which they did not recognise; and thus they had the encouragement arising from appreciation of their efforts.

MR. ARTHUR SMITHELLS, B.Sc. (London), assistant lecturer and demonstrator in chemistry at the Owens College, Manchester, has been elected to the Professorship of Chemistry at the Yorkshire College, Leeds, rendered vacant by the appointment of Dr. Thorpe to the Chair of Chemistry in the Royal School of Mines and Normal School of Science, South Kensington.

SCIENTIFIC SERIALS

Journal of Franklin Institute, No. 713, May.—Prof. C. F. Himes, actinism. A lecture delivered at the Philadelphia Electrical Exhibition, giving a succinct account of modern investigations.—F. E. Ives, isochromatic photography. Describes his blue-myrtle chlorophyll process.—C. J. Hexamer, fire hazards in textile mills. Deals with relative risks of cotton, wool, and shoddy of various qualities.—W. B. Le Van, economy in the use of high-pressure steam. Describes a new high-pressure boiler.—Prof. Pliny E. Chase, further experiments in weather forecast. Of interest to meteorologists.—Prof. E. J. Houston, glimpses of the International Electrical Exhibition, No. 7, Drawbaugh's telephonic inventions. Description and drawings of the instruments of this notorious person.

No. 714, June.—Dr. Persifor Frazer, the World's Industrial and Cotton Centennial exposition. Gossip about the New Orleans Exhibition.—Prof. J. Burkitt Webb, a simple form of draught gauge; a simple instrument for measuring the decrease of pressure in a flue directly by scales.—Dr. Werner Siemens, on the electromotive action of illuminated selenium, discovered by Mr. Fritts. In this communication, which is translated from the German, Dr. Siemens describes as being entirely new and scientifically of the most far-reaching importance, the phenomena discovered by Mr. Fritts, which were, at Philadelphia, condemned by Prof. Rowland as unworthy of being brought before the Physics section of the American Association. Dr. Siemens agrees with Mr. Fritts that in his experiments there is a direct conversion of the energy of light into electrical energy.—E. L. Corthell, the Tehuantepec Ship Railway.—Prof. E. J. Houston, facsimile telegraphy.—Appended to this number are the reports of the examiners of the Philadelphia Electrical Exhibition on electric arc lamps, and on carbons for arc lamps.

Annalen der Physik und Chemie, xxiv. No. 4, April.—Prof. F. Melde, experimental researches in acoustics. Gives account of new experiments with a phonic wheel and other electromagnetic means of exciting vibrations.—G. Tammann, on the vapour-pressure of salt solutions. Gives many hundreds of determinations of lowering of pressure of aqueous vapour by addition of some soluble salt. The author concludes that for a given salt the product of the relative pressure-reduction into the volume of the solution relatively to that of the water it contains is a constant. Exceptions are attributed to polymerisation. — Prof. W. von Bezold, on current-figures in liquids. The method consists in observing the forms which result from putting aniline dyes (such as are used for ink in hectograph) upon the liquids. The present paper deals with the internal currents set up by differences of temperature produced by surrounding with a ring of ice, &c. The figures are curious and instructive.—Prof. E. Kittler, on measurement of strength of currents. Describes the method of taking strength of currents by measuring potential when the current is passed through a known resistance.—Prof. G. Quincke, electrical researches, No. xi. This series deals with the constants of electromagnetic rotation. For sodium light, Quincke finds the constant for bisulphide of carbon to be 4·409′ at 21° C. Becquerel found 4·630′ at 0°, and Lord Rayleigh and Mrs. Sidgwick found 4·2002′ at 18°. Quincke gives tables of statistical results for other liquids, agreeing in the main with those of Perkin and of Becquerel.—A. Gockel, on the relation of the Peltier-heat to the efficiency of galvanic elements. A discussion of the work of Braun, Chaperon, Czapsky, Bouty, and others, with redeterminations.—W. Herman Schultze, on the reaction between two mutually perpendicular magnetic distributions. Very careful experiments confirm Siemens's result that longitudinal magnetism diminished by a transverse magnetisation.—A. König and Fr. Richarz, a new method of determining the constant of gravitation.—Leo Arons, interference fringes in the spectrum. Fringes are observed to intrude; which the author eventually traces to the films between the two lenses of the achromatic telescopes.—Robert Weber, the electrical siren. An interesting apparatus producing tones in a receiving telephone by interrupting the circuit by a rotating cylinder having series of electric contacts around its periphery.

xxv. May.—Prof. L. Lorenz, determination of the electric resistance of mercury columns in absolute electro-magnetic measure. The result of the author's method is that the true value of the ohm is represented by a mercury column of 1 square millimetre section and 105·93 centimetres in length.—Franz Stenger, contributions to the electric conductivity of gases.—Hans Jahn, on the validity of Joule's law for electrolytes. The careful experiments establish the validity to a very close degree.—R. Lamprecht, on flexible conductors under magnetic influence. A mathematical discussion.—J. J. Balmer, note on the spectrum lines of hydrogen. The wave-lengths of twelve observed lines are found to agree with the formula $\lambda = N(m^2/m^2 - 4)$, where N is a coefficient, and m and n whole numbers. For hydrogen, $N = 3645 \times 10^{-8}$ cm.—Dr. Fr. Vogel, change of refraction in glass and calc-spar with temperature. The author finds, with Fizeau, a diminution in the difference between the two indices of calc-spar nearly proportional to the elevation of temperature.—Prof. W. Voigt, the optical properties of very thin metal films. Rediscusses Quincke's results.—Julius Elster and Hans Geitel, note on a sensitive Doubler. This is nothing else than a Thomson's water-dropper.—Elster and Geitel, remarks on the electric processes in storm-clouds. The authors regard thunder-clouds as acting as the water-dropping doubler does, in raising at the expense of the kinetic energy of the falling drops the electric potential of the mass placed under electric influence.—Elster and Geitel, on the development of electricity during formation of rain.—Dr. H. Kayser, on lightning photographs.—Prof. G. F. Fitzgerald, on the memoir of Prof. Kundt on the electromagnetic rotation of the plane of polarisation of light by iron, cobalt, and nickel.—Hanichi Muraoka, on the magic Japanese mirror.—K. Exner, remark on the velocity of light in quartz.

Rendiconti del Reale Istituto Lombardo, June 11.—Further remarks on the functions that satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—On the resolution of certain modular equations, a complement to the author's paper on the transformation and division of the elliptical functions, by G. Morera.—Inversion of the movement of the pupil in the case of a person affected by progressive analysis, by Prof. A. Raggi.—On certain physiological functions of the lower organisms: a contribution to the morphology of the Metazooi, by Prof. Leopoldo Maggi.—Reply to the recent objections advanced against a science of penal jurisprudence, by E. A. Buccellati.—Some recent studies on the origin of the Institutions of Justinian, by Prof. C. Ferrini.

THE largest space in the *Nuovo Giornale Botanico Italiano* for July is occupied by a paper by Sig. C. Massolongo, on the Hepaticæ gathered by Dr. Spegazzini in Terra del Fuego in 1882, an important contribution to Hepaticology. Ninety-five species are described, a considerable number of them new, including, also, one new genus, *Pigafettoa*. The paper is illustrated by no less than seventeen plates. The kindred Bryology claims also a paper by Sig. Venturi, on the Italian representatives of the section *Harpidium* of *Hypnum*. Sig. Piccone gives a list of marine and freshwater Algæ observed by him on or near the Ligurian coast, many of them being new to the district. The only papers in this number not concerned with Cryptogamy are teratological—by Sig. Terracciano on a quadrilocular capsule of *Agave*; and by Prof. Caruel on Viridescence in *Verbascum*.

IN the *Journal of Botany* for July, Mr. W. H. Beeby describes and figures the recently-discovered *Sparganium neglectum* from Surrey, for which he claims the rank of a good species. With the exception of a teratological note on Peloria in *Habenaria bifolia* by Mr. H. N. Ridley, all the other papers in this number are descriptive and topographical:—New ferns from Brazil, by J. G. Baker; additions to the British lichen-flora, by Rev. J. M. Crombie; Notes on the flora of Ceylon, by Dr. Trimen; on the flora of the Philippine Islands, by R. A. Rolfe; on Dovedale plants, by Rev. W. N. Purchas.—Dr. Buchanan White records one more addition to the Flowering plants of Great Britain, *Schœnus ferrugineus*, from Perthshire.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 24.—Prof. T. G. Bonney, F.R.S., President, in the chair.—John MacDonald Cameron, Matthew Heckels, and Robert H. Williams, were elected Fellows of the Society.—The following communications were read:—Supplementary notes on the deep boring at Richmond, Surrey, by Prof. John W. Judd, F.R.S., Sec.G.S., and Collett Homersham, F.G.S. Since the author's former communication to the Society on the subject, this boring, in spite of the strenuous efforts made by the Richmond Vestry, and the contractors, Messrs. Docwra and Co., has had to be abandoned, after reaching a total depth of 1447 feet from the surface. This depth is 145 feet greater than that of any other well in the London Basin, and, reckoning from Ordnance datum, reaches a lower level by 312 feet than any other well in the district. Before the termination of the work temperature-observations were obtained, which generally confirm those previously arrived at. The strata in which the boring terminated consisted of the red and variegated sandstones and marls previously described, which were proved to the depth of 208 feet. Although it was demonstrated that these beds have a dip of about 30°, complicated in places by much false-bedding, no conclusive evidence could be obtained concerning their geological age. They may be referred either to some part of the Poikilitic series, or to the Carboniferous (for similar strata have been found intercalated in the Carboniferous series at Gayton, near Northampton), or they may be regarded as of Old Red Sandstone age. Some interesting additional observations have been made since the reading of the former paper, on the Cretaceous rocks passed through in this well. Mr. W. Hill, F.G.S., of Hitchin, has found the exact analogue of the curious conglomerated chalk met with at a depth of 704 feet at Richmond. His observations entirely confirm the conclusion that we have at this depth the "Melbourne rock" with the zone of *Belemnites plenus* in a *remanié* condition at its base. Some new facts concerning the state of preservation of the fossils in the Chalk Marl are also recorded. With respect to the conclusions arrived at by the author concerning the distribution of the Jurassic rocks on the south side of the London Basin, an important piece of confirmatory evidence has been supplied by a deep boring made at the Dockyard-Extension Works at Chatham. This section, for the details of which the authors are indebted to the officers of the Geological Survey, shows that under the Chalk and Gault, with normal characters and thickness, there lie 41 feet of sandy strata of Neocomian age, and that these are directly underlain by blue clays of Middle Oxfordian age, as is proved by the numerous fossils which they have yielded. We have now, therefore, direct evidence of the existence and position of strata of Lower, Middle, and Upper Oolite age, respectively, beneath the Cretaceous rocks of the south-east of England.—On the igneous and associated rocks of the Breidden Hills in East Montgomeryshire and West Shropshire, by W. W. Watts, F.G.S. The author, in this paper, described the succession of rocks in the small tract near the Breidden Hills situated between Welshpool and Shrewsbury. The Cambrian rocks are: (1) Criggion shales, dark and barren, much penetrated by intrusive diabases and about 2700 feet thick. (2) Andesitic lavas and ashes, followed by conglomerates of the same materials. (3) Ashy grits and shales containing *Climacograpsus antiquus? C. bicornis? C. scharenbergi, Cryptograpsus tricornis, Diplograpsus foliaceus, Leptograpsus flaccidus? Beyrichia complicata, Trinucleus concentricus, Orthis testudinaria, Bellerophon bilobatus*, The rocks are thus of Bala age, the fossils indicating that the ashy grits and shales are on the horizon of the top of the Glenkiln or bottom of the Hartfell series. These are followed by Silurian strata. (1) *Pentamerus* beds. Soft sandstones and mudstones yielding *Pentamerus globosus? P. oblongus, P. undatus, Leptæna transversalis, Strophomena rhomboidalis, Petraia subduplicata*. (2) purple shales, unfossiliferous. (3) Lower Wenlock shale, with *Monograptus vomerinus? Cryptograpsus*, sp., *M. priodon*, var. *Flemingi*. These graduate into (4) Upper Wenlock shale, with *M. priodon, M. vomerinus? M. basilicus, M. nilssoni, M. rœmeri*. (5) Lower Ludlow shale. *M. colonus, M. nilssoni, M. salweyi, M. lintwardenensis*. The paper concluded with microscopical descriptions of the igneous rocks, of which there are two sets: (1) An older set interbedded with the Cambrian and consisting of andesites bearing a large percentage of a mineral allied to enstatite, together with augite and a small quantity of hornblende and mica. These are chiefly lavas, but some few are perhaps intrusive rocks and dykes. (2) Intrusive rocks of a diabase type, generally, however, containing a variety of enstatites identical with that in the andesites. These are intrusive in the Cambrian rocks, and from their relations appear to be most probably of post-Silurian age.—Note on the Zoological position of the genus *Microchœrus*, Wood, and its apparent identity with *Hyopsodus*, Leidy, by R. Lydekker, B.A., F.G.S.—Observations on some imperfectly known Madreporaria from the Cretaceous formation of England, by R. F. Tomes, F.G.S.—Correlations of the "Curiosity-Shop" beds, Canterbury, New Zealand, by Capt. F. W. Hutton, F.G.S. The "Curiosity Shop" is a locality on the River Rakaia in the Canterbury Plains, and has been thus named on account of the numerous fossils found in some calcareous sandstones cut through by the river. The section exposed consists of (1) river-gravels; (2) loose grey quartz sands; (3) soft calcareous sandstone with glauconite, passing downwards into tufaceous clay; (4) calcareous sandstone without glauconite; (5) loose grey or yellowish brown sands. By Mr. McKay, of the Geological Survey, No. 2 had been referred to the Pareora series (Miocene?), No. 3 to the Upper Eocene series, and Nos. 4 and 5 to the Cretaceo-Tertiary series. The author, who was inclined to class all these beds in a single series, pointed out that the only difference between the fossils found in Nos 3 and 4, the most important fossiliferous beds, consisted in the presence of a greater number of forms in No. 3, all found in No. 4 being identical with those in the overlying bed. He then gave a complete list of the species of Vertebrata, Mollusca, Brachiopoda, Echinodermata, Bryozoa, and Cœlenterata, from the locality, 48 in all, and compared them with those from the Weka Pass stone, 26 in number, and the Ototara fossils from Oamaru, to show that a large proportion were identical. He gave reasons for not agreeing with the views of Dr. Hestor and Mr. McKay, who held that unconformity exists between the beds referred by them at the Curiosity Shop, in the Weka Pass district, and north of Otago, to the Upper Eocene and Cretaceo-Tertiary series respectively, and showed, both from palæontological and stratigraphical data, that all these rocks must be included in one system, the Oamaru system of Dr. von Haast and himself.—On the fossil flora of Sagor in Carniola, by Constantin, Baron von Ettingshausen, F.C.G.S. The author in this paper gave the principal results of his examination of the fossil flora of Sagor, consisting of 170 genera and 387 species, of which a list was appended. The plants were obtained from fourteen different localities, some of the most important species from each of which were mentioned; in one of these localities the flora underlying the brown coal of the district belonged to the uppermost Eocene, whilst the remaining stations were assigned to the lowest stage of the Miocene system. The great diversity of the fossil plants showed that the Tertiary flora of this and other localities must be considered the origin of all the living floras of the globe; for in the fossil flora of Sagor are found plants representative of forms now found in Australia, North America, and Mexico, California, Chili, India and the East Indian Islands, Europe, Africa, Norfolk Island, and New Zealand. Examples of all these were cited.

Edinburgh

Royal Society, July 6.—Sheriff Forbes Irvine, Vice-President, in the chair.—Dr. R. W. Felkin, F.R.G.S., gave an account of the For tribe, one of the Negro races of Central Africa.—The Astronomer-Royal for Scotland communicated a paper, by Dr. Daniel Draper, on bisulphide of carbon prisms, and also exhibited some stereoscopic photographs.—Drs. Woodhead and Hare, in a paper on the vital relations of micro-organisms to tissue-elements, endeavoured to classify as far as possible the actions of micro-organisms on tissues. They pointed out that the reaction of the tissue-elements themselves had latterly been too much lost sight of, and that a more careful study of the normal cell-life history must in time be the means of throwing considerable light on the subject under discussion. They insisted very strongly on the digestive action of micro-organisms.—Thomas Andrews, F.C.S., submitted a paper on the resistance, during recrystallisation, of fused salts of the halogens, compared with some others and glass.—Prof. Turner gave an account of a specimen of Sowerby's whale (*Mesoplodon bidens*), recently obtained from Shetland, calling special attention to the great complexity of the stomach, the contents of which seemed to indicate that the animal fed upon fish.—Mr. W. E. Hoyle laid before the meeting the second part of the Preliminary Report on the *Challenger* Cephalopoda.

Paris

Academy of Sciences, July 20.—M. Bouley, President, in the chair.—Observations of the small planets made with the large meridian at the Observatory of Paris during the first quarter of the year 1885, communicated by M. Lœwy.—Note on the movement of rotation of the earth around its centre of gravity, by M. Tisserand.—On various propositions relating to the movement of a solid body around a fixed point, by M. G. Darboux.—A spectroscopic study of substances rendered phosphorescent by the action of light or by electric discharges, by M. Edm. Becquerel.—On the metaphosphate of thorium, by M. L. Troost. This substance, obtained by the reaction of the chloride of anhydrous thorium on an excess of metaphosphoric acid in solution, takes the form of crystals insoluble in water and easily separated from metaphosphoric acid. Its analysis yielded metaphosphoric acid 52·45; thorine 47·64.—Researches on the duration of excitability in the excito-motor regions of the brain proper after death, by M. Vulpian.—Observations on the fauna of the island of Great Comoro, to the north-west of Madagascar, by MM. Milne-Edwards and E. Oustalet. From a careful study of the mammals and birds of this island the authors conclude that it is not a geographical dependence on Madagascar, that it never was attached to that region, and that its fauna has borrowed from the surrounding lands.—Note on the intermediary orbit of the moon, by M. Hugo Gyldén.—On the vaso-motor action of suggestion on hysterial subjects in a state of somnambulism, by M. Dumontpallier. From experiments made on two women subject to hysteria in the hospital de la Pitié it appears that, under certain conditions, suggestion may produce a vaso-motor modification characterised by a considerable increase of temperature in any region determined at pleasure. This result opens the way to a series of fresh experiments of the same order, and renders possible a physiological interpretation of phenomena, the reality of which science had hitherto regarded as somewhat doubtful.—Observations of Barnard's new comet made at the Observatory of Nice (Gautier's equatorial), by M. Charlois.—On the sixteen systems of planes of the regular convex icosahedral, by M. E. Héward.—On the capillary constants of the saline solutions, by M. A. Chervet.—Note on the production of the lowest temperatures, by M. K. Olszewski.—Experiments on the regulation of the charges and discharges in electric accumulators, by MM. Crova and Garbe.—Note on the electric resistance of alcohol, by M. G. Foussereau.—Heats of formation for some phtalates, by M. Colson.—Remarks on some phenomena of oxidation and reduction produced by the microscopic organisms of the soil, by M. A. Müntz.—On the variation of the physical properties in the series of chloro-acetic derived substances, by M. L. Henry.—On the existence of glycogene in the yeast of beer, by M. Léo Errera.—On the existence of a nervous system and of an organ of sense in *Rhabdocœles acœles, Convolvula Schultzii*, and other members of the same group, by M. Yves Delage.—Note on the analytical and comparative morphology of the mandible in the hymenopteræ, by M. Joannes Chatin.—The Coregoni of the Swiss lakes (*C. dispersus, C. balleus*, &c); their marine origin, classification, reproductive processes and gradual adaptation to their changed surroundings, by M. V. Tatis.—Note on the tertiary basin of Grenada, by MM. M. Bertrand and W. Kilian.—A contribution to the study of antiseptics; action of the antiseptics on the higher organisms (continued); phenic acid and resorcine, by MM. A. Mairet, Pilatte and Combemale.—Experiments made on the body of a criminal recently guillotined at Troyes, by MM. P. Regnard and P. Loye. These experiments mainly confirm those already observed on animals, and tend to reassure those who suspect the persistence of conscious life after decapitation.—Observations on the foregoing experiments, by M. Paul Bert.—On the photographic determination of the trajectory of a point in the human body during the movements of locomotion, by M. J. L. Soret.—Note on the theory of the perception of colours, by M. Aug. Charpentier.—A formal denial of the reports regarding the appearance of cholera in Hérault was made by M. Colson on the authority of a letter from Dr. Boissier, local medical inspector.

Berlin

Physical Society, June 12.—Dr. Lummer communicated his further observations on the interference-phenomena produced by glasses parallel to the same plane. If monochromatic light fell from a luminous surface on a glass plate of moderate thickness, differences of phase arose by reflection on the anterior and posterior surface, in the beams of light falling under different angles. These differences of phase, as the speaker demonstrated by showing the course of the single bundles of rays produced on the retina of an eye focussed for parallel rays, a system of coloured and dark concentric rings, similar to Newton's rings of colour. This system of rings appeared, however, only when the plates were exactly parallel, at least to as great a degree of precision as that of the rays which enter the pupillary aperture by reflection from any point. These rings might therefore be utilised as a test of the parallelism of the glasses. Deviations of 0·2 wave-length caused no disturbance in the rings, but differences in the thickness of the glass amounting to 0·5 λ certainly gave rise to such disturbance. Bringing the glass before the eye, which was always accommodated to infinitude, considerably large spaces of the glass might be tested in reference to their parallelism. Any thinning or any thickening of the glass would be at once marked by displacements in the ring-systems and their wandering from the interior to the outside, or from the outside to the interior. The speaker compared his method of observing the interference phenomena, and testing the parallelism of the glass surfaces with that of Fizeau, and brought out the differences of the two, as also the advantages of his method.—Dr. Kayser gave a report of two works quite recently published on spectrum analysis, which seemed to make an important advance in the theory of spectral lines. It had formerly been attempted in vain to find harmonic relations, such as those existing among the upper tones of a sounding body, among the lines shown by the spectrum of a metal vapour, but the attempt to find such simple relations was abandoned after the question had been discussed by Prof. Schuster. Lately, however, Herr Balmer, in calculating the wave-lengths of the hydrogen lines, as given by Angström, had found a relation between these lines, expressed by the formula $h = \frac{m^2}{m^2 - 4} \cdot C$, when C had the value of 3645·6 millionths of a millimetre. In place of m let there be put in turn the numbers 3, 4, 5, 6, then were obtained Ångström's undulatory lengths of the four visible hydrogen lines. If the calculation were carried still further, and for m were placed the values 7, 8, &c., on to 16, then were obtained values for hydrogen lines which coincided very well with the wave-lengths of the lines which Dr. Huggins had found in the ultra-violet spectrum of the white stars, and had recognised as the invisible hydrogen lines. The longest among these ultra-violet hydrogen lines had been photographed by Prof. Vogel in the spectrum of a glowing hydrogen tube. This relation between the hydrogen lines had now received an increased significance from an investigation by Prof. Cornu, in which he had found a perfectly determinate proportionality in the lines of the ultra-violet spectrum of aluminium and of thallium to the ultra-violet hydrogen lines. Like the hydrogen lines, the pairs of lines of the two metals referred to advanced so much nearer to one another, and became so much paler the more one approached the more refrangible end of the spectrum; and if any line of the aluminium or the thallium spectrum was made to coincide with the corresponding line of the hydrogen, then did all the remaining lines coincide. This relation obtained both for the first and for the second lines of the pairs of lines in the metal spectra.—Prof. von Helmholtz drew the attention of the Society to an investigation of Dr. Wernicke, which will shortly be published, of great importance for the theory of the reflection of light. The experiments had reference to the reflection of thin plates in which each ray divided into two, one being reflected, the other refracted and again reflected by the posterior surface, in addition, still further secondary refractions and reflections came into account. The difference of phase in the reflected rays, on monochromatic light being applied, was observed through their interference phenomena. According to the theoretical development given by Dr. Wernicke, without any hypothetical assumption whatsoever, the difference of phase depended on the sine of the angle of incidence, on the cosine of the angle of refraction, and on three constants. By examining a large series of solid bodies—transparent crystals as well as metal films—Dr. Wernicke found in the case of incidences which were approximate to the angle of polarisation that, if the plane of polarisation were parallel to the plane of incidence, the three constants became zero. If, on the other hand, the plane of polarisation was perpendicular to the plane of incidence, the constants had a definite value. This experimental result was in agreement with Fresnel's theory of reflection. According to Naumann's theory the constants must become zero in the case of perpendicular polarisation planes and have a definite value in case of parallel direction. According to Ketteler's theory the constants could never become zero.

STOCKHOLM

Academy of Sciences, June 10.—The following papers were presented for insertion in the *Transactions* of the Academy: Contributions to the physiological anatomy of the algæ, by Herr N. Wille.—On Japanese cephalopoda, by Herr A. Appellöf, B.A.—On the determination of the amount of electromotive power of the voltaic arc, by Prof. E. Edlund.—Contribution to the question of the action of fluidity upon the electric conducting power of electrolytes, by Dr. S. Arrhenius.—Researches on the electric spark in fluids, by Dr. C. A. Mebius.—On the conformation of the hypostoma in some Scandinavian Asaphids, by Prof. W. Brögger.—On an Inoceramus from Queensland, by Prof. B. Lundgren.—A catalogue of the Silurian crustacea of Gothland, I. Trilobites and Merostoma, by Prof. G. Lindström.—On intermediate orbits, which at a given moment with a contact of the third order, join with the real orbits, by Prof. Gyldén.—On alcohol in beer, by Prof. Hamberg.—On marine vertebrates from the northernmost part of the province of Tromsö and West Finmark, by Dr. C. Aurivillius.—On rhodonite from Pajsberg and Langbau, by Hen. G. Flink.—On the crystallographic constituents of godolinite, by Hen. F. Eichstedt.—Crystallographic researches on the rarer metals, by Hen. C. Morton.—On some combinations derived from dicyanphenylhydracin, by Dr. J. J. A. Bladén.—On melanism and combinations of melam, by Dr. P. Claesson.—Some speculations and experiments on filtration in its bearing upon the processes of transudation in the animal body, by Drs. R. Tigerstedt and C. G. Santesson.—Prof. Smitt reported on the International Ornithological Congress in Vienna of last year.—Prof. Wittrock exhibited the first fasciculus of the fodder-herbs of Sweden, edited by Drs. Jönsson and Whalsted, and gave an account of a report on a botanical expedition to Norrland and Norway, for the purpose of studying the morphology and phylogeny of the Hierarsia, by D. S. Almquist.

CONTENTS

THURSDAY, AUGUST 6, 1885

A POSSIBLE WINDFALL FOR SCIENCE

IN a recent article we referred to the question of the amalgamation, so to speak, of the astronomical and civil day, in connection with the introduction of world time or prime meridian time, suggested by the Washington Conference. We pointed out that there were various opinions touching the time at which the change should be made, but that the concensus in its favour is so strong that it is certain to be made some time or another.

Our contemporary *Science* has recently called attention to a point which, if carried out, will make the work complete at an annual saving on the outlay of the present of something like 20,000*l.*

How is this to come about? In this wise. Let us suppose four nations *A*, *B*, *C*, or *D*, who each support a national observatory chiefly for the benefit of its Marine. This benefit consists in telling the mariners at what instant, according to the time shown by the clocks of *A*, *B*, *C*, or *D*, any celestial event, useful to him for determining his place at sea, will happen.

Let four ships, one of them representing each one nation, be within a cable's length of each other in the middle of the Pacific when the time comes for making an observation to determine position. Four books will be used, the production of which has been enormously costly, as each consists almost entirely of figures which depend upon elaborate calculations.

If the books are rightly calculated and the captains are skilful, of course the same position will come out in each case.

Evidently this work has been done four times over, and it is equally obvious that the result should have come out the same if the position had been determined properly on either ship from data supplied by either book. Why is this? Because our nations, though they have accepted in common the art of printing, the art of binding of printed pages together to form a book, and Arabic numerals, have not accepted a common time.

To come down from our generalities the four ships might have belonged to Germany, France, the United States, and Great Britain, and the four books might have been the *Berliner Jahrbuch*, the *Connaissance des Temps*, the *American Ephemeris*, and the *Nautical Almanac*. Sympathetically with these four books, at least three different times might have been indicated by the chronometers. And here lies the point. *Because* these chronometers show the time at Paris, or Berlin, or London therefore the computations of each celestial event, using the same data, employing the same processes, have been undertaken by each nation.

But even this is not all. We have said that at least three different times might have been indicated, and on our supposition only three times would have been indicated, because the U.S. Marine actually use Greenwich time.

Now it is clear that the general introduction of world time or prime meridian time, with the idea of which we are beginning to be familiar, will do for time what the introduction of the Arabic numeral did for numbers—it will denationalise and generalise it whenever necessary; and each observatory, sooner or later, is certain to have a clock showing the prime meridian time of the earth as it has one already of the skies, and when this comes about it will be to the general advantage for all to deal with the common time for purposes common to the planet.

Now among these what can be imagined more planetary than those with which the mariner has to do, and if this be so why shall there not be one unique planetary ephemeris.

From the abstract point of view more than one ephemeris cannot be defended, though it may be pardoned if, as *Science* suggests, the nations, to save their *amour propre*, must have ephemerides for their several meridians "much the same as all patent medicine firms and pill vendors feel the need of an almanac and calendar for the conservation of individual interests: it saves themselves and their patrons the indignity of referring to somebody else's almanac, and advertises the fact that they are enterprising enough to have one."

We cannot believe that the feeling characterised above, though it exists, would stand in the way of such a vast saving of labour and such a general improvement as might be brought about by an International Ephemeris, provided the question were well ventilated and wisely discussed by a congress summoned *ad hoc*. On this point *Science* writes:—

"It is certain that the deliberations of such a congress could not fail to advise governmental co-operation in the preparation of the nautical almanacs now existing, national pride aside, and this might be done in a multitude of ways, most prominently in the case of the preparation of the data relating to the moon. Take, for example, the hourly lunar ephemeris and the lunar distances as printed each year in the *British Nautical Almanac* and the *American Ephemeris*. These data occupy about one-third of the entire number of pages of each of these publications; they are now prepared independently by the two offices, but are, when printed, substantially identical in both; and, further, the work being done at about the same time in the two countries, the results of the one do not serve any sufficient purpose as a check upon the accuracy of the other. The cost of this part of the almanac alone to each nation amounts to several thousand dollars annually, —an amount which might be reduced one-half by the preparation of these data conjointly, to say nothing of other immediate and favourable results which might be secured by such co-operation.

"The wisest conservatism would appear to suggest the annual publication by the nations conjointly of a single volume of astronomical predictions, which, in addition to other improvements, should combine all those desirable features not dependent upon individual meridians, and which in some degree characterise all the astronomical ephemerides of the several Governments. The contents and arrangement of the articles of such an ephemeris could only be determined by an international conference. While this may be little better than mere speculation, any one who has the four principal ephemerides in constant use will readily recognise how small a portion of each is employed, and, with extended interpolation-tables, how little the inconvenience of using the ideal ephemeris solely would be."

It is sufficiently obvious that this enormous simplification and improvement must come about some time or the other, and it is to be hoped that no very long time will be allowed to elapse before some Government stirs in the matter. We have already a permanent international organisation, which, if its functions were to be extended so as to include the measurement of time as well as of space, might consider the question without any large increase of its numbers; we refer to the *Commission du Mètre*, which already largely consists of astronomers. We point this out to show that there are no real difficulties in the way of a preliminary consideration of the matter—nay more, that there are ways of reducing the difficulties by the choice of a body which already exists, and exists too in France, where the idea of a neutral meridian still lingers. We believe that a serious practical discussion would show that the idea which lies at the root of the contention for a neutral meridian is as impossible now as it has been in the past with regard to other internationalisations, such as Roman letters and Arabic numerals. If this were so, a great step would have been gained.

The writer in *Science*, however, does not propose that the Governments should be urged forward by any idea of saving their share of the sum we have already mentioned, and quite rightly. The idea is thrown out that it should be spent in an international mountain observatory, where in turns astronomers of all countries could carry out their special researches. The idea is a most admirable one, and will commend itself to all who know how years, and we may even say centuries, are being lost by heartbreaking attempts to do at a low level important work which is really only practicable at a high elevation.

PROFESSOR TAIT'S "PROPERTIES OF MATTER"

Properties of Matter. By Prof. Tait. (Edinburgh: Black, 1885.)

THE subject of this excellent little book includes the mechanical properties of matter, and much that is usually treated under the head of Chemical Physics, such as Diffusion and Capillarity. It might be difficult to give a reason why the electric and thermal conductivities of mercury, for example, should not be included among its properties as much as its density and its capillarity; but the distinction is convenient, and to some extent sanctioned by usage.

In the introductory chapters the author expounds some rather peculiar views with perhaps more insistance than is desirable in an elementary work. The word "force" is introduced apologetically, and with the explanation that "as it does not denote either matter or energy it is not a term for anything objective." No one will dispute the immense importance of the property of conservation, but the author appears to me to press his view too far. As Dr. Lodge has already pointed out, if conservation is to be the test of existence, Prof. Tait himself does not exist. I forbear from speculating what Dr. Lodge will say when he reads on p 11 that "not to have its price is conclusive against objectivity."

Chapters IV. to VII. form an elementary treatise on Mechanics, in which even the learned reader will find much that is interesting in the way of acute remark and illustration. Under the head of Gravitation are considered Kepler's laws, the experimental methods for determining the constant of gravitation ("the mean density of the earth"), and the attempts (such as Le Sage's) which have been made to explain the origin of gravitation.

The succeeding chapters on the deformation of solids and the compression of solids, liquids, and gases, are perhaps the most valuable part of the work, and will convey a much needed precision of ideas to many students of physics whose want of mathematical training deters them from consulting the rather formidable writings of the original workers in this field. The connection of Young's modulus of elasticity, applicable to a rod subject to purely longitudinal pull or push, with the more fundamental elastic constants expressing the behaviour of the body under hydrostatic pressure and pure shearing stress respectively, is demonstrated in full. Prof. Tait remarks that "Young's treatment of the subject of elasticity is one of the few really imperfect portions of his great work ('Lectures on Natural Philosophy.'). He gives the value of his modulus for water, mercury, air, &c.!" A deficiency of explanation must be admitted, but I am not sure that Young's ideas were really confused. The modulus for solids corresponds to a condition of no lateral *force*, that for liquids to no lateral *extension*. The distinction should certainly have been pointed out; but the moduli are really comparable in respect of very important effects, which Young probably had in his mind—viz. the propagation of sound along a bar of the solid in one case, and in the other through a fluid, whether unlimited or contained in an unyielding tube.

As a great admirer of Dr. Young's work, I cannot resist adding that if in some respects his treatment of elasticity is defective, in others it is in advance of many modern writings. Witness the following passage:—"There is, however, a limit beyond which the velocity of a body striking another cannot be increased without overcoming its resilience, and breaking it, however small the bulk of the first body may be, and this limit depends upon the inertia of the parts of the second body, which must not be disregarded, when they are impelled with a considerable velocity. For it is demonstrable that there is a certain velocity, dependent on the nature of a substance, with which the effect of any impulse or pressure is transmitted through it; a certain portion of time, which is shorter, according as the body is more elastic, being required for the propagation of the force through any part of it; and if the actual velocity of any impulse be in a greater proportion to the velocity than the extension or compression, of which the substance is capable, is to its whole length, it is obvious that a separation must be produced, since no parts can be extended or compressed which are not yet affected by the impulse, and the length of the portion affected at any instant is not sufficient to allow the required extension or compression."

The theory of "bending" and of "torsion" are discussed in Chapter XI. When the section of the rod deviates from the circular form, the torsional problem becomes rather complicated; but a statement is given of some of the interesting results of Saint Venant's investigations. In his treatment of the compression of solids and liquids, the author is able to make valuable contributions derived from his own experimental work.

In the chapter on "gases," a long extract is given from Boyle's "Defence of the Doctrine Touching the Spring and Weight of the Air," in order to show how completely the writer had established his case in 1662. As to this there can hardly be two opinions; and Prof. Tait is fully justified in insisting upon his objections to "Mariotte's law." In Appendix IV. a curious passage from Newton is discussed, in which the illustrious author appears to speak of Mariotte sarcastically. It is proper that these matters should be put right; but Prof. Tait is hardly impartial enough himself to succeed in enlisting the complete sympathy of foreigners. Cases of glaring injustice should be rectified; but there will always be a tendency (from which Englishmen cannot claim to be exempt) to give a full measure of credit to one's own countrymen, if only because one is better informed concerning their labours.

There is one matter, suitable to an elementary work, which I should be glad to see included in a future edition, viz., the principle of dynamical similarity, or the influence of *scale* upon dynamical and physical phenomena. It often happens that simple reasoning founded upon this principle tells us nearly all that is to be learned from even a successful mathematical investigation; and in the very numerous cases in which such an investigation is beyond our powers, the principle gives us information of the utmost importance. An example will make this clear. The pitch of a tuning-fork of homogeneous steel is dependent upon the size and shape as well as upon the elastic quality of the material; but the matter is too difficult for rigorous mathematical treatment. If, however, it be asked, How does the pitch depend upon the *size* of the fork, the shape and material being given? we need no complicated mathematics at all. The principle of dynamical similarity tells us at once that the time of vibration is proportional to the linear dimension.

Another example might be taken from a reaction which Prof. Tait describes as specially complex—viz., collision. A glass ball drops upon a marble floor from a height of one foot. How does the size of the ball affect the strains during collision and the danger of rupture? The principle teaches that if the scale of time be altered in the same proportion as the scale of length, similarity is secured, so that the strains are equal at corresponding times and at corresponding places. Hence a larger ball is not more likely to break than a smaller one, unless in consequence of the greater *duration* of the strains. I feel sure that in Prof. Tait's hands this very important and fundamental principle might be made intelligible to the great mass of physical students.

It would lead us too far to refer in detail to the various subjects treated in the later chapters under capillarity, diffusion, osmose, transpiration, viscosity, &c., but there is one point that I should like to mention. The explanation on p. 249 of the behaviour under water of drops of ink and of solution of permanganate of potash assumes the existence of a capillary tension in the surface separating the two fluids. In my own experiments on jets with this very solution, I have never seen any tendency to break up into drops (as, according to Savart and Plateau, there would be in air), and have therefore supposed that the capillary force was *nil*, or at any rate very small. Moreover, theory shows that the force depends entirely upon the suddenness of transition between two media, which suddenness must be broken down almost instantaneously when two miscible liquids come into contact. As the matter stands there seems to be here some discrepancy, which, perhaps, Prof. Tait could elucidate.

In his preface the author holds out hopes of further volumes on the same plan, dealing with dynamics, sound, and electricity. The readers of the present work will, I am sure, join in the wish that the appearance of these may be delayed no longer than is absolutely necessary.

RAYLEIGH

GRISEBACH'S "VEGETATION OF THE EARTH"

Die Vegetation der Erde nach ihrer klimatischen Anordnung. Ein Abriss der vergleichenden Geographie der Pflanzen. Von A. Grisebach. Zweite vermehrte und berichtigte Auflage. 8vo. Vol. I., pp. 567; Vol. II., pp. 693. (Leipzig: Wilhelm Engelmann, 1884.)

FROM the date, and the statement on the title-page that this is an augmented and corrected second edition of a work which was published in 1871, it might be expected that it contains the results of much more recent investigation; but an examination of the present edition is very disappointing. Indeed, it is doubtful, to say the least, whether it deserves the descriptive title given to it; for the "Quellenschriften und Erläuterungen" do not appear to contain a single additional reference, and it is not easy to discover that it has a claim to be anything more than a reprint, with some trifling alterations, of the original edition of 1871. The author died in 1879, so that one naturally looked to see who was the editor of this edition, and it was only after much seeking that a clue was found in a foot-note on p. 15 of the preface. After the appearance of the "Vegetation der Erde," A. Grisebach continued to write annual reports on the progress of geographical botany, and these, together with other scattered articles, were published in a collective form in 1880 by his eldest son, under the title, "Gesammelte Abhandlungen und kleinere Schriften zur Pflanzengeographie." From the foot-note in question it appears that this son—a gentleman in the Consular service of his country, and presumably unacquainted, or imperfectly acquainted with botanical literature—edited the new edition of the "Vegetation der Erde," "based upon the corrections and additions left by the author." Now it is perfectly certain that Grisebach regarded the annual reports referred to as so many supplements to his greater work, and the substance of which he would doubtless have incorporated therein had he himself prepared a second edition. Since his death, too, considerable additional information on geographical botany has come to light; and, what is more, it has been collected and published in German by Drude, Engler, and others; yet, as already mentioned, the additions and corrections in the present edition are merely trivial, and cannot be said to enhance materially the value of the work. In a footnote to Grisebach's preface to Tchihatcheff's admirable French edition of the original work, reproduced here, it is stated that some additions of Grisebach's thereto are here intercalated in their respective places. This is very good, but why Tchihatcheff's copious annotations and additions, recognised and sanctioned, as it were, by the author himself, should be ignored in a second German edition, is incomprehensible, saving the assumption that both with respect to his father's annual reports and other sources, the son was wholly incapable of doing his father justice. It is a pity that the task of preparing a second German edition was not entrusted to a competent botanist, because the original work, apart from the uncompromising antagonism to Evolution that pervades it, still occupies an undisputed position in modern botanical literature. As it is, the French edition is not merely an advance on the original German—it is incomparably better than the second German edition. It is only, however, fair that some justification of such assertions should be given. Taking the chapter on Oceanic Islands as an example, it may be confidently stated that no additional information is given; yet there is no branch of geographical botany that has advanced more during the last decade than insular. On the other hand Tchihatcheff embodies nearly all that was known up to date. One slight alteration observed in this chapter is—Madeira is stated to be 50 German geographical miles nearer Europe than the Azores, instead of 150, as in the original. Then certain unfounded statements in refutation of the arguments of other botanists concerning the relationships of insular floras remain uncorrected. Thus, in allusion to Sir Joseph Hooker's demonstration ("Insular Floras," p. 7) that the vegetation of St. Helena has, on the whole, its nearest affinities in South Africa, it is objected, on the authority of Roxburgh, that three out of the five genera named by Hooker were originally introduced into the island from the Cape of Good Hope, whereas an examination of Roxburgh's enumeration of the plants of St. Helena reveals the fact that the indigenous, and endemic, St. Helena species of the genera in question were unknown to him, and his remarks apply only to actually introduced species. Again, to repeat in 1884 such statements as that the vegetation of Juan Fernandez has little systematic relationship with that of the Chilian or Antarctic floras and that *Pringlea antiscorbutica* is restricted to Kerguelen Island is unpardonable, because the contrary is now historical. Defects such as those pointed out are numerous, but as they are mostly due to the state of knowledge fifteen years ago, the author of the work of that date is not to be blamed for them; rather the present editor and publisher for offering the public an old book as new.

W. BOTTING HEMSLEY

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Nomenclature in Elasticity

THE word *stress* is used, sometimes in the sense of *load*, sometimes in that of *load per unit area*. Clearness, however, requires these two ideas to be kept perfectly distinct, and therefore to be denoted by separate terms. *Load* is surely expressive enough, or, if not, there is the more comprehensive word *force*: why then use *stress* synonymously? It would be far better to reserve *stress* to signify *load per unit area*. This Prof. Kennedy (p. 269) calls *intensty of stress*; but why not *stress* simply? The word *intensity* is not in itself suggestive of anything distinctive, and is therefore useless.

Pressure and *tension* are terms used in the same loose manner, though, when intended to represent *force*, they sometimes have the word *whole* prefixed. Is it not better to say *force* when we mean *force*? We can then reserve *pressure* and *tension* as vector-synonyms of *stress* in the sense of *force per unit area*, which is indeed their usual *rôle*.

Another misused term is *resilience*, which sometimes denotes the *work* done in producing *proof* strain in a body (Rankine's definition), sometimes the *work* done *per unit volume* in producing *proof* strain, sometimes the *work* done *per unit volume* in producing *any* strain. I prefer, myself, the third definition: the second would then be the *proof resilience*, and the first might be called the *strain-energy*.

However, whatever terminology is finally agreed upon, let it be perfectly definite and consistent.

In his Fig. 1 (p. 269) Prof. Kennedy writes: "Breaking load, 18·85 tons per square inch." According to his own nomenclature, he should surely say: "*intensity of* breaking *stress* 18·85 tons per square inch," and this I should prefer to call simply the breaking stress—premising that for *tons* I should write *tons' weight*. In this case, as the diameter is ¾ inch, and therefore the section ·442 square inch, the breaking *load* is 8·33 tons' weight. Similarly in the other figures.

Christ Church, Oxford ROBERT E. BAYNES

Earthquake-Proof Buildings

MR. MUIR is quite correct as to the facts and date of the introduction of the aseismatic tables into Japan. In 1869-70 seven aseismatic tables for carrying the lighting apparatus were sent from here and erected in Japan, and Mr. Simpkins, who has recently returned from Japan, informs me that there are three in action at present. Two iron towers, 46 feet high, with this arrangement at their base, were also constructed and shipped for Japan, but the vessel was lost and no more were sent out, as the engineer in charge—Mr. Brunton—took an unfavourable view of their efficiency—his idea being that they would not work, as he considered that buildings of "great weight and solidity, thereby adding to their inertia and checking their oscillation, were best suited to meet the difficulty in Japan." Mr. Milne's experiments with aseismatic tables have borne out Mr. David Stevenson's original view as to their power of mitigating an earthquake shock. For fuller information see NATURE, vol. xxx. p. 193. D. A. STEVENSON

Edinburgh, August 3

A Mechanical Telephone

HAVING observed in this week's NATURE a notice of a "mechanical telephone" said to be brought from America, I may state that so far back as 1878 I experimented on the transmission of sounds by wires, and communicated the results obtained, from a large number of experiments, to the Physical Society of London in March, 1878; the paper being afterwards published in the *Philosophical Magazine* for August, 1878. These experiments are referred to by the Count du Moncel in his book on "The Telephone," published in 1879. I found no difficulty in carrying on a conversation through wires laid in various ways from room to room of a house; and musical sounds, breathing, and whistling were also readily transmitted, and through most unlikely arrangements, such as a common wire fence. Various materials were tried for the transmitting and receiving ends—disks of cardboard set in deepish rims being found to give excellent results with a No. 16 copper wire. In one of my experiments I found that the disks were not required, the wire itself picking up and transmitting the sounds. The results obtained were most interesting; but as the range was necessarily limited, it did not seem to me that there was much scope for practical application. W. J. MILLAR

100, Wellington Street, Glasgow, July 31

Electrical Phenomenon

ABOUT ten o'clock in the evening of July 23 a party of four of us were standing at the head of the avenue leading to this house, when we saw a feebly-luminous flash appear on the ground at a distance of some thirty yards down the avenue. It rushed towards us with a wave-like motion, at a rate which I estimate at thirty miles an hour, and seemed to envelop us for an instant.

My left hand, which was hanging by my side, experienced precisely the same sensation as I have felt in receiving a shock from a weak galvanic battery. About three minutes afterwards we heard a peal of thunder, but, though we waited for some time, we neither saw nor heard anything further.

The gardener, who was one of the four, thus describes what he saw:—I thought it was a cloud of dust blowing up the avenue, and before I could think how that could be when there was not a breath of wind, I saw you three gentlemen covered for a second in a bright light, and that was all. Another of the party says that he observed what seemed to be a luminous cloud running up the avenue with a wavy motion. When it reached the party it rose off the ground and passed over the bodies of two of them, casting a sort of flash on their shoulders. The distance traversed was about twenty yards, and the time occupied between two and three seconds. (My own estimate of distance and velocity makes the time occupied almost exactly two seconds.) The day had been extremely hot and sultry, as also had the preceding day been, the thermometer readings being sometimes 80° F. in the shade.

On asking the gardener for further particulars, he tells me that the distance traversed by the luminous cloud was about forty yards, and that, when it had gone about half the distance, he saw a flash of lightning in the direction of it, but sideways; also that the top of the cloud seemed to be three or four feet from the ground, and it gradually rose higher as it came along. When the cloud reached the party he saw one of them distinctly by its light, the night being otherwise quite dark at the time; and, lastly, that the cloud went a few yards beyond the party into the open space in front of the house, and then disappeared.

J. B. A. WATT

Marchfield, Davidson's Mains, Midlothian

Our Ancestors

DURING eight centuries—say to the time of the Norman conquest—one's direct ancestors amount to a far greater number than would at first be contemplated. Taking three generations to a century, one has father and mother (2), grandparents (4), great-grandparents (8). At the end of the second century the number of ancestors springs to 64. Following the calculation you will find that at the end of eight centuries one is descended from no less than 16,000,000 ancestors. Intermarriage of course would reduce this estimate, and there is no doubt it must have largely prevailed. But the figures are so enormous that, in spite of all, I venture to suggest that the words "All ye are brethren" are literally true.

$\left(\frac{1}{2}\right)^n$

CO-ORDINATION OF THE SCIENTIFIC BUREAUS OF THE U.S. GOVERNMENT

A MOVEMENT is on foot in the United States for rearranging the various scientific departments of the Government under one central authority, and a report on the subject has been made by a committee of the National Academy of Sciences, consisting of Gen. Meigs, and Professors Trowbridge, Pickering, Young, Walker, and Langley, appointed for the purpose. The Report is published at length in *Science*. After referring to the state of things in Europe in this respect, it gives a brief account of the method in which such bureaus are organised in other countries; discusses at some length the character of the work done by the coast and geodetic and the geological surveys, especially in those points where their provinces are similar, pointing out that two distinct and independent trigonometric surveys of the United States are now in process of execution; distinguishes between the military and meteorological work of the Signal Service, and recommends their complete separation; indicates the danger of duplication of work by the Coast Survey and Hydrographic Office, but is not prepared to recommend that the latter be detached in any way from the control of the Navy Department, nor that the hydrographic work of the Coast Survey, for over forty years conducted so satisfactorily, be separated from that organisation, but suggests the lines on which it thinks the Coast Survey should work; lays down the principle that the Government should not undertake any work which can be equally well done by the enterprise of individual investigators, and that such work should be confined to what will "promote the general welfare of the country;" urges the importance of a proper extension of the trigonometrical survey of the United States; and, finally, recommends either the establishment of a department of science, or of a mixed commission of nine members—two of them scientific civilians to be appointed by the president for six years, two scientific men from the army and navy, three heads of the principal scientific bureaus, together with the president of the National Academy, and the secretary of the Smithsonian Institution.

To the Department of Science, or to the supervision of this Commission, it would transfer the Coast Survey, the Geological Survey, and the Meteorological Bureau, and establishing a physical laboratory, add to it a Bureau of Weights and Measures, the functions of which are now performed by the Coast Survey. The province of the proposed Commission is amply defined.

In the course of the Report the Committee give an interesting sketch of the work accomplished by the Coast Survey.

The Coast Survey was originally organised for the purpose of constructing maps and charts of the coast and harbours for the benefit of commerce and navigation. Conflicting opinions respecting the proper management of the Survey led to the formation, in 1843, of a board of officers with the duty of reorganising the Survey. This board submitted a plan which was enacted by Congress into law, upon and under which law the Survey has hitherto been executed. This plan provided for the cooperation of military officers, naval officers, and civilians in the various parts of the work. Under it the work of the Coast Survey has been continued to the present time.

In recent times a great extension of the field of operations of the Survey has been made, apparently looking to a triangulation covering the entire territory of the United States. The maps published annually with the report of the Survey enable us to know the geodetic work it has executed. It appears, from the maps accompanying the report of 1882, that on June 30 of that year a chain of triangles had been extended throughout the entire length of the Atlantic and Gulf coasts, and throughout about half the Pacific coast. Besides these coast-lines, extensive regions in the interior are seen to be triangulated. In the north-east, the triangulation covers the greater part of the States of New Hampshire, Vermont, and Massachusetts, about half of Connecticut, and it also includes a considerable part of the State of New York.

The reconnaissance has extended westward from the New Jersey coast, so as to include the greater part of the State of New Jersey, and a long strip in Pennsylvania. From Pennsylvania, the extended line of primary triangulation follows the Alleghany Mountains into Northern Alabama, and is now being continued across the country to Memphis.

A triangulation of the Mississippi River was extended from its mouth nearly to Memphis, where it would meet the last-described chain of triangles. The chain connecting the Atlantic and Pacific coasts has been completed nearly across the State of Nevada, and the reconnaissance includes nearly half of Utah Territory. The line is also surveyed at various points in Colorado, Kansas, Missouri, and Illinois. Besides all this, isolated regions in Wisconsin, Indiana, Illinois, Ohio, Kentucky, and Tennessee have been reconnoitred by the Coast and Geodetic Survey, in a way indicative of a plan designed ultimately to cover the entire territory. As its appropriations for some years past have made provision for the collection of data for a general map of the United States, we may fairly regard the Coast and Geodetic Survey as having undertaken a trigonometric survey of the whole United States.

The general views of the Committee respecting the working of the departments of the Government are worthy of special attention. They conceive it to be a sound principle that Congress should not undertake any work which can be equally well done by the enterprise of individual investigators. The leading universities are constantly increasing the means of scientific research by their professors and students; and, while the Government may with propriety encourage and cooperate with them, there is no reason why it should compete with them. The scientific work of the Government ought not, therefore, to be such as can be undertaken by individuals. It should also be confined to the increase and systematisation of knowledge tending "to promote the general welfare" of the country. Within these two restrictions there is a large and increasing field, which is only partly occupied by the organisations now under consideration.

The attention of Congress should be directed to the fact that the administration of a scientific bureau or department involves greater difficulties than that of a purely business department. The connections between the work done and the results ultimately to be attained for the public are not at all obvious to the people and press, and thus the great benefit of vigilant watching and constant criticism is wanting. Again: its administration requires a combination of scientific knowledge with administrative ability, which is more difficult to command than either of these qualities separately. These difficulties are intensified by the absence of any central authority to control the work of a Government scientific organisation. Each head of a scientific organisation is now practically absolutely independent, and, in his individual judgment of what his organisation shall do, is controlled only by Congress itself, acting only through its annual appropriation bills. The Committee conceive that this state of things calls for measures of reform.

A feature of such reform will be the collection of the organisations now under consideration, together with such other scientific bureaus as Congress may see fit to include in the scheme, under one central authority, to be recognised as responsible for, and controlling generally, the scientific operations of the Government. Various forms of such an authority might be devised, the choice of which will some day be made by Congress. The best form would be, in the opinion of the Committee, perhaps, the establishment of a "department of science," the head of which should be an administrator familiar with scientific affairs, but not necessarily an investigator in any special branch.

"Your Committee," the Report concludes, "states only the general sentiment and wish of men of science, when it says that its members believe the time is near when the country will demand the institution of a branch of the executive government devoted especially to the direction and control of all the purely scientific work of the Government. In this day the pursuit of science itself is, visibly to all men of education, directly connected with the promotion of the general welfare.

"Should such a department be now impracticable, should public opinion not be now ready for it, the next best measure, in the opinion of scientific men, would be to transfer all such work or bureaus to some one executive department. Keeping in mind what has been said respecting the two classes of work under the Signal Service, we are of opinion that the functions of the several organisations under consideration could now be most advantageously divided among perhaps four bureaus, viz.:—

"1. The Coast and Interior Survey, to be concerned principally with geodesy and hydrography, and to consist of the present Coast and Geodetic Survey.

"2. The Geological Survey, to comprise the present Geological Survey with its organisation unchanged.

"3. The Meteorological Bureau, to which should be transferred so much of the present *personnel* and functions of the chief signal office as are not necessary to the military duties of that office.

"4. A physical observatory, to investigate the laws of solar and terrestrial radiation, and their application to meteorology, with such other investigations in exact science as the Government might assign to it. In this connection, attention is called to a resolution passed by the recent Electrical Conference in Philadelphia, requesting the establishment, by the Government, of a Bureau of Electrical Standards. We are of opinion that the functions of the Bureau of Weights and Measures, now performed by the Coast Survey, could be advantageously transferred to the proposed bureau, and extended so as to include electrical measures.

"The members of your committee are conscious that placing these bureaus under one department would not necessarily result in the proper co-ordination of their work, because the head of such department would probably find it impracticable to enter into the consideration of all details necessary to that purpose. It appears to us that the evils already pointed out require, in any case, the organisation of a permanent Commission to prescribe a general policy for each of these bureaus. The functions of this Commission would be:—

"1. To examine, improve, and approve the plans of work proposed by the several bureaus, and to revise their estimates in accordance with such plan. The performance of this duty would require consultation with their chiefs generally and separately respecting the character of their work, and they should be members of the Commission.

"2. To approve in detail the methods of expenditure of the appropriations.

"3. To recommend such measures as they deem necessary to the efficiency of the bureaus under their supervision. It should, however, be understood that this Commission is not charged with purely administrative responsibility. It prescribes what shall be done, and recommends any measures necessary to secure that object, but does not concern itself with administrative details.

"We submit the following as a suggestion for the formation and *personnel* of such a Commission:—

"The Commission shall consist of (1) the President of the National Academy of Sciences; (2) the Secretary of the Smithsonian Institution; (3) and (4) two civilians of high scientific reputation, not otherwise in the Government service, to be appointed by the President of the United States for the term of six years; (5) one officer of the Corps of Engineers of the army; (6) one Professor of Mathematics in the navy, skilled in astronomy—these two to be designated by the President of the United States for a term of six years—who, with (7) the Superintendent of the Coast and Geodetic Survey; (8) the Director of the Geological Survey; and (9) the officer in charge of the Meteorological Service; shall constitute the Commission of ——. The Secretary of the —— department shall be *ex officio* President of the Commission.

"The members of the Commission, for their services as such, shall each be paid by the United States compensation in the sum of —— dollars per annum. Their necessary transportation and travelling expenses shall be provided for as are those of the officers of the army and navy when travelling on public business or duty, to be paid out of the appropriations for the services under their supervision.

"The Commission shall meet in Washington, D.C., for the transaction of business, not less than four times a year; but the President of the Commission may convene it whenever in his judgment the exigencies of the service require a meeting.

"The Commission shall be attached to the office of the secretary of the department of ——, and under his superintendence shall exercise a general control over the plans of work of the Coast and Geodetic Survey, the Geological Survey, and the Meteorological Service, and shall have the charge and custody of all the archives, books, documents, drawings, models, returns, apparatus, instruments, and all other things appertaining to the Commission.

"The estimates of the heads of these bureaus or offices shall pass through the Commission for revision and approval; and, after the annual appropriations have been made, no money shall be expended under them, except after revision and approval by the Commission of projects submitted by these bureaus in compliance with such projects.

"If at any time public money is being spent by any of these bureaus not in accordance with the views of the Commission, the Commission shall notify the proper auditor of the fact."

Our readers are already aware that the Congressional Committee appointed to consider the organisation of the surveys and other scientific work of the Government made no report at the last Session of Congress. The Commission was, however, continued as a Commission of the succeeding Congress. The expired places of Messrs. Pendleton and Lyman were filled by new appointments from the members elected to the next Congress. A meeting of the reorganised body has been held, which adjourned until next November without coming to any definite conclusion respecting the measures to be finally proposed. Before adjourning, Major Powell was authorised to make public the testimony which he had laid before them on different occasions, and which covers most of the points to be acted on by the Commission.

Major Powell's statements naturally include a very detailed account of the methods, work, organisation, and expenses of the Survey over which he presides. He also submitted his views upon the best method of consolidating the geological and coast surveys with the other scientific bureaus of the Government. This is the really important question before the Commission, since upon its decision must turn the general efficiency of the Government scientific service for a long time to come. The necessity for some such consolidation is strongly felt in Congress as well as outside of it. The one danger to be avoided is that of some hasty plan being adopted which may suit the exigencies of the moment, but may not work well after those exigencies have passed.

One very strong reason for placing the scientific bureaus under one head, or in one department, is that scientific work has many features peculiar to itself, which require it to be conducted upon principles different in some respects from those which prevail in other departments. The head of an ordinary bureau or department of the government, and indeed every man in public life, is conversant only with offices and duties which there is no serious difficulty in satisfactorily filling, with the aid of that knowledge of men and of the world which he acquires through his daily intercourse with others. Such a person is accustomed to finding scores of candidates for every office, from whom a suitable selectionis always possible. The idea of an office for which there may be no applicants, or, if there are any, for which it is morally certain that the applicants are all unfitted, no matter how good their recommendations, is one which he finds it difficult to assimilate. Indeed, in the case of the purely scientific office, the ability to find the proper men must be a part of the life education of the man who is to make the selection. It is safe to say that the best officers who have served in the coast and geological surveys are men who, under the ordinary system of Government appointments, would never have been heard of in connection with the positions which they so ably fill.

The same thing is true of the administration of a scientific bureau. No uniform system can be devised which will apply to all the details of a great scientific work. When we go beyond the regular routine operations it is needful that the duties shall be accommodated to the man, and that in many cases a larger measure of liberty shall be allowed the latter than could be tolerated in the usual operations of a Government department. All this requires, on the part of the administrative head of the department, an appreciation of the subject which can only be acquired by long familiarity. If the head is not specially charged with mastering the peculiar methods of administration thus rendered necessary, the chances are that he will fall into one of two opposite errors: either he will leave the heads of the scientific bureaus to manage things in their own way, without any administrative control whatever, or he will exert his authority in such a way as to endanger the efficiency of the work. The former is undoubtedly the more natural course to take, and thus arise the friction and duplication of work which so seriously impair efficiency and discipline.

Yet another feature of Government scientific work is that it is far removed from that public criticism which is so conducive to efficiency in other branches of the service. It is difficult to conceive that such a state of things as was exhibited by the surveys of the territories ten years ago could have existed in the performance of any work with which the public were conversant. At that time we had at least two independent surveys of the territories, prosecuted by different departments of the Government and with nominally different objects, but which were practically identical in their actual work. The officers in charge were independently surveying and mapping the very same regions. At the time that Hayden's Atlas of Colorado was published, Capt. Wheeler was engaged in surveying Colorado and making maps of the territory substantially identical in their objects with those of Hayden. Both surveys were intended to cover the whole public domain.

Nothing quite so bad as this is likely to arise in the future. But there is still room for much duplication of work as well as taste through competition in getting possession of particular fields. As a general rule, the head of a department is quite ready to approve of any extension of work which any of his bureau officers may propose, and has not always time to learn that the same work is being done, or might be better done, by some other department. The annual provision which Congress has got into the habit of inserting into the appropriations for the Signal Office—"provided that hereafter the work of no other department, bureau, or commission authorised by law shall be duplicated by this bureau"—is not quite satisfactory: it leaves open the question whether any proposed work is "the work of any other department, bureau, or commission."

The report of the National Academy of Sciences proposes to remedy some of these evils by placing the general policy of the scientific bureaus under the control of a mixed commission, organised somewhat after the plan of the Lighthouse Board. If the bureaus are to remain separate, we see no better plan than this for securing the proper coordination of their work; but Major Powell points out certain difficulties in the way of its successful operation. His strongest objection is, that subordinate officers of various departments would have to practically control the work, thus reducing the heads of the departments to channels for transmitting instructions. If the proposed Commission were to assume any administrative control of the work, this objection would certainly be fatal. The official responsibility of the head of a department for the work of his bureaus should not be interfered with. But the report of the Academy expressly disclaims charging the Commission with any administrative responsibility. Its sole function was to prescribe the policy o the bureaus; that is, to decide what each one should do, and what each one should refrain from doing, the whole execution of the work decided upon being left completely in the hands of the regular authorities. We see no reason why this should be "irksome" to the heads of the departments. We also feel that Major Powell assigns undue importance to the influence of the single military officer proposed by the Academy as one of the nine members of the Commission. It is not so clear to us, as it seems to be to him, that one such officer could leaven the whole lump of the Commission with ideas of military discipline unsuitable to the conduct of a scientific bureau.

But however favourably we may view the plan of this Commission, we must hold that the consolidation of the bureaus under a single head, or in a single department, would give far more assurance of efficiency. Especially is this the case with the two national surveys. Their work now covers the same fields, and their mutual interdependence is such that they should work under a common plan. The Geological Survey requires for its proper execution certain geodetic and astronomical work, the execution of which is not within the proper province of the geologist. It is absolutelynecessary that this geodetic and astronomical work should be so planned and executed as to meet the wants of the Geological Survey, and at the same time it is the proper function of the geodetic survey. We are informed by Major Powell that he makes use of all the coast-survey results so far as they are available, but he does not indicate what fraction of his labour is thus saved; and it goes without saying that he has no authority, directly or indirectly, to require that the coast and geodetic survey shall do anything which he may want done.

Among the suggestions made by Major Powell was one that all the scientific bureaus should be placed under the general direction of the regents of the Smithsonian Institution. This does not appear to have been considered practicable, and was not further urged by the director himself. One of the possible plans is to place all these bureaus under the interior department. The principal objection to this course is that that department is already overloaded with work, so that its head could not give the proper consideration to the subject. Yet this is the simplest course, and would certainly be an improvement on the present state of things. The more effective course would be to form a separate department of science and public works. To this there seems to be no positive and serious obstacle except the difficulty of getting any measure of the sort enacted into a law. The question whether the head of the department should be a scientific expert or a public administrator is an ulterior one, which need not be discussed at present. In the latter case the question of its being regarded as a cabinet office would arise. There will be little hesitation in deciding this question in the negative.

THE LICK OBSERVATORY[1]

THE Lick Observatory, in its present condition on the summit of Mount Hamilton, California, is so nearly completed, with the exception of the great telescope, that the institution may now be sketched to advantage in its permanent form. In an early issue of *Science*, therefore, this enterprise will be traced through its various stages, from the inception onward. Astronomers have been slow to avail themselves of the great advantages of mountain elevation and isolation in the prosecution of astronomical research, partly because of the pecuniary outlay attending the necessary expeditions, but chiefly because some of the earlier expeditions to mountain summits were not attended with results of especial importance, and, on good theoretical grounds, the meteorological conditions of such stations appeared likely to be so unfavourable as to counterbalance fully the advantages to be derived from mere elevation. And besides, the evidence derived from the two most famous expeditions—that of Prof. C. Piazzi Smythe to the Peak of Teneriffe and of Mr. William Lassell to Malta—was so contradictory in character as to afford very good ground for abandoning the hope of immediate advantage to astronomy from superior elevations.

[1] From *Science*.

It is not possible to say how far Mr. James Lick was acquainted with these endeavours of scientific men; nor need the immediate circumstances or events which impelled him to his extraordinary astronomical bequest be considered here. Prof. Newcomb points out the fact that his movement followed close upon the completion of the great Washington telescope in 1873, then the largest in existence. Had Mr. Lick known the opinions of the best astronomers on the subject of mountain observatories, and the likelihood of securing, on elevated and isolated peaks, results at all commensurate with the trouble and expense of occupying such stations, he would have found very little to encourage the project. In this case, however, as very often before, a little experience has proved to be worth more than an indefinite amount of scientific theorising. It has been said that the scheme of building "a powerful telescope, superior to and more powerful than any yet made," was the nearest of all to the heart of Mr. Lick: there is abundant evidence that this is true; and it may be also true that he regarded the Observatory as an appendage of the telescope. But the course of subsequent events has proved it a matter for sincere gratulation in astronomical circles that he ever regarded either the Observatory or the telescope at all; for, had not the prospective researches with the great telescope arrested his attention, there is very little reason for believing that, in so far as he was concerned, astronomical science would ever have been in a position to reap benefit from the splendidly equipped Observatory which already exists on the summit of Mount Hamilton.

That Mr. Lick was bound, heart and soul, in the project, not only of a great telescope, but of the best possible location for it, is evident from the fact that, when nearing his eightieth year, and although oppressed with physical infirmity, he resolutely undertook a waggon journey of some forty miles or more, reclining on a mattress, all for the sake of investigating a proposed mountain site in person. His solicitous concern for the enterprise was very marked. Those who knew him best say that, if his practical knowledge of astronomy had been greater, he would have given every penny of his vast fortune for the great telescope, and the Observatory and its endowment. He would have recognised, too, the great improbability of such an institution being completed within a period of a few short years, and would thus have been led to provide for the reasonable use of the instrumental equipment as fast as it was put in place on the mountain. The failure to make such provision constitutes the chief point of unfavourable criticism on the part of astronomers, and is in many respects unfortunate; but sundry advantages also have arisen from it, which may be recognised with more profit, particularly as this condition of things must remain unalterable until the great telescope is completed, and the entire institution comes under the administration of the University of California, in full accord with the terms of Mr. Lick's bequest.

Five years ago no one could have anticipated that the year 1886 must pass with the great telescope still unfinished. It is worthy of note, however, that, while the delay in obtaining the necessary glass for the objective has proved so great an embarrassment to the work of the opticians, it has not as yet sensibly impeded the progress of the construction of the Observatory itself. To this fact we alluded at p. 377 of the current volume of *Science*, stating as well the very reasonable grounds for the belief that the plans of the Lick trustees, in so far as they pertain to the construction of the great telescope and the conjoint Observatory, will be completely executed at the close of the year 1887. With its unparalleled instrumental equipment, and an unusual endowment for the prosecution of astronomical research; located where the sky is cloudless most of the year, and at such an elevation as to be above the clouds a great part of the remainder; and situate in a region, too, where the steadiness of the air permits astronomical measurement of the highest precision to proceed uninterruptedly throughout the entire night for months at a time,—the Lick Observatory is destined, under prudent management, to take its place at once in the foremost rank; and, although it is the first established mountain observatory, it may well expect to hold its own in the emulation of similar institutions which may subsequently be inaugurated at greater elevations.

TWILIGHT[1]

THIS essay, an extract from a more comprehensive work on the problem of twilight, which the author hopes to conclude in the course of this year, and embodying a lecture recently delivered by him both in Hamburg and Leipzig, describes the phenomena of twilight in general and of the remarkable sky-glows of the winter of 1883 in particular, with clearness, fullness, and exactness, and explains the physical causes of these phenomena from a special and mature study of that universally interesting field of observation, by numerous highly pertinent and illustrative experiments, and altogether in a manner which should bring home, even to the unscientific reader, a new sense and a new intelligence of the painting offered anew every morning and evening to the study and delight of man universally.

After relating and taking measure of the stupendous outburst of Krakatoa and the brilliant glows involving nearly the whole earth for a long period after that event, and comparing these two consecutive phenomena with the analogous phenomena of the outburst of "Graham Island" in 1831, followed by brilliant twilights and peculiar blue and violet sun colours, attracting the admiration, in particular, of Italy, France, and Germany, the book addresses itself to the task of investigating the physical laws concatening these two apparently heterogeneous phenomena, and why all volcanic outbursts are not attended by the same wonderful optic displays. While each particle of dust, smoke, or fog causes a bending or diffraction of the light, a collective effect, comprehending a brilliant development of colours, is produced only when all the particles of matter are of equal size and are distributed uniformly in space—a condition not even most remotely fulfilled in the case of ordinary smoke and fog. Diffraction includes the lateral dispersion of the light, which is all the more efficient the nearer the edges lie to each other, and therefore the smaller the particles are, and also the "interference" of like-coloured rays of light. When a red light falls, for example, on a fine glass thread or a diamond stroke scratched into glass, the shadow will consist not of one thin black line, but of a whole system of parallel stripes alternately dark and brilliant, *i.e.* black and red. When, again, a white light falls on the diamond stroke, the reflection shows a system of parallel stripes glowing in all the colours of the rainbow. In the case of a single line the development of colours is indeed so small as to be scarcely perceptible, but with many thousand lines of exactly the same breadth, and situated at exactly the same distance from one another, the reflex image is such that, taken up on a white screen, it is visible at great distances. Perfectly corresponding is the case with granules of dust. The shadow of a single granule of dust in red light consists of a system of concentric rings, alternately dark and redly luminous, which are all the broader the smaller is the granule. In white light, on the other hand, the shadow of the granule consists of alternately dark and bright rainbow coloured rings. If the dust granules are all of the same size, then will the like-coloured rings pretty nearly coincide, and, in the case of a sufficiently large number of granules, the reflex image will be composed of coloured rings of great luminousness. If, on the other hand, the dust-granules are of different size, then will all the different colours coincide, and, according to a well-known optic law, the image will be colourless. The image of a dust-cloud may, therefore, be rich in colours, poor in colours, or colourless, according as the particles of dust of which it is composed are of the same or of different size.

The experiments of Coulier and Mascart, extended by Aitkin, have demonstrated that in a perfectly moist air, no formation of fog is possible, however much the temperature is lowered, so long as the air is absolutely free of dust; and that the more air, sufficiently moist, is charged with such foreign particles, the more intense is the formation of fog under a sufficient lowering of the temperature or pressure of the air. Let filtered and completely moist air in a glass ball have its pressure diminished, then will only a few particles of fog reveal themselves to the most careful inspection, even under the powerful light of an electric lamp—particles of fog which, moreover, yield not the slightest coloured image. Admit now into this filtered air a few cubic millimetres of ordinary house air, then will a very fine, silvery, transparent fog at once form itself, of such slight density that even in the case of a considerable area of it the transparency of the atmosphere would be but very little affected. At the first moment of its formation let a reflected image of the sun, or the reflected light of an electric lamp, be viewed through it: the image will be seen surrounded by an intensely luminous blue or greenish light, with a broad, reddish ring, the colouring of which may range through all stages from brilliant purple red to the most delicate pale pink.

The phenomena of colour produced and explained by experiments of the above description are made to serve as the key to the more extensive but essentially identical phenomena composing the total process of twilight, which is distributed, like a spectacular play, into three acts with a prelude, and sometimes, though comparatively seldom, an afterlude—parts which, however, are not strictly distinguished in time, but occur to some extent simultaneously and overlap each other; as also to the comparatively unimportant deviations—apart from the intensity of colouring—from the normal course, which obtained in the remarkable sky-glows that arrested universal attention throughout the fall and winter of 1883.

[1] "Die Dämmerungserscheinungen im Jahre 1883 und ihre physikalische Erklärung." Von J. Kiessling, Professor am Johanneum zu Hamburg. (Hamburg und Leipzig. 1885.)

HENRY MILNE-EDWARDS

HENRY MILNE-EDWARDS was born at Bruges in October, 1800. Having completed his elementary studies in Belgium he attended medical lectures in Paris, where he took his diploma in medicine in 1823. While he retained an interest in medical and surgical pursuits until late in life, and was a member of the Academy of Medicine, Paris, of the Medical Societies of London, Edinburgh, &c., his earliest passion seems to have been for the study of natural history, and he soon abandoned the practice of his profession and devoted himself to scientific researches among the lower forms of animal life.

During the years 1826 and 1828, in company with his friend and fellow-labourer Audouin, the assistant to Lamarck and Latreille, he made a careful study of the various invertebrates to be met with on the coasts at Granville, around the Isles at Chansey, and as far as Cape Frehel. A member of the French Academy was, during 1828, engaged on some hydrographical work off this coast, and good-naturedly assisted the littoral zone workers, enabling them to use the dredge in somewhat deeper water than they could reach from a row-boat. The results of these investigations were laid before the Academy of Sciences in July and November, 1829, and formed the subject of an elaborate report presented to the Academy in November, 1830, by Cuvier, Dumerit, and Latreille, Baron Cuvier being the writer of the report. In this memoir, for the first time so far as we know, the idea of zones of marine life is promulgated; these were four in number. A considerable portion of the memoir is devoted to the subject of the bristles in Annelids and to a description and classification of the Annelids of the coast of France. The reporters did not hesitate to express their satisfaction with the work the two friends had done, calling the special attention of the Academy to the "efforts heureux par lesquels ces deux habiles naturalistes sont parvenus à enrichir la Faune française d'espèces si nouvelles et si curieuses, et la zoologie en général d'observations si intéressantes." These happy efforts were but the forerunners of others carried on, in the case of Milne-Edwards, throughout a lengthened life.

In 1841 Milne-Edwards was appointed to the Professorship of Natural History in the Collége Royal de Henri IV., and about the same time we find him holding the Chair of Zoology and Comparative Physiology at the Faculty of Sciences, of which Faculty he was afterwards the Dean. On his friend Audouin's death, he was made Professor of Entomology at the Museum, Jardin des Plantes.

A considerable number of original memoirs, the titles of which it is here unnecessary to detail, were published about this period by Milne-Edwards in the *Annales des Sciences Naturelles*. This famous periodical first appeared in 1824, under the editorship of Audouin, Brogniart and Dumas. In 1834 the second series, from which geology and mineralogy were excluded, commenced under the joint editorship, for the zoological portion, of Audouin and Milne-Edwards, so that for now fifty years the zoological department has been under his management.

While labours as important as they were numerous secured for H. Milne-Edwards a high position among men of science, his name was also universally well-known and made popular by his elementary works on zoology. His "Eléments de Zoologie" were published in 1834 and were reissued in 1851 as a "Cours élémentaire de Zoologie." This work had an enormous circulation in France, and has not only been translated into several other languages, but also, until almost the other day, it formed the stock-in-trade, either as to its text or its illustrations, of most of the many small elementary works on natural history published in Europe.

In 1838 Milne-Edwards was elected a member of the Academy of Sciences in the section of anatomy and zoology. He was made an officer of the Legion of Honour in 1847, and a commander of this Order in 1861. In 1862 he succeeded Isidore Geoffroy Saint-Hilaire as Professor of Zoology at the Jardin des Plantes, and in a year or two afterwards was made assistant director of the museum.

Of his more important works as distinct from his memoirs may be mentioned his "Histoire naturelle des Crustacés," 1834-40. In this he was assisted by his friend Audouin, and it long remained as a standard authority on this group.

The "Histoire naturelle des Coralliares," 1857-60, was commenced after Milne-Edwards's return, in 1834, from a collectingtour on the coast of Algeria; but in 1847, in order to satisfy the calls of his publishers, he associated Jules Haime, so well known for his memoirs on the Polyps in the Palæontographical Society of London and in the *Annales des Sciences Naturelles*, with him in this work; but the death of Haime in 1856 compelled Milne-Edwards to complete the work himself. It is in a few tender words dedicated to the memory of Jules Haime.

"Leçons sur la Physiologie et l'Anatomie comparée de l'Homme et des Animaux" were published between 1857 and 1881, in fourteen volumes. The series is dedicated to his friend, M. J. Dumas, to whom he had dedicated the first work of his early pen. These lectures will always possess an importance to the student, from the immense mass of details, accompanied with copious references to the labours of others, that are brought within a limited compass.

"Recherches anatomiques et zoologiques faites pendant un Voyage sur les Côtes de la Sicile, &c.," forms a splendid quarto volume of over 850 pages, which are illustrated with nearly 100 coloured plates. This work is, for the most part, a corrected report of a series of memoirs contributed to the *Annales des Sciences Naturelles* by Milne-Edwards, A. de Quatrefages, and Emile Blanchard.

There can be little question that the name of H. Milne-Edwards will always rank high among the naturalists of the first half of the nineteenth century, and for years he was incontestibly one of the leaders of zoology. He was among the first who, not content with the study of the dead forms of animal life, made prolonged visits to the sea-coasts to study the living forms and to investigate their habits. These were days before biological stations were thought of and when the details of geographical distribution were little known. That Milne-Edwards's study of the geographical distribution of the lower forms of Invertebrates led him to the theory of there being centres of creation was what, from a purely zoological point of view, might have been expected; and when larger and truer views burst upon the world through the genius of Darwin, Milne-Edwards's mind, already preoccupied, was never altogether able to take them in. By the student of biology Milne-Edwards will be remembered by his theory of the division of physiological labour, one which threw an interesting light on many an intricate problem.

H. Milne-Edwards was an excellent linguist. English he spoke like a native. In manner courteous, he was kindly and affable to all. His house at the Jardin des Plantes was for years the focus of attraction for all the men of science in or visiting Paris. He was the possessor of a splendid library, the treasures of which were most freely at the services of students. He was a member of most of the learned Academies of Europe and America, and the possessor of several orders of State. Full of years and service, he died in Paris on July 29 last. As Geoffroy Saint-Hilaire was on his death succeeded by his son Isidore, so, happily for zoology, Henry Milne-Edwards has, in his son Alphonse, handed down his name and place to one every way worthy of both.

RADIANT LIGHT AND HEAT

Preliminary Notions

IT has been known from time immemorial that a sufficiently hot body when left to itself gives out light and heat, and likewise grows cold. It has also been known that a body not sufficiently hot to give out light may yet be capable of giving out heat, cooling as it does so.

If the above facts be studied scientifically they at once give rise to a series of important issues, all of which we are now in a position to reply to. These may be put in the form of the following questions:

(1) Is radiant light a substance or, if not, what is it?
(2) With what velocity does it move through space?
(3) Is radiant heat physically similar to radiant light?
(4) What is meant by a hot body?
(5) In what manner is the issue of radiant light and heat related to the cooling of the body?

Of these five questions the second was the first to receive a solution, and this through the aid of astronomical observations.

Römer, a Danish astronomer, determined in 1675 the velocity of light by means of the eclipses of Jupiter's satellites. It so happens that the planes in which the earth and Jupiter move around the sun, as well as the plane in which Jupiter's satellites move around that planet, coincide very nearly with each other. As a consequence the first or nearest of Jupiter's satellites passes within the shadow of the planet at intervals of 42hr. 28m. 36s., and thus becomes obscured.

Now, if light were to travel instantaneously from Jupiter to the earth we should always see this obscuration at the moment when it took place. But even if light required time to travel, yet if the earth were always at a constant distance from Jupiter we should see the obscuration at a constant interval of time after its occurrence. Now Römer found that when the earth was furthest away from Jupiter there was a retardation in the time of the occurrence equal to 16m. 36s., as compared with that when the earth and Jupiter were nearest together.

It will be seen from the diagram (Fig. 1) that the

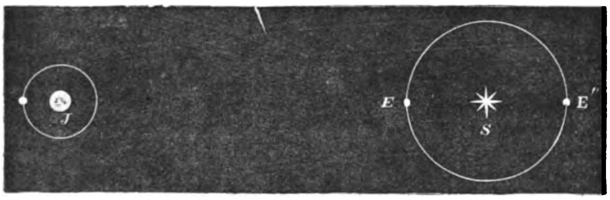


Fig. 1.

earth and Jupiter are nearest together when the earth is between Jupiter and the sun, and that the two are furthest apart when the sun is between the earth and Jupiter. Hence it follows that the difference in the distances from each other of the two planets in these two positions is equal to the diameter of the earth's orbit, or 183,000,000 of miles. If, therefore, light takes 996 seconds to cross this distance it ought to travel at the rate of 184,000 miles per second.

The velocity of light has likewise been determined by experiment. The arrangement for this purpose adopted by Fizeau is the one most easily understood. It consists of a toothed wheel, which may be made to revolve with great rapidity. Now a ray of light is made to pass through one of the intervals between the teeth, and to fall upon a reflecting mirror placed at a considerable distance off in such a manner that when the wheel is at rest the ray will be reflected back through the same interval. If, however, the wheel is in rapid motion it is possible that during the time which the ray takes to travel to the reflecting surface and back again the wheel may have moved so much that the ray is caught by the next tooth, and not allowed to pass through; while, if the motion be still more rapid, the ray may get through the next interval, and so on. Without entering more minutely into the conduct of the experiment, it will at once be seen that we have here the means of measuring the velocity of light.

By these and similar methods this velocity is now very accurately known, and is found to be about 187,000 miles, or 300,000 kilometres per second.

The evidence is very strong that all varieties of light, whether red, orange, yellow, green, blue, indigo, or violet move through vacant space with the same velocity.

Having thus briefly replied to the second of these questions, let me now return to the first, and inquire as to the nature of radiant light. We are able to conceive of two, and only two, varieties of progress in space. The one of these is the progress of actual matter, the other the progress of a form. An arrow discharged from a bow, or a bullet from a gun, represents the former of these, while the ever-widening circles which follow the plunge of a stone into a pool of water represent the latter. The progress which is visible when the wind blows along a field of corn or grass is another good illustration of a moving form. Here the corn or the grass is certainly not carried along, and if the wind is so carried, yet we cannot see the wind. What we see is an advancing form due to the oscillating motion of the various heads of corn or blades of grass. In like manner when a cannon or a gun is discharged at some distance from us the noise reaches our ear after a greater or less interval, depending upon the distance. Here it would be absurd to suppose that certain particles of air had been shot all the way from the cannon into our ear with the constant velocity of 1,100 feet per second—this velocity in the case of a gun or pistol being likewise the same as when the most powerful cannon is discharged. It is well known that in this instance a blow is given to the air, thus causing an arrangement of condensed and rarified particles which progresses with a certain definite velocity. The speed of progress of this form may either be determined by direct experiment, or by calculation founded on the well known properties of air—the two methods agreeing perfectly well together.

Now in many respects there is a strong analogy between sound and light, and these very questions which have been asked for sound are equally appropriate in the case of light. Can it be thought likely that hot bodies emit myriads of very small particles, which pass through space with the enormous velocity of 187,000 miles per second? or again, is it likely that this velocity should be precisely the same for all bodies and for all temperatures?

It is a singular circumstance that the illustrious Newton, to whom science owes so much, and one of whose achievements was a correct, or nearly correct, analysis of the conditions of undulatory motion in air, should nevertheless have become a powerful advocate of the corpuscular theory of light, thus lending his great authority to retard the progress of the rival theory, which represents light as an undulatory motion, similar in many respects to that which constitutes sound.

It is to Huyghens in the first place, and to Young and Fresnel in more recent times, that we owe the establishment of the undulatory theory of light upon so firm a basis that the older hypothesis is now entirely forgotten, or regarded only as a scientific curiosity.

There are two ways in which a theory may break down. Its various assumptions may display a great lack of living energy, or, in other words, may exhibit inability to expand themselves so as to incorporate a large volume of fact. Each new fact would thus imply the construction of a fresh assumption, so that there would be as many hypotheses as facts. A cumbrous structure of this kind, it is needless to say, would be utterly useless as a scientific instrument, and would finally fall to pieces from its own weight.

Another mode in which such a theory may break down is by the promulgation of some statement which is ultimately found to be contrary to fact. The corpuscular theory of light has broken down in both of these directions. For, in the first place, it had to be propped up by many fresh assumptions devised solely for the purpose of explaining fresh facts, and wholly useless in any other respect. In the next place one of its fundamental statements was ultimately contradicted by an appeal to experiment, carried out by M. Foucault, an eminent French observer. According to the corpuscular theory, or that of emission, the velocity of light ought to be greater in water than in air. On the other hand, according to the undulatory theory, the velocity in water is less than in air. If, therefore, it can be shown that light moves faster in air than in water then the undulatory theory is right; if the contrary, then the theory of emissions is right. Foucault succeeded in showing by an experimental method that light travels faster in air than in water, and this result has ever since been considered as decisive in favour of the undulatory theory.

We come now to our third question: Is radiant heat physically similar to radiant light? Here the difficulty is an instrumental one; the difficulty, in fact, of inventing something which shall do for dark heat what the eye can do for light.

At a comparatively early period Sir John Leslie devised his *differential thermometer*, with which he was able to obtain valuable results, to be hereafter alluded to. In this instrument we have two bulbs, A and B, filled with air, and connected together by a bent tube (Fig. 2) the lower

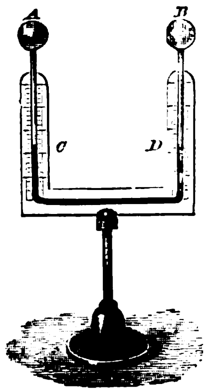


FIG. 2.

portion of which is filled with some coloured liquid, which ought not to be volatile. Let us begin by supposing that both bulbs are of the same temperature, and that under these circumstances the air is at the same pressure in both. The line between C and D, the surfaces of the liquid, in the two tubes will consequently be horizontal. Now suppose that the bulb A is heated, its air pressure is in consequence increased, and hence the liquid will be pushed down at C and up at D. In like manner if B is heated the liquid will be pushed down at D and up at C, and the change may be roughly taken as proportional to the difference in temperature between the two bulbs, this difference being supposed to be small. If, however, both bulbs are heated simultaneously, and to the same extent, there will be no motion in the liquid, inasmuch as there will be no difference in pressure of the air of the two bulbs.

In consequence of this mode of action the instrument has received the name of the differential thermometer;

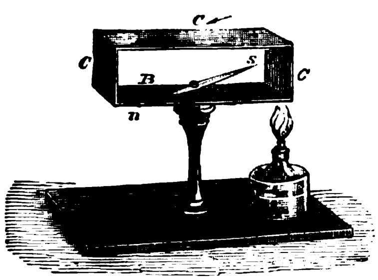


FIG. 3.

indeed, it is abundantly evident that what is measured is not the absolute temperature of A and B, but only the difference in temperature between the two.

Delicate as this instrument might at first sight appear to be, it forms but a poor substitute for the human eye, and had it not been for a new discovery, we should not have been able to make much progress in our knowledge of dark heat. The discovery alluded to is that of Seebeck, who found that in a circuit, composed of two metals soldered together, a current of electricity is produced when one of the junctions is heated, while the other is kept cool. If, however, both junctions be simultaneously heated to the same extent, no current is produced.

Here, then, we have an instrument similar in principle to that of Leslie, or, in other words, a new species of differential thermometer, and we shall now show that this arrangement is capable of being made extremely delicate as a measurer of small differences of temperature. The existence of a current of electricity is easily known by the motion of a magnetized needle, which tends to place itself at right angles to the direction of the current. Suppose now we have a circuit (Fig. 3), in which *C* denotes copper and *B* bismuth, and that we heat one of its junctions as in the Figure. We shall have, in consequence, a positive current following the direction of the arrow head, and the north pole of the needle will be pushed towards the observer as indicated in the Figure. When we make use of a magnet to measure a current we call our instrument a *galvanometer*. Our object, therefore, in this arrangement, is clearly to get as large a current as possible out of a small temperature difference, and then to measure this current by means of a galvanometer made as delicate as possible.

In order to obtain as strong a current as possible we must make use of a considerable number of junctions, as in Fig. 4, only in practice these junctions are very close

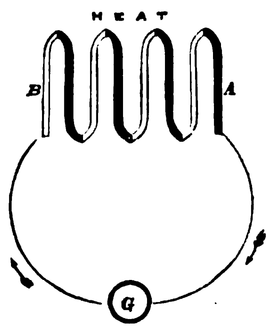


FIG. 4.

together. Here the heating influence is applied to the upper junctions, while the lower ones are kept cool. Another point is to select two suitable metals for our junctions—that is to say, metals the heating of which shall produce a powerful current. This is done by consulting a thermo-electric list of metals; in other words, a list such that the positive current shall go across the heated junction from the metal nearest the top to that nearest the bottom of the list.

The following is a series of this nature:

Bismuth.	
Nickel.	Silver.
Lead.	Zinc.
Tin.	Iron.
Copper.	Antimony.
Platinum.	Tellurium.

Now there is an important law which holds with reference to this series. If, for instance, we have a compound circuit, such as that in Fig. 5, connected with a galvanometer, we shall get the same current *in one direction* by heating through 1° C. the copper and tin junction, and also the tin and antimony junction, as we shall *in the opposite direction* by heating the antimony and copper junction. In other words, the various metals in the above list are to be regarded as being at so many different levels, and the strength of the current depends upon this difference of level, and not at all upon the exact number of halting places we make use of in going from the one level to the other. It thus appears that we shall get the greatest effect by selecting two metals near the opposite extremities of the list. Bismuth and antimony are generallly the metals chosen, and 36 or 49 junctions of these are frequently used, the metals being packed close together, but insulated from each other, and thus forming a sort of cube, each end of which contains, say, 36 junctions. These junctions are generally covered with lamp-black. If the one end of this be heated we shall have a current in the one direction; if the other end, we shall have one in the other direction; while, if both ends be heated simultaneously and to the same extent,

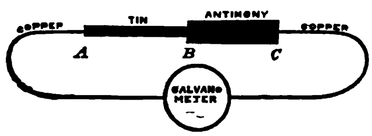


FIG. 5.

we shall have no current whatever. This arrangement forms what is termed a *thermopile,* and the cube of elements is generally encased in a brass covering presenting two terminals, in which the wires of the galvanometer are to be inserted and screwed tight. Inasmuch as this arrangement is generally used for viewing and measuring heat rays, a brass cone polished in the inside is often attached to the thermopile (Fig. 8) with the view of catching a large area of heat rays and reflecting them into the pile.

The galvanometer consists essentially of a magnet, which is delicately suspended by a very fine thread. Around it we have numerous coils of wire (but not in this case *very* numerous coils of *very* fine wire), which convey the current, each single coil counting separately in its action upon the magnet.

The various coils must, of course, be insulated from each other. A comparatively weak current will thus produce a visible effect if there be only a sufficient number of coils.

But yet the result so obtained is not the best, because we are having, after all, a strife between the influence of the current and that of the earth upon the small magnet. Assuming that the galvanometer was so placed to begin with that the magnet was in the magnetic meridian, then the current will tend to move the magnet to a position at right angles to this plane, while the earth's magnetic force will tend to keep it where it is. There is thus a strife between the two, and this will greatly interfere with the delicacy of the instrument. What we have

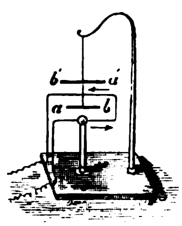


FIG. 6.

to do is so to counteract the earth's directive force that the little magnet may behave as if it was not under any external magnetic influence whatever.

A needle for which the directive effect of the earth's magnetic force is thus neutralised is said to be rendered *astatic.*

There are two ways in which this may be accomplished. We may use two needles of as nearly as possible the same strength, joined rigidly together with their poles in opposite directions, as in Fig. 6. Numerous coils of wire are wound around the lower needle, one of which we have exhibited. Here the upper current will tend to twist *b'* above the plane of the paper, while the lower current will act on *b'* in an opposite direction, this lower current, however, being further removed from the upper needle than the upper current, the latter will predominate, and the needle will, on the whole, be twisted round so as to place *b'* above the plane of the paper. Furthermore, the lower needle will be twisted round by both the upper and the under currents so as to place *a* above the plane of the paper, and hence the two needles will be twisted by the current in the same way, whilst the directive force of the earth's magnetism which opposes any motion of the needle will, by the arrangement above alluded to, be either altogether cancelled or rendered very small.

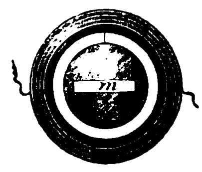


FIG. 7.

A galvanometer of this kind was employed by Melloni along with a thermopile as already described, and it was with these that he obtained the valuable results which we shall presently mention. But before dismissing this subject let us allude to some still further refinements made since the time of Melloni, which have contributed very greatly to increase the delicacy of this combination.

We have spoken about one way in which the effect of the earth's force may be neutralised, but we may likewise adopt the method of Sir W. Thomson, indicated in Fig. 8, where an external magnet, M, is so placed as to cancel the earth's action on the suspended galvanometer magnet which is supposed to be placed in the centre of G.

A still greater refinement consists in the joint use of both the methods now described. A system of two magnets

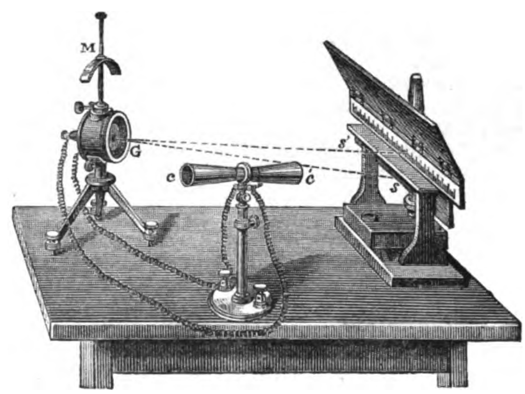


FIG. 8.

placed oppositely and united rigidly together is employed, a separate coil being made to surround each magnet. An external magnet is then so placed as to neutralize any directive force that may yet linger in the system. By this means very great delicacy almost amounting to instability may be obtained.

We shall conclude by mentioning an optical arrangement introduced by Sir W. Thomson, which greatly adds to the delicacy of the galvanometer. In this arrangement (Fig. 7) a small galvanometer magnet is attached to the back of a mirror, which mirror is suspended by a very fine thread.

Again (Fig. 8) there is a lamp behind the scale S S', and a slit, or, better still, a round aperture below the scale, with a wire in its middle, is lighted up by the lamp, and a reflected image of this lighted aperture thrown by means of the magnet-mirror, already described, upon the scale. This image may be made to move over a large space of the scale for a comparatively small motion of the mirror. If the image be that of a round circle of light, with a wire in the centre, we shall be easily able to read the position on the scale of the image of the wire, and by this means measure the motions of the mirror with very great accuracy and delicacy.

Having thus described in detail the various arrangements tending to make the thermopile and galvanometer a very delicate instrument for measuring radiant heat, let us proceed to discuss the reply which this combination gives to the question raised.

Melloni, who it must be remembered did not work with the instrument in its most perfect form, soon began to find that very many of those substances which were transparent for light, were, on the contrary, nearly opaque for dark heat. As he continued his labours he had, however, the satisfaction of finding a substance that was as nearly as possible equally transparent for both—this substance being crystallized rock salt.

He next found that just as by placing together two screens of coloured glass, one of which absorbs the redder portion of white light, while the other absorbs all but the redder portion, we may virtually stop all the radiation, so by certain combinations of screens it was equally possible to stop all the radiation from a source of low temperature heat. In the one case the result was perceived by the eye, and in the other by the thermopile. By this means he found that green glass and alum formed a peculiarly opaque combination. He next tried the same combination for the solar rays, and found that when they were first intercepted by a screen of green glass, they had a very feeble power of passing through a second screen of alum. The similarity in the behaviour of the rays from these two sources led him to imagine that heat accompanied with light and low temperature heat, are not physically dissimilar.

Again, the discovery by Melloni of the *diathermancy* or transparency for heat of rock-salt, led him to construct prisms and lenses of this material. By these means he proved that dark heat is capable of refraction, thereby exhibiting another bond of similarity between it and light. The subject was afterwards taken up by Forbes, who showed that the refrangibility of dark heat is inferior to that of the luminous rays. Forbes likewise showed that dark heat is capable of polarization and depolarization, and more recently other observers have shown that all the various properties of light may be exhibited at will in similar experiments with dark heat.

We have thus strong evidence for believing that dark heat is similar to light, the difference between them being physiological rather than physical, or, to speak more exactly, rays of dark heat may be presumed to differ from one another and from rays of light in no other respect than that in which the various rays of light differ from each other. In fine, the only difference is one of wave length or refrangibility, this being of such a nature that dark heat is less refrangible and has greater wave-length than light.

It is desirable at this stage to say a few words about the spectrum which is obtained from a luminous source by means of a prism.

Let us suppose, for the sake of simplicity, that the luminous source is a thread or slit of light, and that, by means of a lens, after the manner of a photographer, we wish to obtain an image of this slit of light and throw it upon a white screen. This image will appear as a white luminous slit of light. If, however, we interpose a prism between the source of light and the screen we shall obtain a very different result. In the first place the rays will be much bent by the prism, so that the screen will have to be placed in a very different position in order to receive the image of the slit. In the next place all the rays which go to constitute the light will not be bent to the same extent, so that the image of the slit given by one constituent ray will be thrown upon a different portion of the screen from that given by another. Thus the red rays will be least bent, then the orange, the yellow, the green, the blue, the indigo, and the violet, these last forming the most refrangible of the rays that enter into the composition of white light. What we shall really have, therefore, will be a great number of images of the slit placed side by side without any interval between them, these images being red at the one extremity and violet at the other. We shall, in other words, be presented with a long parti-coloured ribbon instead of a single white slit. This ribbon forms what is known as the *spectrum* of white light, and if before it is thrown upon the screen it be reflected from a plane mirror we may easily show, by making the mirror oscillate rapidly backwards and forwards, that this ribbon when in motion reconstitutes itself into a colourless white. The spectrum has various properties. Part of it can affect the eye—we say part of it, for there are dark rays at either extremity which the eye cannot perceive.

Part of it can perform certain chemical changes. Here again we say part of it, because there are certain chemical changes which certain rays seem at first sight incapable of producing.

All of it is, however, capable of heating a substance upon which it falls and by which it can be absorbed. We have thus three effects—the luminous, the actinic, and the heating effects; and certain portions of the spectrum are capable of exhibiting all the three.

If we take the action of the rays in blackening chloride of silver as a type of actinic influence we shall find that the maximum of the action is near, if not beyond, the most refrangible extremity of the visible spectrum.

If we take the effect upon the eye as our measure of light we shall find that the maximum is at the yellow, whilst if we take the heating effect of the spectrum under its usual circumstances of production we shall find that this has a maximum near the least refrangible extremity.

Now these considerations give rise to the following question: Is there only one thing present at one part of the spectrum, or are there three things?

At first it was imagined by some of the physicists of a past generation that there was in reality more than one thing and that the light and heating effects were produced by different agents. It was, however, afterwards found that if you operate on any portion of the spectrum by reflexion, absorption, polarisation, or in any other way, all the various qualities of that region are affected in the same proportion, so that if the light effect is reduced by one-half the actinic and heating effects are reduced by one-half likewise.

This decides the question, for we cannot imagine two or three separate agents existing at the same place and each possessing exactly the same physical qualities as the other; in other words, things which are not physically different from each other must be the same.

Thus we have now come to the conclusion that there is only one physical entity at any one part of the spectrum, and we have likewise been driven to see that in order to compare one part of the spectrum with another we must not use the eye, which has its own peculiarity, or some particular chemical substance which has likewise a partiality for certain rays.

What we have to do is to measure the amount of heat-energy possessed by the various parts of the spectrum, and this is done by allowing the rays in question to fall upon a suitable thermo-pile covered with lamp-black and then measuring the amount of heat to which they give rise by means of the indication of the galvanometer attached to the pile. A coating of lamp-black absorbs most of the rays, and if it is not absolutely perfect in this respect it is at any rate more perfect than any other substance.

We can have now a very clear conception of what takes place when we heat a body such as coal. At first it gives out a spectrum consisting of rays, all of which are less refrangible than those of the visible spectrum. Soon, however, as the coal continues to rise in temperature, it not only increases the number of such rays but takes on others of a more refrangible nature, entering into the visible spectrum when it begins to be red-hot.

Thereafter it pushes its way further and further into this spectrum, taking on successively yellow and green rays, blue, violet, and actinic rays as the temperature still rises, until at length it shines forth with the lustre of the electric light or of the sun.

Let us now proceed to reply to the fourth question, What is meant by a hot body? At first it was supposed that heat was a substance possessing mass but not weight, an imponderable, as it was termed, which insinuated itself between the particles of bodies, thus causing them to expand. This substance was further supposed to be rubbed out by friction and beaten out by percussion. It will be perceived that we have here a corpuscular theory of heat very similar to that of light, the one forming indeed the natural sequel to the other. The experiments of Davy, in which two pieces of ice both below 0° were made to melt one another by their mutual friction, and those of Rumford, made in boring cannon, sufficed, in the course of time, to convince physicists that heat cannot be a substance, inasmuch as the melting of the ice in Davy's experiments, and the heat produced in those of Rumford, would equally imply the creation in large amount of the matter of heat. It was therefore concluded by both these experimentalists that heat is not a substance but rather a species of energy. That is to say the only difference between a hot body and the same body when cold is that, in the former state the molecules of the body are in violent motion backwards and forwards, while in the last state this kind of motion is much less. This is the dynamical theory of heat at present universally held. In it heat is regarded as a kind of energy, so that when heat is produced by friction or percussion, a certain quantity of visible energy disappears from the universe, while at the same instant an equivalent quantity of heat-energy appears, or is created.

A little reflection will, however, show us that there is not here any *real* creation or annihilation, but merely the simultaneous disappearance of one kind of energy and the appearance of another; in fact, nothing more than a transmutation of energy. Joule was the first to prove the definite mechanical relation that exists between the visible energy which disappears and the heat which is generated, and according to his experiments, if a pound of water were to fall from a height of 772 feet under gravity, and if all its visible energy on reaching the earth could at once be converted into heat, the water would be found to have risen 1° Fahr. in temperature. It will at once be recognised that just as the material or corpuscular theory of heat fits into the corpuscular theory of radiant light, so does the dynamical, or energetic theory of heat fit into the undulatory or wave hypothesis. We may, in fact, imagine the little particles or molecules of heated bodies to be in a state of continual vibration resembling in this respect a bell, or the string of a musical instrument, except that their vibrations are much more rapid than those which constitute sound.

And just as the vibrations of a bell are carried off by the gaseous medium, *i.e.* the air which surrounds the bell, and ultimately affect our ear, producing the sensation of sound, so are the vibrations of molecules carried off by a medium (the ether) which surrounds them and ultimately affect our eye, producing the sensation of light. This train of thought enables us at once to reply to our fifth question, and to assert that there is a definite mechanical relation between the amount of heat which leaves a hot body as it cools, and the radiant energy which accompanies the act of cooling. And this definite mechanical relation may be stated in very simple language. If, for instance, a pound of water cools through 10° Fahr. then the radiant energy which it gives out in the process of cooling, if this should be made to impinge upon another pound of water, and be entirely absorbed by it, would heat it through 10°, so that while the one pound of water has become 10° cooler the other has been raised an equal amount in temperature.

We are now in a position to reply as follows to the questions proposed:

(1) Radiant light consists of an undulatory motion in a medium called ether.

(2) It moves with the velocity of 187,000 miles per second.

(3) Radiant heat is physically similar to radiant light, the only difference being that its wave length is greater, and its refrangibility less than those of light.

(4) A hot body is one whose molecules are in rapid motion.

(5) There is an equivalence in energy between the amount of radiant light and heat emitted by a hot body and the sensible heat which the body loses. Radiant light and heat may be termed *radiant energy.*

Without pretending to enter here into a philosophical discussion it is instructive to notice that all of these questions which were capable of being answered in two ways were answered wrongly at first.

Although this procedure of the human mind has delayed the correct solution of a very important series of questions, yet we in the present age cannot reasonably complain of what has taken place. It has given us a confidence in our present views that we could hardly have had if the question between two alternative views had not been threshed out in the past.

We can thus look to the future without dismay, and need not fear the gradual rising into strength of a school which shall call in question any of the very important conclusions at which we have now arrived.

Surely there is an advantage in being wrong first and right afterwards, especially when it was a past generation who went wrong and we ourselves who are right!

BALFOUR STEWART

(*To be continued.*)

NOTES

WE understand that Prof. Huxley, P.R.S., has agreed, at the request of the Lords of the Committee of Council on Education, to continue to act as Dean of the Normal School of Science and Royal School of Mines at South Kensington, and also to be responsible for the general direction of the biological instruction therein.

THE Senatus of the University of Edinburgh resolved at its last meeting that a lectureship of comparative embryology be instituted, and appointed Mr. George Brook, F.L.S., as lecturer, subject to the approval of the University Court. Mr. Brook has for some time been engaged in making investigations for the Fishery Board for Scotland.

THE Indian *Civil and Military Gazette* writing of the ornithological collection presented by Mr. Allan Hume of the Civil Service of India to the British Museum, says that its value and extent are only now beginning to be realised. It amounts to 62,000 skins of all kinds, and it has cost Mr. Bowdler Sharpe, of the Natural History Department of the British Museum, more than three weeks of uninterrupted labour to pack and send it away. Even now the work is not at an end, for the collection of eggs, which is no insignificant one, remains to be despatched. The gift, which represents the labour and learning of a lifetime is described by Mr. Sharpe as "the grandest collection of birds ever made."

FROM the Seventh Annual Report of Examinations in Technology, under the direction of the City and Guilds of London Institute for the Advancement of Technical Education, we notice that there is again a fair increase in the number of candidates who presented themselves, and a satisfactory proportional increase in the number of those who have passed. In 1884, 3,635 candidates were examined, of whom 1,829 passed. In 1885, 3,968 candidates were examined, of whom 2,168 have passed. Thus the increase of passes is six more than the total increase in the number of candidates. There is a slight falling off in the number of subjects in which the examinations have been held, owing to the fact that in four of the subjects, viz.:—Salt Manufacture, Oils and Fats, Silk Manufacture, and Mechanical Preparation of Ores, the number of candidates was below the minimum for which an examination is held. Applications for examination were received, however, in 46 out of the 47 subjects included in the programme. From the returns furnished in November last, it appears that 6,396 persons were receiving instruction in the registered classes of the Institute, as compared with 5,874 in the previous year. These numbers do not include the students in attendance at the technical classes of various schools and colleges at which the Professors do not accept payment on results. Two new subjects were this year added to the list, viz.:—Boot and Shoe Manufacture and Framework Knitting, in which subjects 69 candidates and 40 candidates respectively presented themselves. Nearly all these candidates received instruction in the recently-opened Technical School at Leicester. The percentage of failures on the results of the examinations in all subjects has decreased from 49·7 in 1884 to 45·3 in 1885. The proportion of failures is still large, showing the necessity of better instruction on the part of the teachers, and of more careful and sustained work on the part of the students. Of the inability of the majority of the candidates to make intelligible sketches, the examiners continue to complain; but it is hoped that this defect in the education of artizans will gradually be remedied as linear drawing comes to be more generally taught in our public elementary schools. During the past session, 263 classes have been held in different parts of the kingdom in connection with the Institute's examinations. Of the 6,396 students in attendance at these classes, 3,271 presented themselves for examination, and that of these 1,670 succeeded in satisfying the examiners. Last year, the number of candidates who passed from the registered classes of the Institute was 1,387, showing an increase of 283, which is a large proportion of the total increase, viz., 333 of successful candidates. This year, for the first time, Manchester heads the list of provincial centres from which the largest number of candidates have passed, the number being 147 as against 115 last year. A like number of candidates have passed from the Polytechnic Institution, London. Next in order of merit comes Glasgow, with 119 as against 139 last year, Bradford with 97 as against 90, Leeds with 84 as against 70 (55 from the Yorkshire College), Bolton with 75 as against 98, and Huddersfield with 72 as against 39. It is expected that about 750 of this year's successful candidates will gain a full Technological Certificate, in virtue of their having obtained from the Science and Art Department the necessary qualifying certificates in Science, in addition to their certificate in Technology. Of the 1,829 candidates who passed last year, 566 obtained the full certificate. This increase of 184 in the number of full certificates is a very satisfactory feature in this year's examinations. Compared with the total number of successful candidates, the percentage of those to whom full certificates will be awarded has increased from 31·2 to 34·5. From year to year, improvements suggest themselves in the working of these examinations, by which they are rendered more practical, and at the same time better adapted to the requirements of the students. The opening of the Central Institution, by affording new facilities for the training of technical teachers, will, it is hoped, do much towards improving the character of the instruction in the Institute's classes in connection with these examinations. Summer Courses for teachers, to be continued in subsequent years, have this year been held for the first time at the Central Institution, and the applications for admission to these courses show that the value of the instruction is likely to be fully appreciated by those for whom it is intended.

THE death is announced, at the age of fifty-five years, of Mr. Robert F. Fairlie, the well-known engineer; and also of Dr. Heinrich Wilhelm Reichardt, Professor of Botany in the University of Vienna.

AT the annual speech day at Reading School, on Tuesday, July 28, a new laboratory was opened by Dr. J. H. Gladstone, F.R.S. The Town Clerk (Mr. H. Day) read a statement to the effect that natural science had been taught in the school since the year 1872, but up to 1884 no adequate class-rooms had been fitted up or set apart for that purpose, except in a temporary way. Last year the Head Master submitted a scheme to the Trustees, and after the subject had been fairly thought over, three gentlemen, Messrs. G. W. Palmer, Alfred Palmer, and Walter Palmer, sons of the Member for Reading, volunteered to provide the accommodation recommended by Dr. Walker. The trustees gladly availed themselves of so generous an offer, and the result was that the school now possessed in that room—fitted up for chemical analysis, and in the adjacent lecture-room—excellent means of giving instruction in the usual branches of natural science. Dr. Gladstone then declared the laboratory open. Having praised its general arrangements, he congratulated the school on having obtained so magnificent a gift from the Messrs. Palmer, who were thus endeavouring to place chemistry upon an equal footing with the other studies carried on at that school. He would not go into the great controversy between things and words, but they would all agree that it was necessary that the knowledge of things should precede the knowledge of words, because the knowledge of words was only a kind of simulacrum unless the knowledge of things preceded it. A knowledge of chemistry was pre-eminently an experimental science, and they wanted that kind of training for all boys. Different studies gave a different training to the mind, and chemistry gave a training not only to the perceptive faculties, but also to the reasoning processes, and therefore chemistry had been wisely chosen to take an important part in the curriculum of that school.

THE foundation stone of the new buildings of the Sorbonne, which are to cost 22 millions, was laid on Monday by M. Goblet, French Minister of Education. The cellars and ground floor have already been built.

THE protracted season of midsummer heat throughout the United States has been broken, the *Times* correspondent states, by a series of drenching rains, accompanied by cyclones. A severe easterly storm began on Sunday, continuing throughout Monday, the wind changing to westward, and rains deluging the entire country east of the Mississippi. The heaviest rainfall, which was at Chicago, reached 5½ inches in the twelve hours ending Sunday at midnight. A universal report from all parts of the country tells of the vast damage done by the floods and cyclones. The rainfall on Monday evening at Philadelphia was nearly 3 inches. The cyclone started in Maryland about two o'clock on Monday afternoon, passing northward along the eastern border of Philadelphia at three o'clock. It wrecked houses and mills and destroyed cattle and crops in Maryland and Delaware, doing the severest injury along the Delaware river front of Philadelphia. Passing from south to north, a low, black, revolving ball of smoke moved at the rate of nearly a mile in a minute, crossing twice over the Delaware River, which is crescent-shaped. Five lives have been lost, six persons are missing, and about 100 injured. The damage done is estimated at half a million of dollars. Six hundred buildings were unroofed and the walls partly destroyed, railway cars blown from their tracks, trees uprooted, and several vessels wrecked. Two steamboats on the river had their upper works lifted off and destroyed, the pilot of one being drowned, while from the deck of another horses and a waggon were lifted by the wind and dropped into the river.

THE Government Astronomer of Hong Kong has published a notice with regard to typhoons, from which it appears that the earliest signs of these phenomena in the China seas are clouds of the cirrus type looking like fine hair, feathers, or small white tufts of wool travelling from east to north, a slight rise in the barometer, clear and dry but hot weather, and light winds. These are followed by a falling barometer, while the temperature rises still further. The air becomes oppressive from increasing dampness, and the sky presents a vaporous and threatening appearance. A swell in the sea, and also phosphorescence of the water, as well as glorious sunsets, are other signs useful to the mariner who is acquainted with the usual conditions in the locality. When the typhoon is approaching the sky becomes overcast, the temperature in consequence decreases, the dampness increases, and the barometer falls more rapidly, while the wind increases in force. Nearer the centre the wind blows so that no canvas can withstand it, and the rain pours down in torrents, but there is no thunder and lightning. Still nearer the centre there is less wind and rain, and the sky is partly clear, but the sea is tremendous. This is therefore the most dangerous position. Typhoons may be encountered in any season of the year, but are most frequent in August and September. They appear to originate south-east of the Philippine Islands. In August and September they frequently pass east of Formosa, or travel towards north-west up through the Formosa Channel, or strike the coast of China. Afterwards they usually recurve towards north-east and pass over Japan or across the sea north of Japan, but not with the violence that is characteristic of tropical storms. During the remainder of the year they most frequently cross the China Sea from east to west.

A TELEGRAM from St. Petersburg, dated August 3, states that despatches from Tashkend and Verny announce that there has been a severe earthquake at Pishpek (? Bish-uzek), damaging all the houses at that place. The shock extended to the settlements of Sukuluk and Belovodsk, which were laid in ruins. At Belovodsk a church fell in, many of the congregation assembled in it at the time being killed. Numerous fissures appeared in the ground. A later telegram from Verny reports that altogether fifty-four people were killed and sixty-four injured by the earthquake at Belovodsk and Karabolty. The shocks continue and the people are terror-stricken.

A TELEGRAM from Malaga states that a shock of earthquake occurred at Motril on the afternoon of July 30.

THE *Times* states that much uneasiness is being caused by the continued absence of tidings as to Mr. F. A. Gower, who lately carried on a series of experiments with a view to testing the adaptability of balloons to war purposes. Mr. Gower, who is well known to the scientific world as a joint patentee of the famous Gower-Bell telephone, had made Hythe the centre of his operations, and thence made several ascents. His final undertaking in this country was a successful aërial voyage across the Channel early in June. He continued his trial trips in France, and met with a misadventure while awaiting an opportunity of returning in a balloon to England. Undeterred by this, he made an ascent on July 18 from Cherbourg, and since that date nothing definite is known of his whereabouts. A pilot balloon which he had previously despatched has been found and sent on to Hythe; and a balloon has been picked up without a car some thirty miles off Dieppe. Sixteen days having now elapsed since the ascent and no message having been received from Mr. Gower, whose invariable practice it was at once to notify by wire his safety at either Cherbourg or Hythe, at both of which places he has left property, the gravest fears are entertained that he has been drowned. It may be mentioned that the experiments being carried on by Mr. Gower were within the cognisance of the Government, and have so far, it is believed, proved of a very satisfactory character.

ACCORDING to *Science* the daily papers announce that the U.S. commissioner of agriculture has established as a part of Riley's division a branch of investigation relating to economic ornithology, and has appointed Dr. C. Hart Merriam, a well-known ornithologist and secretary of the American Ornithologists' Union, a special agent to take charge of this part of the work. Dr. Merriam will make his headquarters at Sing Sing, N.Y., until Oct. 1, and after that at Washington. The scope of the investigation will cover the entire field of inter-relation of birds and agriculture, particularly from the entomologist's standpoint. The inquiry will relate primarily to the food and habits of birds, but will include also the collection of data bearing on the migration and geographical distribution of North American species. In this last inquiry the department hopes to have the co-operation of the Ornithologists' Union, Dr. Merriam being at the head of the Union's committee on migration.

DR. ELKIN, in charge of the heliometer of the Yale College observatory, has, *Science* says, been engaged for nearly a year and a half past in measuring the group of the Pleiades, his original plan being to measure with this instrument the same stars which Bessel measured with the Königsberg heliometer about fifty years ago. Dr. Elkin has taken advantage of all the improvements in the instrument and the methods of using it which have been developed in the last half-century; and, in addition to the successful carrying-out of his carefully elaborated plan of triangulation, he has also been able to extend his work to a large number of stars which Bessel did not measure. The position-angle and distance of the Bessel stars from the large star Alcyone are included in the work. The results of this very valuable work cannot be fully discussed and prepared for publication until the positions of certain stars of reference have been obtained from the work of other observatories where they are now being determined. Dr. Elkin has also obtained measures of the distances of a number of craters on the moon from neighbouring stars on thirty-six nights, near the times of first and last quarter. The positions of these craters on the moon itself had been determined; also series of measures made of the diameters of Venus, of the outer ring of Saturn, and of the satellite Titan referred to its primary. A registering micrometer has been devised, and, in the form constructed by the Repsolds, has proved a complete success, greatly increasing the amount of work which the observer can accomplish. Dr. Elkin proposes to devote the heliometer for a year and a half to come to investigations in stellar parallax. The plan of research mapped out and already commenced will, it is hoped, if carried to completion, furnish a reliable value of the relative parallax of stars of the first and eighth magnitude.

PROF. A. LANDMARK, chief director of the Norwegian Fisheries, has published some interesting particulars of his studies of the capability of salmon to jump waterfalls. He is of opinion that the jump depends as much on the height of the fall as on the currents below it. If there be a deep pool right under the fall, where the water is comparatively quiet, a salmon may jump 16 feet perpendicularly; but such jumps are rare, and he can only state with certainty that it has taken place at the Hellefos, in the Drams River, at Haugsend, where two great masts have been placed across the river for the study of the habits of the salmon, so that exact measurements may be effected. The height of the water in the river of course varies, but it is as a rule, when the salmon is running up stream, 16 feet below these masts. The distance between the two is 3½ feet, and the Professor states that he has seen salmon jump from the river below across *both* masts. As another example of high jumping, he mentions some instances of Carratunk waterfall, in Reumbec, in North America, where jumps of 12 feet have been recorded. Prof. Landmark further states that when a salmon jumps a fall nearly perpendicular in shape it is sometimes able to remain in the fall, even if the jump is a foot or two short of the actual height. This, he maintains, has been proved by an overwhelming quantity of evidence. The fish may then be seen to stand for a minute or two a foot or so below the edge of the fall in the same spot, in a trembling motion, when with a smart twitch of the tail the rest of the fall is cleared. But only fish which strike the fall straight with the snout are able to remain in the falling mass of water; if it is struck obliquely, the fish is carried back into the stream below. This Prof. Landmark believes to be the explanation of salmon passing falls with a clear descent of 16 feet. The professor believes that this is the extreme jump a salmon is capable of, and points out that, of course, not all are capable of performing this feat.

IN the new part of the *Transactions* of the Essex Field Club (vol. iv. part 1) the first and perhaps most interesting paper is Prof. Boulger's presidential address on the "Influence of Man upon the Flora of Essex."

ACCORDING to the *Chinese Recorder*, Dr. Wallace Taylor, a missionary doctor of Osaka, Japan, has made important discoveries regarding the origin of the disease *kakké*, or *beriberi*, as it is known in Ceylon. He traces it to a microscopic spore, which is often found largely developed in rice, and which he has finally detected in the earth of certain alluvial and damp localities.

WE have received from Denver the first volume of the *Proceedings* of the Colorado Scientific Society. Denver as a western mining camp, with an evil reputation, and Denver the capital of the State of Colorado, are places separated by ages of civilisation; but mining is prominent in both. The members of the Scientific Society appear from the list to be mainly civil or mining engineers, metallurgists, geologists, assayers, &c., and the papers are largely on these subjects, *e.g.* the estimation of arsenic, and of copper; the ore deposits of the Summit districts of Rio Grande county, Colorado (the principal paper in the volume), löllingite, &c. There are, however, other papers: there is the report by a commission of the society on the Artesian wells of Denver, a paper on extinct glaciers of the San Juan mountains, while one of the members, Mr. van Diest, read several papers on subjects connected with the Malay Archipelago, such as the formation of hills by mineral springs in the Island of Java, the geology of the Sumatra, and the method of mining there 250 years ago, the methods of smelting employed by the Chinese at Banka, &c. There is certainly plenty of vitality in the new society, and doubtless it will grow with the growth and strengthen with the strength of the magnificent State from which it takes its name.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. J. S. Stevens; two Turtle Doves (*Turtur communis*), European, presented by Mr. J. Hare; four Martinican Doves (*Zenaida martinicana*), a Moustache Ground Dove (*Geotrygon mystacea*), four Dominican Kestrels (*Tinnunculus domincensis*), a Green Bittern (*Butorides virescens*) from the West Indies, presented by Dr. A. Boon, M.R.C.S.; a Golden Eagle (*Aquila chrysaetas*) from Perthshire, presented by Mr. Chas. J. Wertheimer; two Larger Hill Mynahs (*Gracula intermedia*) from India, presented by Mr. Thomas Hudson; an Indian Python (*Python molurus*) from India, presented by Mr. Harrington Laing; four Proteus (*Proteus anguinus*), European, presented by Mr. Cook; a Red-headed Cardinal (*Paroaria larvata*), a Yellow Hangnest (*Cassicus persicus*) from South America, deposited; a Vulpine Phalanger (*Phalangista vulpina*), two Snow Birds (*Junco hyemalis*), a Northern Mocking-bird (*Mimus polyglottus*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, AUGUST 9-15

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 9

Sun rises, 4h. 38m.; souths, 12h. 5m. 13·6s.; sets, 19h. 32m.; decl. on meridian, 15° 45′ N.: Sidereal Time at Sunset, 16h. 46m.

Moon (New on August 10) rises, 3h. 19m.; souths, 11h. 1m.; sets, 18h. 34m.; decl. on meridian, 15° 37′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 20 ...	13 45 ...	20 10 ...	4 13 N.
Venus ...	7 3 ...	13 47 ...	20 31 ...	7 55 N.
Mars ...	0 52 ...	9 12 ...	17 32 ...	23 48 N.
Jupiter ...	6 45 ...	13 34 ...	20 23 ...	8 48 N.
Saturn ...	0 57 ...	9 6 ...	17 15 ...	22 29 N.

August 9, 10, *and* 11.—Principal nights for observation of the August (Perseus) meteors.

August	h.	
12 ...	2 ...	Jupiter in conjunction with and 2° 30′ north of the Moon.
12 ...	9 ...	Mercury in conjunction with and 1° 55′ south of the Moon.
12 ...	12 ...	Venus in conjunction with and 2° 13′ north of the Moon.

DR. PERKIN ON THE COAL-TAR COLOURS[1]

Anthraquinone Series

I MUST now draw your attention to the important class of colouring matter compounds obtained from anthracene or anthraquinone.

Alizarin and the other colouring matters related to it form one of the most important branches of the coal-tar colouring industry, and is one of special interest, because alizarin was the first instance of the production of a natural colouring matter artificially. It will be quite unnecessary for me here to say much about the madder root, which was the original source of alizarin, and was grown in such enormous quantities, but now is nearly a thing of the past; nor will I enter into the early chemical history of alizarin, and all the laborious work which was bestowed upon it by Dr. Schunck and others. As you are probably all aware, the relationship of alizarin and its formation from the coal-tar hydrocarbon anthracene was the result of the labours of Graebe and Liebermann, the researches which culminated in this being of a purely scientific nature. The original process for obtaining it has, however, not been found of practical value, but a new one in which sulphuric acid could be used in place of bromine was afterwards discovered by Caro, Graebe, and Liebermann in Germany, and by myself in this country, apparently simultaneously. A second process was also discovered by me, which was worked nearly all the time I was engaged in this industry. In this dichloranthracene was used instead of anthraquinone, and the product thus obtained yielded colours of a brilliancy which it has been found, even to the present time, difficult to match by the anthraquinone process.

At the time of the discovery of artificial alizarin, anthracene

[1] The President's Address at the annual meeting of the Society of Chemical Industry (not the Institute of Chemistry as stated last week). Continued from p. 307.

was not prepared by the tar distillers, as it had no application, and very little was known about it. It was discovered in 1832 by Dumas and Laurent. In 1854-55, when studying under Dr. Hofmann, I worked with it for some time, but my results were never published, because, owing to the erroneous formula given for it by Dumas and Laurent, which was accepted, my results would not fit in; nevertheless the information obtained afterwards proved of great value to me, although at the time the labour spent appeared to be lost labour, showing the value of research even when not successful. The formula of this hydrocarbon was not established until 1862, when it was studied by Dr. Anderson. This was only six years before the discovery of Graebe and Liebermann, and, had not the formula of anthracene been established before these chemists commenced their work, the relationship of alizarin to it would not have been discovered, and up this day it is possible that this artificial alizarin industry would not have been in existence. Researches like that of Dr. Anderson I have often heard spoken of slightingly, because they don't bear much on their surface; but who knows what such work may lead to? Earnest workers cannot be too much encouraged.

As anthracene was not a commercial product, it was necessary to experiment on its production before alizarin could be manufactured, and not only on the best methods of getting it, but also to get a rough idea of how much could be produced, because unless the hydrocarbon could be obtained in large quantities, artificial alizarin could not compete with madder. In our works at Greenford Green we commenced by distilling pitch; but afterwards tar distillers were induced to try to separate it from the last runnings of their stills by cooling and then filtering off the crystalline products which separated out, and in fact visits were paid to most of the tar distillers of the United Kingdom, others being corresponded with on the subject, and the result was that in a short time such quantities came in that the distillation of pitch was abandoned. And although much doubt and anxiety prevailed at first as to the possibility of getting a sufficient supply of this raw material, at the present day there are about 1000 tons of commercial product (about 30 per cent.) produced in excess of the requirements, the annual production in the United Kingdom being estimated at about 6000 tons 30 per cent., or nearly 2000 tons pure anthracene.

Although the colouring matter obtained from anthraquinone or dechloranthracene was at first simply considered as alizarin more or less pure, yet on investigating the matter it was soon found that it contained other colouring matter. To this I drew attention in 1870 (*J. Chem. Soc.* xxiii. 143, footnote), and in 1872 gave the analysis of a product which I named anthrapurpurin, followed by a more extended account a year afterwards (*J. Chem Soc.* xxv. 659, and xxvi. 425). This was called anthrapurpurin; because it is an anthracene derivative having the formula of purpurin, with which it is isomeric. In the latter paper I also referred to another colouring matter dyeing alumina mordants of an orange colour (*J. Chem. Soc.* xxvi. 425). It was also shown that anthrafluoric acid when fused with alkali gave a colouring matter behaving with mordants in the same way (*J. Chem. Soc.* xxvi. 20), and which has proved to be the same body. This latter reaction was afterwards more fully studied by Schunck and Roemer, and the colouring matter produced by it was shown also to have the formula of purpurin; they therefore called it flavopurpurin (*Ber.* ix. 678), so that the colouring matters formed have proved to be three in number—alizarin, anthrapurpurin, and flavopurpurin, all of which are valuable dyes, whereas in madder root there is only alizarin and purpurin, the latter being of only secondary value. This can now also be produced from anthracene. The researches which have been reached on the subject of the conditions under which these different colouring matters are formed, have led to the discovery of methods for their separate production, so that in artificial alizarine, which name commercially embraces all these colouring matters, both mixed and separate, we have more than a simple replacer of madder root, and as these colouring matters just referred to can be applied with the same mordants, varieties of styles of work can be produced by the calico printer and dyer which before were unknown. Anthrapurpurin is, I believe, of as great importance as alizarin itself, and used with it increases its brilliancy, and alone gives very brilliant scarlet shades.

Artificial alizarin was first produced commercially in this country by my firm at Greenford Green in 1869; when one ton was produced in 1870, forty tons were made in 1871, 227 tons, and so on increasingly. It was not produced on the Continent until 1871, when, according to Graebe and Liebermann, 125-150 tons were made. These weights do not apply to dry colour, but to paste.

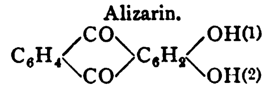
I cannot go into any lengthened account of the chemistry of this industry here; its development, however, has kept pace with theoretical investigations, in some cases it may be said to have forestalled it. For example, in the old methods of working, more anthrapurpurin than alizarin was produced; the conditions required to modify this were found out by experiment. According to all our previous knowledge as to the introduction of hydroxyl into a body by the fusion of its sulphonic acid with alkali, a monosulphonic acid should give a monohydroxyl compound, and a disulphonic acid a dihydroxyl compound. Therefore to produce alizarin, which is a dihydroxyl compound, an anthraquinone disulphonic acid was thought to be the proper thing to use. By experience this was gradually found to be incorrect, a monosulphonic acid being required to produce alizarin, a disulphonic giving anthra or flavopurpurin, the colouring matter not being due to the primary but to a secondary reaction as was afterwards shown by research—the mono and dioxyanthraquinones (the latter known as anthraflavic and isoanthraflavic acids) being the first products of the reaction, and then undergoing oxidation by the caustic alkali employed, and then yielding the corresponding colouring matter, a portion of the products, however, being at the same reduced back to anthraquinone.

A very important improvement preventing this loss by reduction was discovered by J. J. Koch, who found it might be avoided by the use of a small quantity of potassium chlorate with the alkali used in the fusion.

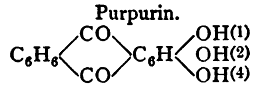
The amount of caustic soda used in this industry is very large at the Badische Aniline and Soda Fabrik—and, I believe, elsewhere—it is made on the spot; and I must say the cleanly way in which alkali is made in the above works contrasts very favourably with what I have seen in some of the alkali works in this country.

Like rosaniline, alizarin has now become a material for preparing other colouring matters. Of these there are two in use, viz., nitroalizarin, which gives orange-yellow shades with alumina mordants, and alizarin blue, a remarkable compound prepared from nitroalizarin by treating it with sulphuric acid and glycerine. This gives shades of colour like indigo. When first discovered, considerable difficulty was found in its application, on account of its insolubility; it has since been found to form a soluble compound with sodium bisulphite, and by this means its application has become much easier. The constitution of the colouring matter derived from anthracene may be represented as follows:—

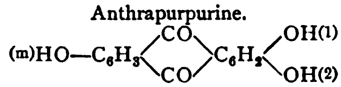
Alizarin.



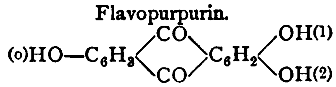
Purpurin.



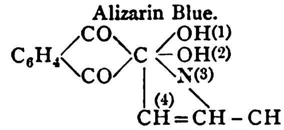
Anthrapurpurine.



Flavopurpurin.



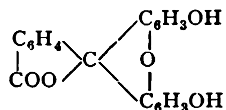
Alizarin Blue.



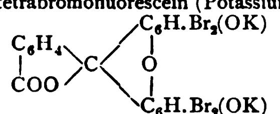
These colouring matters under the name of artificial alizarin are the most important of the coal-tar colours, their money value amounting to more than a third of the entire value of all the colours produced in the industry, and at present the price of artificial alizarin compound tinctorially is not more than one-fourth of that which madder or garancium ordinarily were before their production. There are now three works producing it in this country, but the bulk of that used still comes from Germany.

Phthalines.—The discovery of this class of bodies dates back to 1871, and was the result of the investigation of Baeyer. He found that phenols unite with a number of polybasic acids and with aldehydes, with separation of water when the mixture is heated alone, or with glycerol and sulphuric acid, the compounds formed not being ethers. Those produced when phthaiic anhydride is employed and which embrace those of practical value, are called phthalines. The first of these discovered by Baeyer was gallein (*Ber.* iv. 457), produced by heating pyrogallol with phthalic anhydride; its formula is $C_{20}H_{14}O_5$; by reduction it loses the elements of water and with hydrogen forming *cerulein.* These colouring matters, which for a long time remained unnoticed, are now being extensively used.

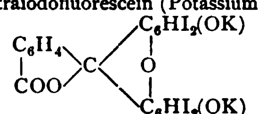
Later, in 1871, Baeyer discovered resophthalin, or fluorescein (*Ber.* iv. 555). This substance, which is remarkable for its yellowish green, fluorescence, dyes silk and wool yellow, but does not combine with mordants, and is not a very useful dyeing agent. But it was discovered by Caro in 1874, the subject being afterwards worked out jointly with Baeyer, that fluorescein when brominated yielded that beautiful dyestuff now called *eosine;* this was introduced into the market in July, 1874. Other substitution products were then studied, and the iodine product was found to give bluer shades of red than the bromine. One of the most beautiful colours of this series is the dichlortetraiodofluorescein, in which dichlorphthalic anhydride is used in its preparation. It is called phloxine. The methylic ether of eosine and its nitro derivative also have become commercial articles. These bodies are now manufactured in a practically firm condition. Their structure has been made out by research to be as follows:—

Fluorescein 

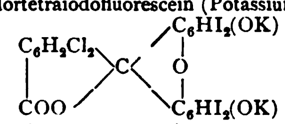
Eosinetetrabromofluorescein (Potassium Salt).

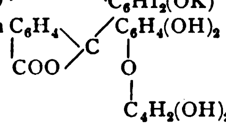


Tetraiodofluorescein (Potassium Salt).



Dichlortetraiodofluorescein (Potassium Salt).



Galliën 

The introduction of these colouring matters had a great influence on the manufacture of phthalic acid. This acid, it will be remembered, was proposed a good many years since for the production of benzoic acid, which was largely in demand for the manufacture of aniline blues, phthalic acid when carefully treated with lime yielding calcium benzoate. But as phthalic acid was required to be produced in an extensive way, new experiments had to be made on the subject. The difficulties connected with this were surmounted by the Badische Aniline Fabrik, who are now the chief manufacturers of this body and its anhydride, which is the substance required; when freshly prepared it is one of the most beautiful products one can see.

Dichlorophthalic acid is now also manufactured for the preparation of the bluish shades of fluorescein derivatives already referred to. But this is not all; it was not only necessary to produce this anhydride in quantity, but it was necessary also to produce *resorcenol.* This substance was originally prepared from galbanum by fusing it with potash, or by distilling brazilin, &c., both technically impractical processes. It was afterwards produced by fusing various halogen derivatives of phenol and benzene sulphonic acid with alkali; these also were not practical processes. It was, however, eventually found that it could be produced by fusing metabenzenedisulphonic acid with potash, the original observation being made by Carrick; and by this process this product, which was a rare compound, is now manufactured and has become a common one, being produced in very large quantities.

Indigo Series.—Indigo is too well known a substance for me to make any remarks in reference to its history as a colouring matter, and with reference to the chemical side of the question I suppose few substances have had more work bestowed upon them than this body, so that I must confine any few remarks to its artificial formation. There is one point of interest, however, connected with indigo, and that is that it was the original source of aniline, this base being discovered in the products of its destructive distillation by Unverdorben, in 1826, as already referred to.

Notwithstanding the large amount of work which has been bestowed upon this colouring matter, its constitution has only been lately arrived at, and for this, and the methods of its artificial formation, we are indebted to the beautiful and laborious researches of Baeyer. The first process for its artificial production was patented by Baeyer in March, 1880. The process consists in preparing orthonitropropiolic acid and acting upon it in presence of an alkali, with a reducing agent, such as grape sugar, xanthate of sodium, &c.

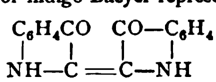
$$2[C_9H_5(NO_2)O_2] + H_4 = 2CO_2 + C_{16}H_{10}N_2O_2 + 2H_2O.$$

This process renders the application of artificial alizarin very easy to calico printing, because the products can be applied to the fabric and the reaction then completed, and thus the indigo is formed and fixed in the fibre, and this process is in use in some of the printworks of Mulhouse, where there is a continued though small demand for nitroorthopropiolic acid. Other processes have been discovered by Baeyer for the formation of Indigo; he has found that it can easily be formed from orthonitrobenzaldehyde by condensation with bodies containing CH_3CO group, such as acetone.

Hitherto this artificial formation of indigo has not met with much practical success. This does not arise from difficulties in its manufacture, but in its cost compared with natural indigo, which is a very cheap dyestuff.

So far as it has been manufactured, however, the possibility of this has been entirely dependant upon scientific research disconnected with its study. To prepare nitropropiolic acid it is necessary to begin with cinnamic acid as a raw material. This acid, until 1877, was only obtained from certain balsams, and was a very costly material. It was then discovered that it could be produced with comparative ease by the action of acetic anhydride and an acetate on benzaldehyde (*Journ. Chem. Soc.* xxxi. 428). Caro afterwards found that this process might be simplified by heating a mixture of benzylidene dichloride with sodium acetate, and it is by this process that it is now prepared.

The constitution of indigo Baeyer represents as follows:—



Several derivatives have been made which are interesting dyes, such as methyl indigo, tetrachlor indigo, etc.

Azo compounds.—The commencement of the history of the azo colours in an industrial sense has little to do with the theoretical side of the question, the early products being the offspring of empirical observations, and in no way connected with the theory of the diazo compounds, a condition of things very different from that now existing. Time will not allow me to enter into the beautiful work of Griess, much of which will be found in the *Philosophical Transactions* for 1864.

The first definite compound of this class, shown to possess dyeing powers, was a substance discovered by Prof. Church and myself, known first as nitrosonaphthalene, then as azodinaphthyldiamine, but now called amidoazonaphthalene. This substance, however, was of no practical value, because its salts, which are violet, cannot exist except in the presence of a certain amount of free acid. This substance has since been found of value in the preparation of the Magdala red.

The first substance of this class sent into the market was the phenylic analogen of amidoazonaphthalene by amidoazobenzene, which was discovered by Mène. It was introduced by Nicholson, who prepared it by a proeess which has not been published. It was afterwards patented by Dale and Caro, in 1863. This was a yellow dye, but did not demand success, because of its volatility. It has, however, since become useful for the manufacture of induline.

The first really successfull azo colour was Manchester and Bismark brown (triamidoazobenzene), which is produced by the action of nitrous acid on metadiaminobenzene.

The next important step took place in 1876, by the discovery of chrysoidine, by Caro and Witt. Independently this product is prepared by the action of diazobenzene on metadiamidobenzene.

About this time the subject began to be worked out on a scientific basis, and since then the number of diazo dyes produced is marvellous, and it will be useless for me to do more than to refer to one or two of the most important. About this period also the value of the sulpho group, began to be realised, and this has greatly added to the value of these dyes.

The first use of the sulpho group in relation to azo colours was in connection with amidoazonaphthalene, patented by myself in 1863.

During the early history of coal-tar colours, innumerable experiments were made with naphthalene derivatives to produce colouring matters, but no results of any value were obtained; the experiments were mostly made with naphthalamine. The first colouring matter that was obtained from it that was of value was Martin's yellow, a dinitronaphthol. After this came the Magdala red, which was not much used. The principal development of the coal-tar colours of late years has, however, been in connection with diazo reaction. In these reactions naphthol is much used, and this product, which a few years ago was unknown, is now manufactured by tons by fixing the naphthalene sulphonic acid with alkali, and is produced at a few pence per pound. Most of the azo colours produced from benzene derivatives are of a yellow or brown colour, but, by taking products of a higher molecular weight, colours of different shades of red are produced. The one which has commanded the greatest success is the scarlet, first known as Meister scarlet, produced by the acting of diazoxylene chloride on the disulphonic acid of β-naphthol; its constitution may be represented thus:—

$$C_6H_3(CH_3)_2 - N_2 - C_{10}H_4(OH)(HSO_3)_2.$$

And in the formation of bluer shades, diazocumene chloride is used. The cumedene used is now made from xylidene, by the beautiful reaction of Hofmann's, in which an alcohol radical associated with the nitrogen becomes that element, and enters with the hydrocarbon radical. These scarlets have had a very injurious influence on the cochineal market, and have in many cases displaced it.

If α-diazonaphthalene chloride be used instead of the xylene or cumene compounds, the colour known as Bordeaux is produced. Then, again, where derivatives of α-naphthol are used, different results are also obtained, so that great varieties of products can be produced. The preparation of these azo colours is a matter of much simplicity, and colouring matter being precipitated in bringing the products together, and, moreover, they can be produced in many theoretical quantities; hence they are remarkably cheap dyeing agents. The following are the formulæ of some of these azo dyers:—

Manchester Brown, Vesuvius or Bismarck Brown.—

$$NH_2C_6H_4 - N_2C_6H_3\overset{(m)}{(NH_2)_2}HCl.$$

$$\text{Chrysoidine } C_6H_5.N_2.C_6H_3\overset{(m)}{(NH_2)_2}HCl.$$

$$\text{Fast yellow } KSO_3.C_6H_4.N_2.C_6H_4NH_2.$$

$$\text{Metaucher yellow } \overset{(3)}{NaSO_3}.\overset{(1)}{NH_4}N_2.C_6H_4NHC_6H_5.$$

$$\text{Orange } \overset{(4)}{NaSO_3}.C_6H_4.\overset{(1)}{N_2}.C_{10}H_6\overset{B}{(OH)}.$$

$$\text{Fast red } NaSO_3.C_{10}H_6.N_2.C_{10}H_6\overset{(B)}{(OH)}.$$

$$\text{Ponceau G. } C_6H_5.N_2.C_{10}H_4OH\overset{(B)}{(NaSO_3)_2}.$$

$$\text{Ponceau 2R } (CH_3)_2C_6H_5.N_2.C_{10}H_4OH\overset{(B)}{(NaSO_3)_2}.$$

$$\text{Bordeaux } C_{10}H_7.\alpha\text{-}N_2.C_{10}H_4OH\overset{(B)}{(NaSO_3)_2}.$$

From which it will be seen that the colour changes from yellow to red and claret by the increase of the molecular weight of the radicals introduced, and also by the relative position occupied by the group, &c.

Products of the quinoline series have of late been claiming attention in relation to colouring matters. It will perhaps be remembered that, in the early days of the coal-tar colour industry, a beautiful blue colour belonging to this series, discovered by Greville Williams (*Chem. News*, Oct. 11, 1860, 219), was introduced. This substance was called cyanine. The employment as a dye for silk at first produced quite a sensation, on account of the beauty of the colour; but unfortunately it was too fugitive to be of any practical value. Recent researches have shown that chryaniline is also to be regarded as a body of the chinoline class. Alizarin blue, and also the beautiful yellow dye obtained from acetonilide by Fischer, and known as flavanilin, are found also to belong to this class of substance.

Other colouring matters which have long been prepared from quinoline direct might be referred to did time permit. The peculiar green which is produced by the condensation of tetramethyldiphenylketone with quinoline is of interest, because the introduction of this quinoline has a very different influence on the resulting colouring matter to that of other groups containing amidogen—in fact, it appears to act more like the phenyl, as the green is very analogous to benzaldehyde green.

There is a very interesting new manufacture growing out of the coal-tar colour industry, and that is, the preparation of derivatives of quinoline as substitutes for quinine. I have mentioned that much work has of late been directed to the study of quinine itself, and although the artificial formation of this substance has not yet been discovered, new bodies have been obtained during these investigations which are thought to possess valuable medical properties. This is rather a remarkable development from this industry, seeing that it was owing to experiments made on the artificial formation of quinine that it owes its foundation.

There is another peculiar colouring matter I have not yet referred to, peculiar—as it contains sulphur. I refer to methyline blue, a very valuable dye, the constitution of which has been so well worked out by Bernthsen, but I feel I must be content with this slight reference to it.

As I have shown, the coal-tar colour industry originated in this country, where for some time it was solely carried on. The second impulse was from France in the discovery of magenta and its blue and purple phenylic derivatives, which were soon brought to a state of great purity in this country. The Hofmann violets were then discovered and produced also in this country, several other colours being perfected and largely used. By this time the manufacture of coal-tar colouring matter had made some progress in Germany and Switzerland; crude products in a cheap form were first made, but improvements soon followed.

The subject of these colouring matters was taken up with great earnestness in the German laboratories, so much so that it was stated at one time that this industry was acting injuriously to science, as it had diverted an undue amount of attention from other subjects. Time has, however, proved the groundlessness of this statement. This laboratory work, as well as research work generally, fitted a number of highly-trained chemists to enter the works, when they soon improved the processes, and thus they were able to produce products of a quality to compete with those of English manufacture, which had, owing to their purity, given superior and more reliable shades of colour in the hands of the dyer; and the result of the application of this scientific labour to this industry is that Germany produces products of the highest class and at the lowest price. The fact that Germany is now the head-quarters of this industry, raises the important question, Why has England allowed this state of things to come about? All the raw materials are produced in this country, both the products from coal and the other chemicals required, and, as we have seen, the industry originated and was first carried on here, and, in addition, we are the greatest consumers of the colouring matters. This fact is well worth considering, and it is many-sided. In my opinion, the Patent Laws, and the difficulty of preventing infringements from abroad, was one cause which may have prevented this country from maintaining its first position.

When speaking of the early history of the first coal-tar colour, mauvein, I referred to this class of infringement and how it was first met by the proceedings taken against the agents employed in this country, and this course was so far successful, but only pointed out how easily the law could be evaded if foreign manufacturers gave up responsible agents and sold direct to the consumers. Having no duties on such articles, no assistance could be obtained at the Customs, and the colouring matters were generally declared under the name of vegetable dyes or extracts, so that it was impossible to stop them entering the country, and even when found, owing to the onus of proof of their being manufactured by the patentee's process laying with the patentee, an almost insurmountable difficulty was raised, as in most cases no traces of the products used in the preparation were left in the colouring matter. The only other proceedings which could be instituted were against the consumer; here again the difficulties were practically insuperable.

In most cases the consumers were using the patentee's product to some extent, and it was impossible to know to what extent, in fact, without going into the many details connected with this point, it may be assumed that in most cases proceeding against a consumer of this kind of article is detrimental and practically useless.

The result of this infringement, by importation from abroad, is that a patentee had to compete against all other manufacturers with the exception of *his own countrymen.*

There can be but little doubt that this state of things has had much to do with preventing the development of this industry, and crippling enterprise in this country, as it prevented manufacturers even from working under royalties, there being no security whatever except in name. Again, the fact that a foreigner could take a patent in this country, manufacture in his own country, and send the product here, was a great source of loss and mischief to our trade. The new patent laws may probably alter this, but still the difficulty of importation in defiance of patent right still remains.

There is another matter which tells much against this country—namely, that we are not able to export colour to foreign countries upon the same conditions as foreign manufacturers can into this, because we are met with import duties which handicap us to a prohibitive extent, whereas the foreign manufacturer, being protected in his own country, may maintain his prices there and sell at a lower price in this country; but what is still more injurious, he may dispose of surplus production in this country at or even below cost price. The injurious effect of such a course upon our market can be easily understood by business men, and I need not go into it here. These are matters our manufacturers have to contend with, and cannot help themselves; there is, however, one matter in which they are undoubtedly at fault.

We find that in Germany the manufacturer understands the value of well-trained chemists, and sympathises with them; they also realise the value of theoretical chemistry—this is a condition of things we don't find in this country.

Unless I am mistaken, the coal-tar colour industry has acted as the great stimulus to the development of general chemical industries of Germany, and these, by starting with so much scientific aid as they have called to their assistance, have made an amount of progress during the last twenty-five years which is most remarkable. Up to that time England had been the seat of most of the large chemical industries, and the success which we have had appears to me to have produced a feeling of false security, and more attention has been paid by the heads of firms to the markets than to the chemistry of their manufactures.

I believe that thirty years ago there were very few chemists employed in chemical works, either in this country or on the Continent. Now there are very few without them; but in this country they are far less numerous and much less efficient than in Germany, and for this our manufacturers are to a great extent responsible. I am told that at some of our large chemical centres, the chemists, or so-called chemists, are sometimes paid not more than could be earned by a bricklayer. If such openings are put by manufacturers before young men, their parents are not likely to give them an expensive scientific training. If they get any they are not likely to continue it longer than enough to do analysis very imperfectly, say by studying for about nine months. An ordinary tradesman would not be considered efficient unless he passed a much longer apprenticeship than this, but I know teachers complain that it is difficult to get students who are to be works chemists to stay longer than this. The result is that when really efficient men are wanted, they are not to be found, and they have to be got from abroad. In my address to the Chemical Society last year, I referred to the past neglect of research at our chemical schools, so that I need not speak further on that aspect of the subject here, though it is an important one in relation to our industries.

There is no chasm, as we have already seen, between pure and applied chemistry; they do not even stand side by side, but are linked together, so that a technical chemist needs to be a thorough chemist, and unless we employ such men we must be at a great disadvantage in relation to foreign manufacturers.

This brings me to a subject which has occupied much attention of late, but I fear is much misunderstood by the public generally. I refer to the teaching required by technical men, or technical education. The general idea is that it should be carried out in what may be called its narrow sense. That is to say, that it should be in relation to the existing manufactures and the present methods employed in them. Whereas there can be no doubt it will be of small service unless it is carried out on a very broad and scientific basis. As it is, the processes which are *publicly* known and taught, are more or less antiquated, simply because improvements are naturally kept secret as long as possible, and therefore to spend a large amount of time in studying details of old processes would manifestly be a great waste of power, and I am glad to find that this view of the matter is held by some of our leading chemical manufacturers. Our chemical industries are now undergoing such rapid and radical changes, owing to the advances in scientific discovery, that this cannot be too much borne in mind. To train a young man as a technical chemist, I consider, requires first that he should have a thorough knowledge of chemical science and know how to use it by conducting research, that he should have a general knowledge of those sciences which are connected with it, such as physics, and of those subjects required by all manufacturers, such as engineering, mechanics, &c., and also study the way chemical operations are carried out on the large scale, not in one branch of manufacture only, but in many.

With men in our works so trained, and of course possessing the suitable natural qualifications, we might expect to see our chemical industries make good progress and keep well to the front, but such a course of study could not be gone through in twelve months, nor would men so qualified be content to receive the remuneration for their services which is now given.

The proposed course for technical chemists at the Central Institute of the City and Guilds of London Institute is to occupy three years, the students having already devoted one year to elementary chemistry this makes four years of study, and this is hardly sufficient. It is to be hoped that those who are to be principals, or to take responsible positions in works will avail themselves of the opportunities afforded by this Institute or get some similar course elsewhere, so that we may have efficient men in this country to advance our chemical industries, and also that the value of such chemists may be appreciated in this country.

The employment of well-trained chemists in Germany, and the division of labour which results from this, has no doubt been one of the chief causes of the great success not only in the colour but in other chemical industries. In this country it not infrequently happens that an inventor, or the head of a firm, feels that no one can do the work he is connected with like himself, which is probably quite true; but at the same time he forgets that one person is not able to attend to the details of a number of processes adequately from sheer want of time and strength; if, however, properly qualified men can be set over them, although they may be slower and less capable than himself, yet having less divided minds and more time they are able to work out the details under his direction with much more success than he could alone, as well as see things from other points of view, and then greater perfection will be attained. I think this is a matter deserving of careful attention on the part of our manufacturers.

I have now given a very brief, and therefore a very imperfect outline of the history of the coal-tar colour industry, an industry to which none other can be compared for its rapid progress. I have drawn your attention to the fact that it is the offspring of scientific resea ch, that in return, as I before stated, it has in many cases given a fresh impulse to research by giving the chemist new products, and also by opening up new subjects of theoretical interest for consideration, and from the fruits thus resulting again reaping further benefit. This linking together of industrial and theoretical chemistry has undoubtedly been the great cause of its wonderful development. We now have not only all the colours of the rainbow, but we have also the more sombre, but often not less useful, colours, and, moreover, there are also great varieties of products of similar colours possessing different properties which fit them for special uses. This industry is also one of no mean dimensions. I have not been able to get any very recent statistical information on this subject, but notwithstanding the great reduction of prices of the products of late years, yet owing to the extended development it has undergone, the value of the annual output has probably increased, and not declined, and from what information I have on the subject, I should say it is perhaps not less than 3,500,000*l.*

In my remarks I have also been led to refer to some of the points connected with the migration of this industry from this country to Germany and the probable influence our patent laws had upon this, to the matter of technical education, and the employment of high-class chemists in chemical work. This latter subject is undoubtedly of great importance, and requires the earnest consideration of our manufacturers. It is found profitable to employ chemists of this class on the Continent, surely it should be found equally profitable to employ them here. In conclusion, I am happy to say there are signs of the coal-tar colour industry returning to our country, in part at any rate, especially in relation to alizarin, for which there are now three large works in existence, and the production of other colouring matters is also increasing.

FAUNA OF TRANS-ALAY

IN the *Izvestia* of the Russian Geographical Society (xx. 6) we find an interesting paper by M. Grum-Grzimailo, who has journeyed in the mountains north of the Alay region of the Pamir, chiefly for zoological purposes. The immense cultivated loess-fields of Osh, devoid of trees, yielded poor zoological results. Only a few uncultivated places had in the spring a rich fauna: great numbers of birds, various *Colubridæ*, the *Pseudapus pallasii*, tortoises, immense numbers of *Bufo variabilis* were met with. Here the author gathered a very rich collection of Lepidoptera; also *Zamenis kaufmanni*, *Taphrometoron lineolatum*, *Elaphis dione*, *Eryx Jaculuj*, and many others. In the middle of May all these disappeared under the burning rays of the sun. On the way to Vadil several species which were not found later on were met with, such as the *Trigonocephalus halis*, the *Anthocaris pyrothoë*, and several others. The neighbourhoods of Vadil yielded nothing interesting at that part of the season (middle of June). Of vertebrates only two *Eremids* and one *Trigonocephalus hydrus* were found. Shankh-mardan and Jordan, on the contrary, gave a rich crop of insects, and M. Grzimailo remained there for ten days. On a rich Alpine pasturage, Artcha-bash, where Kirghizes are in the habit of staying, he found very rich zoological materials. The collections were enriched with a great number of rare species, such as *Pol. tamerlana*, *Colias eogene*, *Arctia erschoffi*, *Hol. jagorum*, which are common almost exclusively to the Himalayas and the South-West Thian-Shan, as also by several new species. On the snow-covered plateaux interesting specimens were found, and among them the *Megaloperdix nigelie* and the *Arctomys caudatus*. On the upper Kok-su, extending to a height of 12,000 feet, M. Grzimailo found a number of species which he did not see either before or afterwards during his journey, especially with regard to Lepidoptera. Vertebrates are few at this height; they were represented by the *Arctomys caudatus*, the eagle (*A. fulva*), one species of *Falco*, the *Frigilis graculus*, the *Pyrrhocorax alpinus?*, *Pica*, *Caccabis huckar*, *Megaloperdix*, and *Columba*. On the pass itself the holes of the *Arctomys caudatus* are seen everywhere, as also holes of some *Arvicola*. The Lepidoptera are richly represented at that part of the summer, especially the two genera *Colias* and *Parnassius*. On the Djekaindy Pass it was the same; the *Lycænæ* were very numerous, so that on the space of 3 metres the author found fifteen species of them, of which three were unknown to him. Without mentioning localities of minor interest, the plateau between the Kara-su and the Aram is worthy of notice for the brilliant collections of Lepidoptera which were made there. One *Lacerta* was found at a height of 11,000 feet, a species of *Elaphis*, the *Canis melanotus*, the *Lepus lehmanni*, the *Ovis polii*; of birds, the Falconidæ were most usual; also the *Upupa epops*, the *Cuculus canorum*, species of *Columba*, the *Orthygion coturnix*, *Caccabis huckar*, *Corvus corax*, and many others, this last reaching the highest parts of the region. Another find of great interest must be mentioned. The late Mr. Fedchenko had already caught one female Lepidopteron, which was determined by M. Erschoff as *Colias nastes*. This species having been found formerly only in Labrador and Northern Lapland, the determination remained doubtful, the individual having been but a female. M. Grzimailo has happened to catch a number of both males and females, which really proved both to belong to *C. nastes*. It remains now to explain the strange extension of this species.

SCIENTIFIC SERIALS

Rendiconto della R. Accademia delle Scienze di Bologna, 1884-5.—On the geometrical construction of the central axis in a given system of forces, by Prof. F. P. Ruffini.—A fresh contribution to clinico-experimental studies, showing the depressing action of ipecacuanha administered in large doses in pulmonary affections, by Prof. F. Verardini.—On the velocity of the polarised rays in a body endowed with rotatory motion, by Prof. Augusto Righi.—On the physico-pathology of the suprarenal capsules, by Prof. Guido Tizzoni.—On *Perineo melus*, a new genus of parasite observed in the pig, by Prof. Cesare Taruffi.—On the antimoniates of bismuth, by Dr. Alfredo Cavazzi.—Action of gaseous phosphated hydrogen on the trichloride of gold dissolved in ether, in alcohol, and in water, by Dr. A. Cavazzi.—On conjugated conic sections, by Prof. Virginio Retali.—Some researches on the so-called syntomatic carbuncle in cattle, by Prof. Alfrede Gotti.—Observations on Jacobson's organ and on Stenson's duct in the camel, by Dr. Francesco Peli.—On the central termination of the optical nerves in mammals, by Prof. Giuseppe Bellonci.—On the paraboloid surfaces in the selliform rhombohedrals of dolomite and other anhydrous carbonates, by Prof. Luigi Bombicci.—Some general observations on the systems of functions, by Prof. Salvatore Pincherle.—On a monstrous fœtus requiring the operation of embriotomy for its delivery, by Dr. Cesare Belluzzi.—On the question of sex in *Tolyposporium cocconii*, by Dr. Fausto Morini.—On the fossil remains of Dioplodon and Mesoplodon occurring in the Upper Tertiary formations in Italy, by Prof. Giovanni Capellini.—Forensic experiments in traumatology with firearms, by Dr. Giuseppe Ravaglia.—Contributions to the chemical study of intestinal perforation in typhoid fever, by Prof. Giovanni Brugnoli.—On the mode of genesis of a polar globule in the ovarium of certain mammals, by Prof. Giuseppe Bellonci.—A systematic enumeration of the funguses in the province of Bologna, by Dr. Fausto Marini.—On the thermal emissive power of electric sparks, by Prof. Emilio Villari.—On the use of curvilinear co-ordinates in the theory of the potential and of elasticity, by Prof. Eugenio Beltrami.—An analytic method of determining the equation of time, by Prof Antonio Saporetti.

SOCIETIES AND ACADEMIES

BERLIN

Physiological Society, June 19.—Dr. J. Munk gave a brief sketch of the different views put forth respecting the formation of fat in the animal body, and then gave a short account of the now almost universally accepted view of Voit, who, on the basis of his very numerous experiments, laid down the doctrine that the fat in the animal body proceeded either from the alimentary fat, or, when this was not sufficient, from the albumen, which on its decomposition yielded products that by synthesis became transformed into fat, while the carbo-hydrates never yielded material towards the formation of fat in the animal body. Opposition to this doctrine was raised on the side only of agricultural chemists, who, by experiments on swine and geese produced direct demonstration that the deposition of fat was considerably increased by feeding with carbo-hydrates. In consequence of these experiments Prof. Voit admitted that omnivorous and herbivorous animals might in certain circumstances form fat out of carbo-hydrates; such, however, he maintained, was never the case with carnivorous animals and man; in them all fat was derived from the alimentary fat and the decomposition of albumen, both in his own experiments and in all hitherto published, and the fat was seen to be derivable from these two sources alone, even though only 12 per cent. of the decomposed albumen were taken for the formation of fat, and much more if, according to the theoretic calculations of Herr Henneberg, it was assumed that as much as 51 per cent. of the decomposed albumen might be utilised towards the formation of fat. Seeing now that Prof. Voit admitted that, in the case of omnivorous and herbivorous animals fat was produced from carbo-hydrates, the speaker set himself the task of establishing experimental conditions under which fat might be formed from carbo-hydrates in the case, likewise, of carnivorous animals. For these experiments he selected a dog, completely impoverished it of all fat by means of long fasting, and then gave it an aliment very rich in carbo-hydrates. The animal required to be young, or otherwise the loss of fat by fasting could not be complete, and if it were desired to obtain certainty respecting the attainment of perfect deprivation of fat, the decomposition of the albumen during the period of fasting would have to be traced by regular determinations of the quantity of azote in the urine and the excrement. Prof. Voit had (as was already known) proved that on account of its ready decomposibility, fat was a protection against the decomposition of albumen; such would necessarily be the case in the fasting organism likewise, and the corporeal fat would necessarily protect the albumen from decomposition. In point of fact Dr. Munk found in fasting animals that when they were poor in fat the decomposition of albumen slowly abated in correspondence with the ever less abatement of the weight, whereas in the case of individuals rich in fat, the nitrogenous secretions in the last period, after the corporeal fat at disposal had been decomposed, did not only not abate, but even increased somewhat. The same cause as that followed by the nitrogenous secretion was also observed in the case of the elimination of sulphur. The exact process of albuminous decomposition during fasting thus offered an indication of the attainment of complete deprivation of fat in the body. The carrying out of the experiments was, however, attended with so many difficulties, that hitherto only one experiment had succeeded. It had reference to a large dog of three to four years old, weighing about 35 kilogrammes, which had been made to fast for thirty-one days, and was then fed daily with 200 grammes of meat, 100 grammes of lime, 400 grammes of starch, and 500 grammes of sugar, made into a preparation very acceptable to the dog. The gluten was occasionally added to the aliment to restrict the decomposition of the albumen. The experiment might be continued for twenty-five days; in the two last days diarrhœa set in, and the dog was killed in order to determine precisely the contents of fat in the body. The weight of the body of the dog during the process of feeding had increased by four kilogrammes, and amounted at the end of the experiment to 27 kilogrammes. Of the albumen partaken only 800 grammes were left undecomposed in the whole body. At the outset, therefore, it could be inferred that the dog had formed and deposited a considerable quantity of fat—an inference which was confirmed by the examination of the body. The fat of the underskin tissue and of the mesentery was carefully cut out, melted, and weighed. Then the amount of fat on the muscles was determined in particular samples, and the fat on all the muscles of the animal calculated. The fat of the liver was directly ascertained, and, finally, an account was taken of the fat of the bones, the nerves, and the other organs, which was admitted to be only half the amount which other physiologists had obtained on the same parts in an individual whose skin, muscle, and liver fat corresponded with that of the dog examined in the present case. Certainly the quantity of fat thus found was considerably less than the quantity actually formed during the time of the experiment. From this sum of fat deposited by the dog there was now deducted the total amount of the alimentary fat which had been appropriated, and of the fat which might have been formed from the decomposed albumen (12 per cent.). The result was a remainder of over 900 grammes of fat formed by the dog, which was derivable neither from the alimentary fat nor from the decomposed albumen, and which had, therefore, to be attributed to the carbo-hydrates that had been copiously administered. The speaker instituted a second calculation, taking account of the assumption which had hitherto, however, never been proved or even rendered probable by a single experiment, but was purely a deduction from constitutional formulæ—the assumption, namely, that of the decomposed albumen as much as 51 per cent. might be utilised towards the formation of fat. But even under this supposition there still remained more than 400 grammes of fat formed by the dog which, contrary to the doctrine of Prof. Voit, must have been produced from the carbo-hydrates. In compliance with a suggestion thrown out in the discussion of the question the speaker had, furthermore, calculated as a fat-former the whole of the lime taken by the dog, although all experiments had demonstrated that lime in no case produced fat; and yet, after that item had been fully taken account of, there were about 60 grammes of fat left that could be derived only from the carbo-hydrates. Dr. Munk therefore deemed it indisputably demonstrated by this experiment that in the case of carnivorous as well as omnivorous and herbivorous animals carbo-hydrates might in certain circumstances contribute towards the formation of fat.—Dr. Höltzke, following up a communication recently made by him respecting the influence of narcotics on pressure in the eye, reported experiments he had made concerning the influence of the blood-pressure on the intra-ocular pressure. The view had hitherto been universally accepted that the pressure in the eye was dependent on the blood pressure, and a series of experiences and experiments had been collected by way of proving this dependence. The nerves had likewise shown that they exerted an influence on the pressure in the eye, so far as they influenced the vascular system. Of the sympathetic in particular it was asserted that its paralysis induced an augmentation, whereas stimulation of the nerve caused a diminution of the intraocular pressure, and this converse process was said to be connected with the expansion and contraction of the vessels. Seeing, however, that some investigators maintained that the effect of the sympathetic on the pressure of the eye was exactly the opposite to that just referred to, the speaker had instituted new measurements by means of a manometer, utilising the second eye in the way of control. The result at which he arrived by this means was that the cutting of the sympathetic always entailed an abatement of the pressure to an average of 6 mm. mercury, and that stimulation of the peripheral nerve ending caused an increase of the pressure amounting to 14 mm. mercury. Stimulation of the supreme ganglion of the sympathetic had the same effect. If the veins of the neck were bound on the under side and the carotid was compressed then had neither the cutting nor the stimulation of the sympathetic absolutely any effect on the pressure in the eye—a proof that the influence of the sympathetic as above stated was only mediate, that the paralysis of the sympathetic induced the lowering of the ocular pressure only in consequence of the decrease of pressure in the vascular system and that the stimulation of the nerve caused the increase of the intra-ocular pressure only because of a rise of pressure in the blood. An experiment with a view to measuring the influence of the sympathetic on an atropinised eye did not yield perfectly decisive results, a circumstance which determined the speaker to investigate once more the influence of atropine on the ocular pressure. The result was somewhat different from that recently communicated. It was now ascertained with perfect certainty that the influence of atropine by itself was a diminution of the ocular pressure and therefore the contrary of that of eserine. Only when the pupil was powerfully expanded by the atropine did the pressure in the eye rise in correspondence with the other experiences that each expansion of the pupil was accompanied by an augmentation of pressure, and each contraction of the pupil was followed by an abatement of the ocular pressure. On the expansion and contraction of the pupil, the rise or the reduction of the blood-pressure became, in turn observable, and this latter again on its side generated a rise, or, as it might be, a fall of the pressure in the eye. This parallelism of the ocular and the blood-pressure the speaker had found to hold good in all his experiments. The pressure in the vitreous body invariably showed the same changes as did the pressure in the watery chamber.

CONTENTS

THURSDAY, AUGUST 13, 1885

DR. LAUDER BRUNTON'S "PHARMACOLOGY"

A Text-Book of Pharmacology, Therapeutics, and Materia Medica. By T. Lauder Brunton, M.D., D.Sc., F.R.S., &c. Pp. 1139. (London: Macmillan and Co., 1885.)

IT is nearly twenty years since Dr. Brunton, then a student in the University of Edinburgh, commenced, by his researches on the physiological action of digitalis, which were followed soon after by others on nitrite of amyl, a life of laborious work which has been marked at every stage by contributions which testify to his scientific acumen and his burning love for research, and which have enriched physiology and many branches of medicine with newly-discovered facts.

Now, when the second decade of his professional life is drawing to a close, he presents us with a work which stamps him as a teacher in the highest sense of the word.

It may appear to some that an apology is needed for introducing into the columns of NATURE a review of a work dealing with departments of medicine. To any such we would reply that it falls within the scope of this journal to review the progress of all departments of natural science, and that large sections of Dr. Brunton's book are full of interest to all biologists, and almost as much to the specialised physiologist as to the practical physician.

By the term "materia medica" it has long been the custom to designate the study of the agents, whether derived from the mineral, vegetable, or animal kingdoms, which are employed in the treatment of disease. By "therapeutics" we understand the study of the application of these remedial agents to the cure of disease. Until very recently the study of therapeutics was based entirely on pure empiricism, and under conditions where empiricism (*i.e.* experiment), uncontrolled by theory and unassisted by proper methods of observation, could not but yield misleading and contradictory results. The physician employed a drug because others had prescribed it before and found it useful in certain diseases, possessing but rarely any knowledge whatever of the mode in which the drug would affect a healthy subject, or of the manner in which it affected the diseased organism. All that was taught concerning the action of drugs was based upon successive individual experiences, accumulated by individuals who were of necessity destitute of the scientific knowledge, as yet unexisting, which alone could make them "empirics" in the best sense of the word.

These observations are not intended to disparage the work of those who, sometimes possessed of marvellous intuition, worked in bygone days, nor to lead to the inference that old therapeutical experience was barren of useful results. However great the knowledge otherwise acquired of the action of a new drug, however stringent the reasoning which leads us to surmise that it is likely to exert a valuable influence in the treatment of disease, yet ultimately it is by a rational empiricism—*i.e.* by a rational and cautious series of observations on actual cases of disease—that its value will be determined; and, further, he alone will be worthy of the name of a good physician who, irrespective of theoretical considerations, bases his use of remedial agents on the results of rational empiricism. To the older therapeutic studies we owe our knowledge of the usefulness of such drugs as iron, cinchona, and digitalis, a statement which of itself is sufficient to express our obligations to the empiricism of bygone days.

There were many causes which, until lately, stood in the way of a proper study of therapeutics. It was only when the natural history of disease came to be studied by men imbued with physiological knowledge and furnished with all the appliances which physiology has borrowed from chemistry and practical physics that it became possible to lay the foundations of sound therapeutics. From such studies it appears that a morbid process is not to be looked upon as a morbid entity to be destroyed, but usually as the resultant of complex deviations in physiological processes; often, it is true, associated with structural alterations of particular organs which stand more or less closely in the relation of proximate causes of the diseased phenomena. They have shown that, in general, in the treatment of disease, the scope of the physician must be to combat particular phenomena by the use of agents affecting specially the organ and function which are the principal factors in the production of the morbid process.

In order, then, to place medicine on a proper basis, it was needed (1) that the functions of the healthy organism (*physiology*) should be studied in the full light afforded by anatomy, chemistry, and natural philosophy; (2) that the exact deviations of the several functions from the normal standard which constitute particular diseases should be ascertained with the utmost exactitude, not only so as to permit of accurate recognition (*diagnosis*) and classification, but to furnish the elements for a philosophical treatment; (3) that alterations induced in the structure of organs by disease (*pathological anatomy*) should be minutely observed, and that by the light of *experimental pathology*, the course of these alterations and, if possible, their proximate as well as their more remote causes should be ascertained; (4) that the so-called physiological action of drugs and other remedial agents should be submitted to a searching investigation: to this study the vague and misleading term of *pharmacology*, previously employed by German writers, has, unfortunately as we think, been applied; (5) that the subsequent application of drugs and other remedial agents to treatment (*therapeutics*) should be studied not only with the object of showing their influence on particular diseases, but also the way in which individual phenomena of disease have been modified.

All the above branches of inquiry are now being pursued by men imbued with the scientific spirit and furnished with all the scientific knowledge of the day. As a result, in spite of the great difficulty of the task, the physician is acquiring more and more that power of anticipating and predicting events which springs out of a knowledge of principles and distinguishes science from mere empiricism.

Until a comparatively recent period the study of the physiological action of drugs and consequently of therapeutics remained in a backward condition, which contrasted unfavourably with that of other departments of medicine. The researches of Claude Bernard on carbonic oxide and curare were the first fruits of the application of physiology to the elucidation of the action of agents capable of modifying in a definite manner the functions of the body, and opened up the path which others were to follow. Thanks to the researches of such men as Schmiedeberg, T. R. Fraser, Sidney Ringer, and our author, the representatives of a host of active and successful workers, facts have been amassed, and the prospect is daily becoming clearer of the time when the physician shall rely less and less upon mere unsupported experience, and will be guided, as by an unerring compass, in the treatment of the diseases which come under his care. We realise as we read the fine work which lies before us how much has been done in a comparatively short time; we cannot help recognising that this very work places us on a higher platform than before, and thereby gives us a wider prospect towards all points of the compass. Yet we reflect and admit that at present we have only the title-deeds of the estate. We need still to go forth to possess the land.

Dr. Brunton's book contains an enormous amount of information. It is a work which will satisfy alike the student and the expert. Clear and logical it stimulates the student by constant reference to his previous work, and compels the expert to acknowledge that the whole bibliography of the subject has been ransacked to supply the innumerable facts which are so skilfully interwoven with the results of the author's own experience.

The book is divided into six sections. The first, entitled "General Pharmacology and Therapeutics," occupies nearly half the volume. It is a successful attempt to press the most recent and often apparently most abstract conclusions of science into the service of medicine. At the very outset the reader is surprised to find himself confronted with such questions as the unity of matter, Mendeljeff's law, chemical constitution and isomorphism, all placed in more or less direct relationship to pharmacology. It is a specimen of what must be expected throughout this section. Varied scientific facts are reproduced for the sake of overburdened memories, and then in a few pregnant sentences the author connects them with his subject, and, between the lines, opens out new avenues of research.

We would draw special attention to the remark of the author on the object, value, conditions, and objections to the study of experimental pharmacology (pp. 37-41). In the ordinary administration of any drug the difficulties in the way of a correct conclusion as to its action on the system are extremely great. The conditions are so complex that the most experienced physician will often hesitate between the "post" and the "propter." We must by experiment diminish the number of coincident phenomena in order that we may link the right antecedent and consequent. This may be accomplished in various ways, as the author indicates. A simpler organism and one more open to direct investigation may be employed; an organ or tissue may be isolated from the rest of the body, *e.g.* a muscle-nerve preparation; by ligature of blood-vessels, or otherwise, the drug may be excluded from part or parts of the body, and so comparisons instituted; or the normal mechanism of a part may be modified in a definite manner, and the action of the drug examined under these circumstances, as in experiments on drugs affecting the organs of circulation, and in which the vagus is cut or stimulated. Pharmacology is based on experiments thus made, and no one who reads Dr. Brunton's book can doubt their value. The observations of the author on objections to experiments appear to us so just that we cannot avoid reproducing them :—

"*Objections to Experiment.*—Some people object entirely to experiments upon animals. They do this chiefly on two grounds. The first is that such experiments are useless, and the second, that even if they were useful, we have no right to inflict pain upon animals.

"The first objection is due to ignorance. Almost all our exact knowledge of the action of drugs on the various organs of the body, as well as the physiological functions of these organisms themselves, has been obtained by experiments on animals.

"Their second objection is one which, if pushed to its utmost limits and steadily carried out, would soon drive man off the face of the earth.

"The struggle for existence is constantly going on, not only between man and man, but between man, the lower animals and plants, and man's very being depends upon his success.

"We kill animals for food. We destroy them when they are dangerous like the tiger or cobra, or destructive like the rat or mouse. We oblige them to work for us, for no reward but their food; and we urge them on by whip and spur when they are unwilling or flag. No one would think of blaming the messenger who should apply whip and spur to bring a reprieve, and thus save the life of a human being about to die on the scaffold, even although his horse should die under him at the end of the journey. Humane people will give an extra shilling to a cabman in order that they may catch the train which will take them to soothe the dying moments of a friend without regarding the consequences to the cab-horse. Yet if one-tenth of the suffering which the horse has to endure in either of the cases just mentioned were to be inflicted by a physiologist in order to obtain the knowledge which would help to relieve the suffering and lengthen the life, not of one human being only, but of thousands, many persons would exclaim against him. Such objections as these are due either to want of knowledge or want of thought on the part of people who make them. They either do not know the benefits which medicine derives from experiment, or they thoughtlessly (sometimes, perhaps, wilfully) ignore the evidence regarding the utility of experiment."

As protoplasm is the physical basis of life and the cell its unit, Dr. Brunton commences Pharmacology with the action of drugs on amœbæ, white corpuscles, infusoria, and the various forms of specialised protoplasm found in the higher animals. A section is also devoted to microorganisms. The late extensive corroboration of the truth of the germ theory of disease throws special interest around the investigations which deal with their life-history and the manner in which they are affected by drugs. A short chapter on the pharmacology of the Invertebrata serves to reveal the comparative poverty of our knowledge in this branch, and suggests further inquiry.

We must pass over the elaborate and lengthy chapters on physiology, pharmacology, and pathology as applied to the various organs and systems of the body. It is the centrepiece of the book, and reveals the versatility, the learning and the scientific instincts of the writer.

Section II., entitled "General Pharmacy," contains a succinct account of the various classes of pharmaceutical preparations, with tables of doses of the individual members of each.

The rest of the book is chiefly taken up with an account of the preparation, characters, doses, actions, and uses of the various remedial agents. Here we find all that valuable empirical knowledge of the use of drugs which science has so far failed to analyse, but which in course of time will no doubt be incorporated with the first section. Section III. is concerned with the inorganic remedies, Section V. with those obtained from plants, and Section VI. with those derived from animals. Section IV., "Organic Materia Medica," requires special notice. It includes all the carbon compounds employed in medicine which are obtained by synthesis.

Pharmacology owes much to the enterprise of the chemist. In the first place, the extraction of definite active principles from the various vegetable structures used in the Pharmacopœia has been of inestimable value. It was formerly impossible to be sure that the preparations made year by year were of the same strength. The environment of the plant varies more or less each season, so that at one time it may manufacture more of its active principles than at another. Moreover some plants contain several powerful ingredients which are of more value apart than together. The extraction and isolation of these substances has therefore led to a correct dosage and their more definite application to the treatment of disease.

In the second place the chemist is making us by degrees independent of the plant world by producing synthetically the bodies thus isolated. Just as the manufacture of alizarine from anthracene made the dyer independent of the madder root, so the artificial production of salicylic acid has supplanted the willow. In course of time, no doubt, as Dr. Brunton suggests, this section of Materia Medica will develop greatly, whilst the number of animal and vegetable preparations will correspondingly diminish. We are not, however—thanks again to chemical research—limited merely to those principles already in the Pharmacopœia. Already we are supplied with a host of substances, the products of synthesis, amongst which many of the valuable drugs of the future will doubtless be found. Organic synthesis, apart from the valuable substances which it may yield us, as the bodies kairin and antipyrin, which have already found their use in medicine, is of extreme importance to the pharmacologist from another standpoint, for it enables him to form conjectures as to the molecular structure of compounds. So far but few definite relations have been established between chemical constitution and physiological action. Still, enough has been done to demonstrate the existence of such relations and to promise a fruitful harvest hereafter. It has been proved, for instance (Crum Brown and Fraser), that the introduction of the methyl group into the molecule of an alkaloid gives it the power of paralysing the end-organs of motor nerves. Similarly Drs. Brunton and Cash have found as a general rule that most of the compound radicals formed by the union of amidogen with the radicals of the marsh-gas series possess a paralysing action on motor nerves.

It is probable that just as in the members of homologous series we have a gradation of physical properties and a similarity of chemical reactions, so bodies having similar chemical constitution will be found to resemble each other in physiological action. Induction will then lead to deduction, and the paths in which we are to tread in order to find drugs endowed with certain properties will be indicated; in illustration of this we note that already we know where to experiment if we wish to add to the number of our anæsthetics and antipyretics.

This review could not well close without a reference to the many useful illustrations and to the elaborate indices (extending to 131 pages), which add materially to the value of the work. It will rank as the text-book on the subjects of which it treats, being at once the best exponent of existing knowledge and a powerful stimulus to further progress.

ARTHUR GAMGEE

ELEMENTARY PRACTICAL PHYSICS

Lessons in Elementary Practical Physics. By Balfour Stewart, M.A., LL.D., F.R.S., Professor of Physics Victoria University, the Owens College, Manchester, and W. W. Haldane Gee, Demonstrator and Assistant Lecturer in Physics, the Owens College. Vol. I. (London: Macmillan and Co., 1885.)

IN this the first volume of what will evidently be an elaborate work on practical physics, the authors have treated of general physical processes only, *i.e.* of the methods employed in the laboratory for the exact determination or measurement of the geometrical and mechanical properties of bodies. It is impossible to over-estimate the importance of these fundamental measures, for upon them depends the accuracy of almost all physical work. That this is the view of the authors is made evident by their having devoted nearly the whole of the first volume out of a promised three to matters purely geometrical and mechanical. Throughout the volume the most minute attention to details is apparent, so much so that it is likely to weary those who read it only; but those who use it to guide them in making the measures given will certainly benefit by the completeness with which each subject is treated.

The first chapter, on the measurement of length, may be taken as a type of the whole volume. The metre and the yard are first defined and their absolute relation stated; the actual relation of metre and yard scales—slightly differing from the absolute owing to the fact that 0° C. and 62° F. are the two temperatures of reference—is next explained. A paragraph on "end measure" and "line measure" concludes what is in effect an introduction to the first chapter. Then the "Lessons" in this chapter begin. The first lesson is on the use of scales. In this instructions are given for measuring a length with a pair of compasses and an ordinary or a diagonal scale. Results are given showing the limit of accuracy by this method. The second lesson is on the straight Vernier, the third on the barometer Vernier, the fourth on the spherometer, and the fifth on the micrometer wire gauge. Lesson 6 is a description with figures of the dividing engine of M. Perreaux, the use of which is the subject of the next lesson. The next five lessons of this chapter explain the copying of scales, the cathetometer with its adjustments, the micrometer microscope, the Whitworth measuring machine, the eyepiece and stage micrometer, while a general review of the subject of length measurement, in which other instruments and tools, including the cathetometer microscope, are described, concludes the chapter.

This brief review of the first is sufficient to show the system on which each of the eight chapters is put together.

In the second chapter on angular measurement the circular Vernier, the mirror and scale, and the spirit level of course form the subject of lessons. There is also a lesson on that simple and easily-constructed instrument of M. Cornu, the optical lever.

The chapter on the estimation of mass is very complete, for, besides an explanation of the theory and use of the balance, there is a page headed "precautions in weighing," a copy of which might well be placed on the wall above every balance in a laboratory; there is an excellent paragraph on the sensibility of the balance, with a diagram showing the observed sensibility of an Oertling, a Bunge, and another short beam balance. There is, lastly, a lesson on the errors of weights, in which instructions are given for testing a set of weights.

In the chapter on measurement of area and volume a large amount of space is given to an explanation of the Amsler planimeter. This beautiful little instrument, as is well known, gives the area of a figure round which its point is traced. In a new edition it is to be hoped that the new "precision" planimeters which in accuracy and some other respects are superior to that of Amsler, will be described.

In Chapter V., on the determination of density, are to be found full instructions for finding the specific gravity of solids and liquids by a host of methods. The corrections for buoyancy are carried to such an extent that account is taken of the latitude and the height above the sea-level in calculating the density of the air from the barometer reading; further, the effect of moisture in lightening the air is guarded against. The hydrometers of Fahrenheit, Baumé and Twaddle are described, and instructions are given for making them. The exact determination of the density of a gas, being a problem of great difficulty, is considered unsuitable for imitation in the laboratory; however, an outline of Regnault's method is given.

The chapter on elasticity, tenacity, and capillarity differs from others in the book in that the theory of the subject is given at length, as well as instructions for performing experiments in the laboratory.

The chapter on the determination of atmospheric pressure contains a full account of the method of filling and using a standard mercurial barometer. The aneroid barometer is not mentioned.

The last chapter, on time, gravitation, and moments of inertia, is purely mechanical. The difference between the sidereal, solar, and mean solar days is explained, but instructions are not given for taking a transit. Clocks, chronometers, stop-watches, the water-clock, and the chronograph of Hipp, in which a reed vibrating 1000 times a second replaces the pendulum of a clock, are briefly described.

The determination of g by Borda's and by Kater's method is given. Several forms of electro-chronograph are described—among them one in which a primary circuit is broken at the beginning and end of the interval to be measured, while the induced currents cause a spark to pass between the style of a tuning-fork and a smoked drum, so that the number of waves between the two dots produced by the sparks measures the time.

As has been already said, completeness and attention to details are apparent in every chapter of the first volume, while the names of the authors are sufficient as a guarantee of accuracy. The only cause for regret is the fact that the public has to wait for the two volumes on real physics, for those who read the first, which deals mainly with measurements of geometrical and mechanical properties, and which is therefore essentially an introduction, are likely to be impatient to see the series completed.

OUR BOOK SHELF

The History of a Lump of Gold from the Mine to the Mint. By Alexander Watt. (London: A. Johnson.)

THE author has endeavoured to treat his subject so as to interest general readers, but he might have spared them such moralisations, suggested by the word "gold," as "With what silent rapture we receive it as our own, and how different is the feeling when it comes into our hands merely to convey to another." The compilation of facts connected with the history of gold and its manufacture into coin has, however, been carefully done. Considering that the superstructure of modern chemistry was built up on the labours of the "early alchemists," we object to their being described as "those remarkable imposters," and indeed the quotations from the writings of the early chemists which are given abundantly prove their claim to more respectful treatment. The metallurgy of gold is dealt with in the most slender way, but the chapter relating to the operations of coinage is more satisfactory, and is confessedly an abstract of a series of Cantor lectures recently delivered by the chemist of the Mint.

The important question of the amount of gold actually in circulation has not been lost sight of, and the author sums it up by quoting the following passage:—"The amount of gold actually in circulation is estimated to be 100,000,000*l.*, but the coinage returns show that the amount of sovereigns and half-sovereigns issued since 1816, when their coinage began, is 247,521,429. What, then, has become of the one hundred and forty-seven millions not in circulation?" No doubt a considerable proportion has been exported never to return, but we do not think, with the author, that the operations of manufacturing goldsmiths and jewellers would account for a very large proportion of the deficiency.

There are some remarkable slips in the printing. For instance, the well-known historian of the coinage is called the Rev. Rogers Rudling, and Sir John Pettus appears as Petters; but viewed as a whole, the work may be commended as tending to disseminate information respecting the precious metal which it is desirable should be widely known.

Magnetism and Electricity. By W. G. Baker. (London: Blackie and Son.)

WITH the multitude of elementary text-books on magnetism and electricity already existing the production of a fresh one might well have seemed an unnecessary task. Nor is there anything in the little book now before us in the least degree new, either in matter or in arrangement. So far as it goes, however, it is quite satisfactory. It consists of 143 pages, and in this space the author has managed to give in a clear manner an account of so much of the subject as might reasonably be put before a school class for beginners. As it appears from his preface that this was the sole object of the author in writing the little book, he is entitled, we think, to consider that his object has been attained.

Bacillary Phthisis of the Lungs. By Germain Sée, translated by William H. Weddell. (London: Kegan Paul, Trench and Co., 1885.)

THIS is in many respects an unsatisfactory book. It is divided into seven parts. Of these the preliminaries and the first four parts comprise anatomical and histological notes, the biological study of micro-organisms generally, and the study of the bacillus tuberculosis especially, and all kinds of promiscuous notes on the causes of tuberculosis; but, owing to the dogmatic way in which these subjects are treated, the omission of details and the numerous mycological inaccuracies this portion of the book is very weak. The rest, treating of clinical, hygienic, and therapeutic subjects, is more within the author's proper domain, and will be found instructive to the medical practitioner.

Mineral Resources of the United States. By A. Williams. (Published by the U.S. Geological Survey, 1883.)

THIS book consists of a series of essays, of various degrees of importance, on the mining and metallurgic industries of the United States. The work has been mainly carried out by entrusting each subject, or a special branch of each subject, to a gentleman intimately acquainted with that branch. The thoroughness with which the subject is treated is shown by the fact that the natural history of so rare a substance as hiddenite is very fully discussed by the original discoverer, Mr. W. E. Hidden.

Naturally the most important and the most extensive essays are those on coal, iron, copper, and zinc. Silver, the position of which is at present one of the most difficult problems connected with the metals, was excluded by Act of Congress from the present investigation, and tables of the production of gold and silver in recent years are all the information given. Former publications of the U.S. Government have already made known the enormous wealth of the silver-mines, and have given fair means by which persons interested in mining may estimate the prospect of success in such undertakings.

Under iron, an account is given of the Bower-Barff process of protecting iron from rust by means of a thin film of magnetic oxide—a process which bids fair, if it stand the trial of some years' wear, to replace the process of galvanising.

To professional people who need accurate information as to the condition of the various industries, the book possesses great value. It is also full of interest to the scientific mineralogist who has mainly to depend on the opening of new mines for fresh discoveries in the mineral kingdom. One cannot help regretting, however, the space given to a history of the divining-rod, "natural magnets," and similar absurdities. The subject is as much out of place as an account of the astrological nonsense practised in the Middle Ages would be in a modern treatise on spherical astronomy.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Pitcher Plants

PERHAPS you will allow me to set "W. C. M." right with regard to *Sarracenia variolaris* and pitcher plants generally (p. 295). I am afraid the sources from whence he obtained his information were not very reliable, as will be seen from the following:—

There are six species of Sarracenia found in North America, all of them characterised by the same trumpet-shaped leaves growing in tufts, and in several of the species attaining a length of a yard. In addition to these there is the *Darlingtonia californica*, which has long twisted trumpet-shaped leaves, the top of which is curved over, forming a sort of hood, and having a rather small aperture on each side. These constitute the whole of the pitcher plants of North America. "W. C. M.," whilst professing to describe the "curious characteristics" of the Sarracenia, really describes the leaf and pitcher of Nepenthes, which, as almost everybody knows, are tropical plants, mostly natives of the Indian Archipelago, and well known in this country as ornamental stove plants. The pitchers vary much in size, some of the species producing them quite eighteen inches long and capable of holding a quart of water, whilst others have pitchers no larger than a thimble. "W. C. M." is quite wrong in saying that the lids of the pitchers of Nepenthes, or indeed of any pitcher-plant known, close again after they have once opened. When the pitcher is about full-grown, the lid pushes open, widely in some species, only slightly in others, and remains quite stationary till the pitcher dies. When the lid opens, the pitcher is found to be about one-quarter filled with a sweetish watery liquid. Under cultivation it is necessary to keep the pitchers filled with water, or they soon shrivel; and it is found that, however frequently the water is renewed, it soon acquires a slight sweetness; so that the secretion of "honey" going on in the pitcher must be somewhat copious. If the water which is in the pitcher when it first opens dries up, there is no further secretion of liquid—at least such is the case with cultivated plants. At Kew the oldest pitchers on the Nepenthes attract insects as long as they contain moisture. The Sarracenias have their pitchers formed by the folding and joining of the edges of the leaves, so as to make a long funnel which is wide at the mouth and narrowed to almost a point at the base. Over the mouth the flap-like lid is fixed and in some of the species stands erect so as to admit rain-water into the pitchers, whilst in others the lid curves over in such a manner as to hinder the rain from falling into them. In 1815 the then President of the Linnean Society, Dr. James McBride, read a communication on the fly-catching propensity of Sarracenias, from which the following is worth quoting, as it describes accurately what we have repeatedly observed in the collection of Sarracenias cultivated at Kew. He says, writing chiefly about *Sarracenia variolaris*: "If, in the months of May, June, or July, when the leaves of these plants perform their extraordinary functions in the greatest perfection, some of them should be removed to a house and fixed in an erect position, it will soon be perceived that flies are attracted by them. These insects immediately approach the fauces of the leaves, and, leaning over their edges, appear to sip with eagerness something from their internal surface. In this position they linger, but, at length allured, as it would seem by the pleasures of taste, they enter the tubes. The fly, which has thus changed its situation, will be seen to stand unsteadily, it totters for a few seconds, slips, and falls to the bottom of the tube, where it is either drowned or attempts in vain to ascend against the points of the hairs. The fly seldom takes wing in its fall and escapes. In a house much infested with flies this entrapment goes on so rapidly that a tube is filled within a few hours, and it becomes necessary to add water, the natural quantity being insufficient to drown the imprisoned insects. The leaves of other species might well be employed as fly-catchers; indeed I am credibly informed that they are in some neighbourhoods. The leaves of *Sarracenia flava*, although they are very capacious, and often grow to a height of three feet or more, are never found to contain so many insects as those of other species. The cause which attracts flies is evidently a sweet viscid substance resembling honey, secreted by, or exuding from, the internal surface of the tube. From the margin, where it commences, it does not extend lower than one-fourth of an inch. The falling of the insect as soon as it enters the tube is wholly attributable to the downward or inverted position of the hairs of the internal surface of the leaf. At the bottom of a tube, split open, the hairs are plainly discernible pointing downwards; as the eye ranges upwards they gradually become shorter and attenuated, till at, or just below, the surface covered by the bait, they are no longer perceptible to the naked eye nor to the most delicate touch. It is here that the fly cannot take a hold sufficiently strong to support itself, but falls. The inability of insects to crawl up against the points of the hairs I have often tested in the most satisfactory manner" (*Trans.* Linnean Society, vol. xii.). I have again and again released blue-bottle flies after they have been trapped, and have never yet found them act in any way that would suggest an intoxicating property in the secretion which they had fed upon—this is contrary to the information of "W. C. M.," who says:—"After feeding upon the secretion for two or three minutes they [the insects] become quite stupid, unsteady on their feet, &c." To prevent the pitchers being injured by the large number of insects which are lured into them, we find it necessary at Kew to fill the mouths of the pitchers with cotton-wool; this prevents the insects from falling in. Before this precaution was taken many of our finest pitchers were lost, owing to the decay which was caused by the rotten mass of insects which had accumulated in the bottom of the pitchers. "W. C. M." will be surprised to hear that, in spite of this cutting off of the supply of insects to the pitchers, the plants were in no way affected as regarded growth or vigour, but that the length and general health of the pitchers were more satisfactory after the insects were not allowed to enter them, than before. The concluding sentence in his remarks is rather startling, as, so far as investigations conducted by physiologists have gone hitherto, the Sarracenias are not known to be carnivorous. Mr. W. H. Gilburt, of the Quekett Microscopical Club, says:—"The pitchers contain fluid, but nothing corresponding to a digestive fluid has been detected in them; so that, if the insects which perish in the pitcher are of any value to the plant and afford any nutriment, it must be simply by maceration, and the glands can be regarded as absorbent only." Of course it may be said that Sarracenias would not have been constructed with what appears to be a view specially to catching insects, if the insects were not to serve some useful purpose in the economy of the plant. Anyhow, at present it is only safe to say of Sarracenias that they allure and ultimately destroy insects, but we do not yet know that they obtain nourishment from them. Certainly under cultivation there is abundance of evidence to prove that these, and in fact all those plants which are considered to be distinctly carnivorous, grow and thrive at least as well when insect food is not allowed them as when it is.

Kew W. WATSON

Colourless Chlorophyll

IN his elaborate "Contributions to the Chemistry of Chlorophyll" (NATURE, vol. xxxii. p. 117), Mr. E. Schunck rightly observes that the explanation given by Mr. Tschirch for the curious fact discovered by Mr. Church is not based on sufficient proof. Indeed it could hardly be admitted that the action of metallic zinc is a process of reduction, since a similar result may be arrived at when zinc oxide is used instead of the metal. (A fact that I stated in 1869).

But quite recently I have had the opportunity to convince myself that the reaction that takes place when a chlorophyll solution is *treated by metallic zinc and an organic acid* is of an utterly different nature. Through the agency of nascent hydrogen generated in the reaction, *chlorophyll is* actually *reduced, the resulting substance being* not of a green colour, but perfectly *colourless*, and presenting no traces of the characteristic chlorophyll spectrum or fluorescence. It is only on coming in contact with the air that it gradually acquires both its green colour and specific optical properties. It is highly instructive to watch the phenomenon in a test-tube placed before the slit of a spectroscope and observe the first appearance and subsequent growth of the dark bands, the colourless substance regaining in the mean while its original splendid emerald green.

The physiological importance of this fact will be obvious to all botanists interested in the subject; for my part I consider that the discovery of this colourless modification of chlorophyll brings additional proof in favour of an hypothesis that I proposed in 1875 concerning the chemical nature of chlorophyll—viz. that the green colour of this substance is due to the presence of iron in the state of a $FeOFe_2O_3$ compound. In fact, all the changes that this substance undergoes, its production, its destruction, the action of acids, of metallic zinc and zinc oxide, might be easily accounted for by admitting this simple and very plausible hypothesis.

But whatever may be the ultimate fate of this "provisional" hypothesis, the fact just stated will lose nothing of its importance. Its chief interest lies in the establishment of the existence of a colourless substance, acquiring by oxidation all the optical properties of chlorophyll. It is evident that chlorophyll is generated in this case by a process similar to that which takes place in the living plant. (The existence of such a substance has been often announced, but continues to be a subject of doubt). At the same time we may see the reason why, admitting that chlorophyll undergoes a process of reduction when CO_2 is dissociated through the agency of light (this supposition is highly probable), this transformation may not be attended by a visible change of its colour, and other optical properties—the produce of reduction being colourless and having no dark lines in the spectrum. However, the change of colour that M. Sachs observed in a great number of leaves on exposing them to direct sunlight, and which is generally attributed to a migration of the chlorophyll grains, might, partly at least, be due to this process of reduction. C. TIMIRIAZEFF

Moscow, July 15

July Meteors

BETWEEN July 8 and 14, 111 shooting stars were recorded here in 11¾ hours of observation. The paths of these, reproduced upon an 18-inch celestial globe, enabled me to fix the radiant points of 12 showers with considerable distinctness:—

No.	Epoch. July.	Radiant. ° °	Notes.
1 ...	13–14 ...	11+48	Meteors long, swift with streaks.
2 ...	8–13 ...	245+52	Slow, yellow, max. July 8.
3 ...	13–14 ...	255+37	Slow, faint, near π Herculis.
4 ...	9–13 ...	265+63	Slow, faint, near ζ Draconis.
5 ...	9–14 ...	271+21	Slow, faint. In Cerberus.
6 ...	9–13 ...	280−14	Very slow, long paths.
7 ...	13–14 ...	285+42	Very swift and short, near α Lyræ.
8 ...	9–13 ...	289+31	Swift, faint, near γ Lyræ.
9 ...	8–13 ...	290+60	Slow, bright, near ο Draconis.
10 ...	8–13 ...	303+24	Swift. In Vulpecula.
11 ...	13–14 ...	314+47	Very swift, short, bright, near α Cygni.
12 ...	9–14 ...	329+36	Swift, reddish streaks. S. of Lacerta.

Nos. 1, 7, 8, 9, 11, and 12 were well observed by Zezioli in 1867–68, and form Nos. 93, 90, 88, 89, 99, and 98 of the catalogue of radiants derived by Schiaparelli from his observations.

Generally the meteors observed here during the past month were small, but three were estimated as bright as Jupiter. The first of these appeared on July 8 at 12h. 1m., shooting rapidly along a course of 27 degrees a little west of ζ, η, θ Draconis. It left a brilliant streak, enabling the path to be very accurately noted. This meteor belonged to the radiant at 11° + 48°, and soon afterwards, at 12h. 10m., another fine one was seen pursuing a greatly foreshortened path near δ Draconis and throwing off a dense train of yellowish sparks. Its motion and appearance prove it to have been a Draconid and a member of the display from 290° + 60°. On July 9, at 13h. 50m., I recorded a fine meteor shooting upwards, just east of Altair, from a centre at 304° − 15° near α and β Capricorni; but I have not included this position in the list, as I only saw one other shooting star with a conformable direction during the period included by my observations.

On July 31 a few fine and early members of the August Perseids were seen, and on August 1, between 9h. 45m. and 9h. 50m., I noted three others, two of which were unusually brilliant, and projected vivid streaks upon their long, graceful flights through the Milky Way west of Aquila. This conspicuous and early appearance of the Perseids would seem to predicate a bright maximum on the night of August 10.

Bristol, August 2 W. F. DENNING

The August Meteors

LAST night at 9.32 a brilliant meteor crossed Cassiopeia's Chair from W. to E. parallel to the horizon. Its trail was visible for twenty-six seconds after the bursting of the meteor. During a five mile walk, lighted by many meteors, the summer lightning incessantly flashed from the northern horizon, but its brightness was never comparable to that of this meteor. It resembled most a magnesium rocket in the Crystal Palace fireworks. But even this comparison is hardly adequate.

Chatham, August 12 H. B. JUPP

A Possible Windfall for Science

IS not the better course for immediate action that the departments in England and the United States should first combine?

Let each apportion a part of the calculation, and then print it in an agreed form. The sterotype plates would be interchanged, and what a private firm does the Government can effect. In this way the English-speaking marine, including many Dutch and German captains, will be at once supplied, and part of the proposed economy and benefit be obtained without waiting for negotiations with France and Germany. HYDE CLARKE

Electrical Phenomenon in Mid-Lothian

I HAVE observed in a daily contemporary a communication quoted from your journal with reference to this occurrence on the 23rd ult.

For the information of those of your readers who are interested in such matters perhaps you will kindly allow me to observe that I also witnessed a similar, or the same, phenomenon that evening.

When driving home from a professional visit in the country, and a mile south of this town, about ten o'clock I was suddenly startled by a peculiar sensation or slight shock, and immediately perceived, ten yards in front, on the road, a bright opalescent luminosity which travelled deliberately away in a northerly direction. This cloud or wave of light covered the whole breadth of the road, and was distinctly visible for some seconds. It seemed to rest entirely on the ground, and in character reminded one somewhat of the illumination resulting from the electric light. I should imagine it was travelling at the rate of twenty miles an hour, as it was going much in the same direction I was, but of course much faster. The part of the road where it showed itself is lined by high trees on both sides in full foliage. I heard no thunder and saw no lightning or meteor to account for the strange and weird-looking light.

The interesting question then arises, What was the nature of this phenomenon?

It will be remembered that the thermometer was for several days at that time above 80° F. in the shade. Might it not be possible, therefore, for a certain volume of air to become electrified, and then, perfectly insulated by the dry surrounding atmosphere, show its existence in this manner as a luminous cloud rushing along the ground?

I may mention in conclusion that my groom, who was driving me at the time, also witnessed the occurrence.

Dalkeith, N.B., August 10, 1885 ROBERT LUCAS

On a Radiant Energy Recorder

A FEW weeks ago I wrote a short article for NATURE under the above title, describing an instrument for the measurement of radiation in heat units which was based upon the principle of the integration of temperature by the distillation of water in vacuo. Since then Mr. Edward Vivian, M.A., has kindly written me a very interesting letter, in which he says that he had several forms of an instrument based upon essentially the same principles, made for him by Messrs. Negretti and Zambra many years ago, and that some of them are still in use in his garden at Torquay. Mr. Vivian's instruments were shown at the British Association (*B. A. Report*, 1856, p. 48) and at the Royal Institution of Great Britain (*Journal R. I.*, 1857, p. 438), but no description of them appears to have been printed, which probably accounts for their not being more generally known.

University College, Liverpool J. W. CLARK

Our Ancestors

THE number of "Our Ancestors" since "the time of the Norman Conquest," mentioned in your last issue by $\left(\frac{1}{2}\right)^n$, and the consequences to be deduced therefrom, have been very interestingly discussed already by Mr. Grove in his presidential address to the British Association at Nottingham, 1866.

Freiburg, Badenia, August 8 N.

THE INSTITUTION OF MECHANICAL ENGINEERS

THE Institution of Mechanical Engineers held their summer meeting at Lincoln last week, under the presidency of Mr. Jeremiah Head, who, in his inaugural address, treated of the relative advantages of iron and steel for the various purposes for which these metals are employed. The reasons why steel *rails* are now used almost to the exclusion of iron are that they can be produced more cheaply, can be manufactured of equally good quality by either the Bessemer or Siemens process with either acid or basic-lined vessels and of almost any iron ore, and they can better withstand abrasion, disintegration, or crushing under heavy rolling loads; for the same reasons steel tires are now almost universally employed. For *ship-building* steel is superior to iron, as, owing to its greater ductility, ships built of the former metal are able to outlive collisions and minor accidents that would be fatal to iron ships. As is well known, owing to the superior tensile strength of steel, Lloyd's Committee agreed in 1877 to allow a reduction of 20 per cent. in weight of scantlings over iron, and in the thickness of plates; Mr. Head argues that, considering a ship's plate is a broad girder, its strength diminishes as the square of the thickness, and that, therefore, although a steel ship would be superior to an iron one of equal weight, an iron ship is likely to retain its form better than a steel one built 20 per cent. lighter. As regards *bridges and roofs*, the employment of iron or steel depends mainly upon the size of the structure; for light edifices, owing to its greater cheapness, iron has hitherto been used, whilst for large spans, where the weight of the structure itself is an important function, steel has been employed in the erection of bridges of spans which could not have been attempted if the engineer had been dependent on iron alone. For *boilers*, except in the matter of corrosion, in which authorities seem to differ as to the resisting power of iron and steel, but appear to be rather favourable to the former, steel is much more advantageous than iron, both on account of its being as cheap, and on account of a steam boiler of the same weight being able to withstand much higher pressures if made of steel than if made of iron; hence boilers, and marine boilers particularly, are now scarcely ever built of iron. The President recommended the application of metal in the construction of the frames of rolling stock and for railway-sleepers. As regards the continued use of wooden sleepers, there can be no question that "it is a form of waste that should be reprehended in the public interest, just as should the use of coal for ballasting or other obviously wasteful purpose. The same timber which would become useless for sleepers in, say, nine years, would last at least a century in the roof or flooring of a house." Another argument advanced, and a most important one, is that the substitution of iron and steel for timber railway-sleepers would not only give an enormous impetus to these industries while the substitution was being effected, but would permanently maintain a population of 100,000, or 3 per cent. of the whole population of the country, for renewals.

Leaving special branches of industry, to refer to special forms in which iron and steel are supplied, the President drew attention to *bar-iron* still maintaining its position, because wherever implements are *made* they come sooner or later to the village blacksmith to be *repaired*, and these find steel harder to work, more difficult to weld, and requiring more care to smith; and therefore the original manufacturer has to adopt a material and construction within the compass of the ideas and resources of the rural repairer.

As regards *castings*, an urgent need has long existed for a material which could be cast in a mould, and which should yet have the toughness and tenacity of wrought iron; and steel, exactly supplying this want, has come very generally into use, more particularly as the cost of steel castings has been greatly cheapened latterly by the employment of the Bessemer and Open Hearth processes; still, steel castings are much dearer than iron ones, because the molten metal is dearer, and the higher melting point of steel compared with iron necessitates more costly moulds. But in a majority of cases in which cast iron has hitherto been used, mass and stiffness due thereto, are required, rather than great tenacity and ductility, and there is, therefore, likely to be a simultaneous demand for castings of both steel and iron. Concurrently with steel castings, steel *forgings* have gradually been coming more and more into general use for fine and delicate work, where cost is no consideration, and homogeneity and capacity to harden of the very greatest importance.

Steel has practically no grain, and is as strong in one direction as another; thus it is eminently suitable for such work, and is naturally superseding iron completely. The conclusion of the President on the subject of the employment of iron and steel in the arts is one in which upon full consideration all must agree—viz. that the laws of gradual change, and of the survival of the fittest, apply equally in the arts as in nature, and that in the long run the fittest material will prevail according to the peculiarities and necessities of each particular case.

The first paper read at the meeting was by Mr. J. Ruston, M.P., descriptive of Dunbar and Ruston's steam navvy.

This machine may be described generally as consisting of a strong rectangular wrought-iron frame mounted on wheels. On the back end is placed the engine; at the front end rises a wrought-iron tower carrying the top pivot of a crane jib, the lower pivot resting on girders fixed to the main frame. The jib is of twin construction, being composed of two sides united only at the post and at the outer end or point; between them is a long slot, in which swings an arm of adjustable length, depending from a fulcrum fixed on the upper member of the jib; and at the base of the post is a circular platform, on which a man stands to regulate by means of a hand-wheel the "reach," or length of radius of the arm. The scoop or bucket is fixed at the lower end of the arm, and is raised or lowered by the main chain passing over the extremity of the jib. The whole of the movements are controlled by two men, called the "driver" and the "wheelman." The driver raises the scoop while making its cut, swings it round into position for discharging, and back again afterwards, and lowers it down. The wheelman regulates the depth of the cut, releases the scoop from the face of the bank, and opens the door or bottom for discharging its contents.

Supposing the navvy to be in position, the mode of working is as follows:—The bucket having been lowered till its arm is vertical, the wheelman regulates the length of the arm by means of his hand-wheel, so that the cutting edge of the bucket shall get its proper grip of the soil. The driver throws the main chain-drum into gear, and the scoop is dragged forwards and upwards by the chain, describing a circular arc of about 80 degrees. By the time it reaches the top it is fully loaded, and the driver, throwing the drum out of gear, holds it with a footbrake; at the same instant the wheelman by easing his footbrake allows the bucket to fall back so as to clear itself from the face of the bank. The driver next swings the jib round till the bucket is over the waggon, when the wheelman releases the latch by means of a cord, and the door falling open, the contents instantly drop through. The driver then swings the jib back again, and at the same time lets go the footbrake of the chain drum, thus causing the bucket to descend through a sort of spiral course, until he brings it up sharply by the brake again. The wheelman at the same moment adjusts the fall by means of his brake, so as to lower the bucket to its first position with just the right reach of arm for the next cut. During the fall the door of the bucket closes and latches itself automatically by its own weight; and all is then ready for repeating the operation.

Upwards of a hundred of these machines are now in use, the majority in Great Britain, and the remainder in various parts of the world.

In the discussion of this paper the various speakers testified to the success with which the navvy did its work when excavating materials of various degrees of hardness and toughness.

Mr. John Richardson's paper on recent adaptations of the Robey semi-portable engine was an extension of a paper read in 1873. The engine is erected on a massive wrought-iron foundation plate, to which all the working parts are fixed, together with one of the drum-shaft bearings, and the brackets for carrying the brake-straps and levers. The whole of the strains due to the working of the machinery are contained within the base plate, and are brought, as they should be, near to the position of greatest stability—namely, the ground line; while the boiler is set free from all mechanical strain, and is left to its legitimate purpose of making steam. A specially light engine has been designed for use in countries where there is little facility for transport, wrought iron and steel have been substituted as far as possible for cast iron, with the result of a large saving in dead weight and consequent saving in cost of transport.

A paper on private installations of electric lighting, by Mr. Ralph Neville, is interesting as descriptive of an application in which existing engine power was utilised and modifications made in the governing of the engine to suit the purpose of driving a dynamo machine, in which, as is well known, the action on the engine has to be prompt, the electric lamps acting as visible instantaneous galvanometers. The dynamo employed was a Siemens S 9, the lamps being mostly 100 volt 20 candle-power of Edison and Swan make. The current generated is led from the dynamo to a set of switches, by which it can be distributed into five separate circuits, the first exciting the field magnets of the dynamo itself and the others furnishing current for lights in various parts. Certain points are taken as lighting centres, and the electromotive force between them is kept constant; for this purpose small wires are connected with the mains at the required points, and the current to actuate the governor is taken off there, instead of direct from the terminals of the dynamo. The original governor attached to the engine was found to have so great an inertia that its position would remain the same for a very considerable variation of speed, so the author set up an electrical governor.

The regulating part of this governor consists of a double solenoid magnet, placed vertically and wound with insulated copper wire, within which works a double core; and to the cross-piece at the bottom of the cores is linked the long arm of a lever, the short arm of which presses upon the spindle of a double-beat Cornish valve that controls the admission of the steam to the steam-chest. For incandescent lighting in parallel, the wire on bobbins is placed in shunt circuit between the main leads; and the size of wire used is adjusted according to the electromotive force which it is desired to maintain between the mains, so that when the electromotive force is at the right point the cores are suspended within the solenoids by their attraction. Inasmuch as the resistance of the solenoids is fixed, any increase in electromotive force causes an increased current to flow through them, whereby the cores are immediately attracted with an increased force, and are caused to move upwards, thereby acting through the lever to close the valve until the electromotive force has been brought down again to its normal amount. The required movement of the valve is exceedingly small; and this method appears to be the best suited for electric lighting. An automatic expansion-gear, on which the governor might be caused to act, has the disadvantage that, when but few lights are burning, the steam is cut off at so early a period of the stroke that, unless the fly-wheel is exceedingly heavy, a fluctuation occurs in the the light during the revolution of the fly-wheel. In an engine where economy of coal has to be considered probably the best way would be to have an expansion-gear actuated by hand, which can be set approximately to the expansion required leaving the throttle-value to regulate the speed finally. But where perfect steadiness is desired it is probably better not to cut off much before half stroke, especially if a single-cylinder engine is used. The use of accumulators as regulators would of course prevent a great deal of the fluctuation, and would permit of the steam being cut off much earlier without causing any apparent unsteadiness in the light.

The electric governor was fixed on the engine and worked for the first time on January 13 last. The improvement was remarkable, the lights remaining steady, without the sudden alternations of brightness and dulness which had occurred before. But it was still found that with any considerable variation of boiler pressure or of load the electromotive force in the mains varied more than was thought conducive to long life in the lamps. As however it was found that, by augmenting or diminishing the weight suspended from the core bars, the electromotive force could be brought back to its normal amount, it occurred to the author to fix an upright cylinder in direct communication with the boiler, and to make its piston-rod press upwards on the core-bars: the diameter of the cylinder being experimentally determined by observing the weight necessary to be added or removed for certain variations in boiler pressure. This arrangement caused a very great improvement; and when the load was approximately the same it maintained the electromotive force constant under very considerable variation of steam pressure. When, however, the load was varied very considerably, say from one lamp to a hundred, it was found that more variation took place in the electromotive force than was desirable.

The arrangement was accordingly modified by causing the piston-rod to act upon a lever, and by introducing a second cylinder supplied with steam from the steam-chest, the second piston-rod acting not upon the same lever but upon the other side of the fulcrum. The end of the lever was furnished with a steel knife-edge, bearing against another knife-edge set at right angles to it upon the prolongation of the core-bars. The cylinders were also both of them made larger, and were placed so that they could either of them be moved nearer to or further from the fulcrum of the lever, whereby the resultant effect of their differential power could be easily adjusted. This arrangement answered very well indeed, and it was found that the lights could be varied from 1 to 100 and the boiler pressure from 30 lbs. to 60 lbs. with but very slight variation of electromotive force in the mains: provided of course there was sufficient steam to do the work required. It is also quite easy to cause the electromotive force to rise as the load on the engine increases—or in other words as more current passes through the main—by simply giving greater leverage to the piston connected with the steam-chest. In fact with this arrangement the electromotive force can be maintained practically constant, or can be made to vary in any desired manner with variations of steam pressure or of load.

Several experiments were made by Mr. Richardson and the author on the action of this regulator, the results of which were as follows:—When the load on the engine was allowed to remain constant, with only one lamp alight, it was found that while the steam pressure was allowed to vary between 31 lbs. and 55 lbs., the electromotive force remained constant at 90 volts. Afterwards, with the same extent of variation in steam pressure, and with the load also varying from 1 lamp to 91 lamps, the electromotive force varied only 2 volts—from 91 volts to 93 volts. The introduction of this governor has, in the author's opinion, contributed very largely to the duration of the lamps also. The discussion of this paper, which was very full, was mainly upon the governor described and the governing of engines for electric work, the necessity of an electric governor being maintained on the one side, whilst on the other it was held that all that was required was an ordinary mechanical governor of great sensibility.

The Rev. E. Venables, at the conclusion of the discussion, invited electrical engineers to advise the Cathedral authorities, as they should like to see, as a practical result of the visit of the Institution of Mechanical Engineers to Lincoln, the lighting of Lincoln Cathedral by electricity.

A VOLTAIC CELL WITH A SOLID ELECTROLYTE

I BELIEVE that there has never hitherto been made a voltaic cell with a solid electrolyte which was capable of generating the smallest sensible current—at least at ordinary temperatures. Sir William Thomson found that when warm glass was placed between plates of zinc and copper, the existence of an electromotive force was indicated by an electrometer in connection with the metals, and Profs. Ayrton and Perry extended the observation to the cases of paraffin-wax, gutta-percha, indiarubber, and shellac. But it is needless to say that with electrolytes of such enormous resistance no current could be generated of sufficient strength to be detected by any galvanometer, however delicate.

On June 27 I exhibited to the Physical Society a little cell consisting of plates of silver and copper, between which was contained a mixture of 1 part of copper-sulphide with 5 of sulphur. When this cell was connected with a reflecting galvanometer it produced a current by which the spot of light was at once deflected off the scale, copper being the positive pole. The electromotive force was found to be ·07 volt, and the internal resistance 6537 ohms. The current, therefore, though far more than merely sensible, was small. Attempts were made to reduce the internal resistance by diminishing the proportion of sulphur contained in the mixture, but it appeared that as the sulphur was diminished the electromotive force was also diminished, until, when there was no free sulphur at all, the cell failed to produce the smallest measurable current.

It occurred to me that the sulphur owed its efficacy to the fact that it formed a film of silver sulphide upon the surface of the silver plate by direct combination. I therefore made a cell thus:—A thin layer of copper sulphide was spread upon a copper plate and compressed into a compact mass against a surface of polished steel. A layer of silver sulphide was then spread upon the copper sulphide, and the cell was completed by pressing a silver plate upon the silver sulphide. The current which this cell produced through the shunted galvanometer was considerably stronger than that generated by the cell first described; but still the result was not quite satisfactory, and there seemed to be indications of short-circuiting, which I thought might possibly be due to the penetration of particles of copper sulphide through the layer of silver sulphide. The silver plate was therefore removed from the cell, and, having been brushed over with a weak solution of sulphur in bisulphide of carbon, it was heated over a gas flame, and soon became covered with a uniform and continuous coating of sulphide. The heating was continued until all the free sulphur was evaporated. When the cell was reconstructed with this prepared plate it produced a current of 6800 micro-amperes through an external resistance of ·2 ohm, and was able to deflect the pivoted needle of an ordinary coarse galvanometer.

The dimensions of the cell are as follows:—The copper and silver plates measure 2½ inches by 2 inches; the thickness of the two layers of sulphide (strongly compressed) is about 1-20th inch; the E.M.F. is ·053 volt, and the internal resistance is therefore about 7 ohms.

This cell seems to be exactly analogous in its action to a Daniell cell in which plates of copper and zinc are immersed in solutions of copper sulphate and zinc sulphate. Silver is probably the best (or only) possible metal for the positive plate, but some other metal might perhaps be substituted for the copper with advantage.

SHELFORD BIDWELL

FORMOSAN ETHNOLOGY

RECENT political events in the East have directed public attention in Europe, more especially in France, to the large and important island of Formosa. They have shown how scanty our knowledge really is of everything relating to an island which has been known to Europeans for about three centuries, which has been actually held by an European power for twenty years, and in which for about a quarter of a century there have been three ports opened to the trade of the world. Such knowledge as we possess is derived from the works of Dutch writers of the commencement of the seventeenth century, and from fugitive papers published by one or two learned societies in Europe and the East, and especially by journals and magazines in various parts of the Far East, the names of which are hardly known beyond a limited circle of special students, some of them being extinct for years. This paucity of information regarding one of the most important islands in the world, which, moreover, lies in the fair way of a considerable portion of the trade of the world, is not due to lack of inquirers or of zeal, but to physical and ethnological obstacles in the way of research which will appear presently. Such information as could be obtained from the sources here indicated with regard to the ethnology of Formosa has been collected by M. Girard de Rialle, and arranged in two articles contributed to the latest numbers of the *Revue d'Anthropologie* (January and April, 1885). The value of these articles, besides collecting and sifting much scattered information not readily accessible, or accessible at all except in the most comprehensive national libraries, is that they contain a sound working theory on one of the perplexing problems of modern ethnology, viz. the origin of certain little-known tribes inhabiting for the most part the recesses of the chain of mountains running from north to south, but nearer to the east than the west coast of Formosa, and generally known as the Formosan aborigines.

Broadly, the population of Formosa may be divided into three classes—the immigrants from China, aborigines who have submitted to Chinese rule, and the independent tribes. It would be useless to attempt to decide which of the estimates of the number of the population is most likely to be correct, for they vary between ten millions and 300,000 souls. The Chinese immigrants may soon be dismissed. They come mostly from Canton and from the neighbouring province of Fokhien. They include amongst them large numbers of Hakkas, a people who are themselves the subject of an interesting ethnological question, which, however, we cannot discuss here beyond saying that by some students they are regarded as the representatives of pure-blooded Chinese who inhabited portions of the valley of the Yellow River before the dawn of history, while others speak of them as of Malay origin. The division of the aborigines into subjugated and free is obviously of no value for ethnological purposes, although it is convenient in certain cases. Two points which may perplex the discussion of the question can be cleared away at once. The aborigines have undoubtedly been head-hunters, like the Dyaks of Borneo and the Igorrotos of Luzon, but there is no modern authority in support of the charge of cannibalism made against them by Chinese writers, especially by Ma-twan-lin in his "Encyclopædia." M. de Rialle thinks that the allegation might have been correct at an earlier period, inasmuch as the practice is known among the Battaks of Sumatra, as well as in Borneo and the Celebes. But no traces of it have appeared recently in Formosa. Another difficulty has been raised by the statement of the early Dutch writers that there is a pure black race in Formosa, of great stature, inhabiting the mountains and speaking a different language to the rest of the inhabitants. This would apparently refer to Papuans, and M. de Rialle asks whether perhaps here, as in the Philippines, we may not perceive the existence of an old autochtonous race, or at any rate one so ancient that it may well be considered such. There would be nothing surprising in this, for in the Indian Archipelago an ethnic substratum of Papuans and Negritos has been discovered. But the statement has not been confirmed by modern explorers, some of whom have travelled through the island in order to settle the question. Neither the Chinese nor the natives have ever heard of this black race, and it is possible that a very dark tribe in the south were so called by the Dutch. But M. Paul Ibis, in his "Promenades Ethnographiques," thinks that when the Malays invaded Formosa it is not impossible they found a black race there, which they exterminated or absorbed, and other ethnologists have a theory that there was once an epoch of pure Negritos in the island. However this may be, there is now no trace of the tall black race of the Dutch writers of two hundred years ago.

The Chinese divide the aborigines of Formosa into three classes—the *Pepo-hoan*, or "barbarians of the plains," the *Sek-hoan*, or "ripe barbarians," and the *Chin-hoan*, or "green barbarians." The island, as already noticed, is divided into two unequal parts by a lofty range of mountains. On the western side, which is the nearer to China, and consequently that peopled by Chinese immigrants, the country consists for the most part of large and fertile plains. The aborigines were gradually driven back from the coast by the immigration from the mainland, and pressed towards the mountains. In course of time a considerable number submitted peacefully to the Chinese authorities and became civilised, or rather sinicised. These are the Pepo-hoan of the Chinese. They live on the plains and smaller hills bordering on the mountains. Here they form large villages surrounded by rich sub-tropical vegetation. In some places near the Chinese settlements they have adopted the language and habits of the conquerors, but they have preserved their ancient culture. They are fetish-worshippers. One traveller found in one of their houses a stake on which was placed the skull of a deer adorned with garlands of flowers and herbs. This he was told was the female fetish; the male, which was by its side, was simply composed of bamboos interlaced like a cradle. A jar of pure water below appeared to be the only offering made to the divine group at the moment. The women have charge of the fetishes. Dancing appears to be associated amongst them with religious ideas and rites, and from the description of their dances they appear similar to those of the Polynesians and Micronesians. M. Paul Ibis, who was present at one of these *fêtes*, states that young women, when dressed for it, presented the closest resemblance to Tagal women. In spite of the name "barbarians" given them by the Chinese, they are no less civilised than the peasants of the Celestial Empire; they are for the most part devoted to agriculture. In some places they act as intermediaries between the independent tribes and the Chinese, conveying the forest products of the former to the coast and obtaining Chinese goods in exchange. Their great stature has been noticed by all Europeans who have seen them. The hair is dressed amongst the men by being oiled and rolled around the head, and then covered with a large turban of coloured stuff. The women twist their hair into a large mat, interlaced spirally with a red ribbon. This is wound round the head, and appears above the forehead like a kind of natural diadem. The Pepo-Hoan, who have been least influenced by the Chinese, and who have preserved their ancient customs and dress, inhabit districts in the centre of the southern half of Formosa, especially in the valley of the Lakoli River, which, flowing almost due south, enters the sea at the harbour of Tan-Kiang. The Sek-hoan, the second of the Chinese divisions of the aborigines, inhabit part of the centre of the northern half of the island, as the

Pepo-hoan do the southern half. The Sek-hoan settlements are mainly in the neighbourhood of Chang-hua, slightly to the north of the 24th parallel, and in the hilly districts dividing the mountains from the plains in the west. They appear to have fully accepted the Chinese yoke, and even the village headmen are appointed by the Chinese authorities. These tribes are absolutely sedentary, and devote themselves wholly to the cultivation of rice, sugar-cane, and indigo, which they have learnt from the Chinese. They have adopted the dress and habits of their masters; they shave the top of the head and wear long queues. The women also dress like the Chinese, but they do not deform the feet. The type of these Sek-hoan appeared quite distinct from that of other Formosans to two travellers, Mr. Bullock and M. Ibis. The former describes them as tall, but feeble, with a comparatively clear skin, large bright eyes, the mouth extremely large, with thick lips, a projecting upper jaw, and teeth long and prominent. The lower part of the face is as ugly as the upper part is prepossessing. But although they bear little resemblance to the aborigines, they have still less to the Chinese and Loochooans, the only peoples amongst whom we should seek for their origin, if they are of different blood from the other Formosans. M. Ibis states that the Sek-hoan present a contrast to the Malay type in the case of the males, although a resemblance may be found among the females. He attributes their anthropological peculiarities to mixture with the Dutch two and a half centuries ago. He states that there are still old Dutch books and documents amongst them, and that the method of cultivating tobacco (which they call *tamako*, and not by a Chinese name) is similar to that of the Batavian colonies. In the extreme north, around Tamsui and Keelung, there are also groups of Sek-hoan. Driven from the coast by the Chinese, and prevented by the savage tribes in the mountains from penetrating into the interior, these have been almost exterminated. The remnants live in scattered communities among the sandy downs or in the rocky islets off the coast. M. Ibis visited one of their villages on a small island in Keelung Bay, where he found them in great destitution, but bearing evident resemblances to the Sek-hoan further south. He also noticed the Caucasian features, which they got from the connection between their ancestors and the Dutch and Spaniards of the seventeenth century. Around Tamsui the Sek-hoan are rapidly becoming extinct; absorption into the Chinese, and opium, alcohol, and small-pox will soon do their work. Many of their most prominent features are Malay, but the form of the skull is quite different, if we may rely on two specimens brought to Europe in 1868. Dr. Schetelig found the cephalic index of the living males to average 77, of the females 76; but, on the other hand, there were the Malay physiognomy and the language of these Sek-hoan to render difficult their ethnological classification. On his return to London, however, Dr. Schetelig saw the collection of Polynesian and New Zealand skulls in the Museum of the College of Surgeons, and he found amongst these remarkable analogies with the skulls collected by him in the north of Formosa. On the north-east coast, at Suwo Bay and the neighbourhood, there are other subjugated tribes called Kabaran, Sui-hoan, and the like. They are all of the Malay type, and appear to be rapidly disappearing through contact with the Chinese.

The whole mountainous region from the north to the extreme south, forming nearly the eastern half of Formosa, is inhabited by aborigines who have accepted neither the yoke nor civilisation of the Chinese. These are called the *Chin-hoan*, or "green, unripe barbarians," in contradistinction to the *Sek-hoan*, or "ripe barbarians." These live in a state of perpetual war with the Chinese, and it is alleged that the latter brought tigers to Formosa and set them loose in order that they should prey on their enemies; the latter, however, succeeded in exterminating them. They are determined head-hunters, the young warrior commencing his career by securing a certain number of Chinese heads. Under these circumstances it is not surprising that our knowledge of these tribes should be exceedingly limited. A Spanish priest visited some of them in 1875-6, and they have been occasionally visited by Europeans who have touched on the east coast. They are represented as like the Malays, but much fairer in colour than even the Chinese. More, however, is known of the tribes in the extreme south than of those on the east coast or in the mountains. They have been heard of in Europe chiefly by their various murders of shipwrecked seamen.

The various tribes are known as Kalis, Bhotans, Koaluts, &c., and their districts have been frequently visited by European officials desirous of obtaining from them some assurance of better treatment for mariners thrown on their coast. The late Mr. Swinhoe, who visited them for this purpose, states that some of them approached the Mongol type, while in others there was an enormous development of the lower jaw. After new observations he described them as resembling the Tagals of Luzon. In 1874 the massacre of the crew of a Loochooan junk by the tribes led to a powerful Japanese expedition being despatched for their chastisement. The Kalis and Bhotans suffered so severely that their subsequent subjugation by the Chinese was rendered easy, and the Chinese Customs established a station and lighthouse on the south cape. An account of the expedition despatched to arrange this latter enterprise was read before the Royal Geographical Society in January last by Mr. Beazeley, the engineer employed in the work. Soon after the Japanese expedition M. Paul Ibis visited the south of Formosa, and has described nine separate tribes differing in linguistic and anthropological details. He thinks their dialects are connected with the Tagal language; seven of the nine had little physical resemblance to the members of the other two. Several other tribes have been described by other travellers, and in most cases they are marked by important peculiarities. It would be impossible, even if it were likely to serve any useful purpose, to go into details of the habits of each of these. All that is necessary for our present purpose is to note that there certainly are numerous distinct tribes amongst these independent aborigines, and that in describing them various travellers refer constantly to their resemblance to Malays, Igorrotos, Tagals, Soolooans, Dyaks, and other peoples of the Malay Archipelago. The reader will therefore be prepared for M. de Rialle's conclusion that these aborigines belong to the great ethnic family known as Malayo-Polynesian. MM. Quatrefages and Hamy speak of them in the "Crania Ethnica" as "analogous to the Acheenese, Lampongs, and Eastern Sundanis. They are Indonesians, closely allied to Polynesians." But there are ancient mixtures with other anthropological elements. Whether these took place in regions from which the ancient immigrants came, or in Formosa itself, will probably never be known positively. The peopling of Formosa is probably due to successive invasions, doubtless far removed from each other in point of time, by Malayo-Polynesians, and this, M. de Rialle believes, is sufficiently proved by the great differences which, notwithstanding their common anthropological origin, have been observed by travellers amongst the various mountain tribes in the island. Whether a comparative study of the Formosan dialects with those of the Philippines, Borneo, the Celebes and other parts of the Malay Archipelago, will carry the solution of the problem any farther than this remains to be seen; but there appears no immediate prospect of any student being able to study the independent tribes of Formosa. They are as remote from us, for any purpose of accurate investigation, as ever they were, and far more remote than they were from the Dutch and Spaniards nearly three centuries ago.

THE AURORA[1]

II.

We next come to the 11-year period. On this the following pertinent remarks are made:—

"It will be perfectly clear that it is chiefly observations from the Temperate Zone which have constituted the material for demonstrating the eleven-year period But as regards the Polar regions, it has been assumed that either the Aurora Borealis also follows the same laws in these parts, or that it appears with the same force and same manner all the year round. Neither of these alternatives seem, however, to be right, as a series of observations prosecuted with great care during fifteen years at Godthaab, in Greenland, have brought me to the somewhat remarkable conclusion that, as regards the varying frequency of the Aurora Borealis at Godthaab, *the law seems to be the reverse of that ruling in southern latitudes.*

"These researches, which were effected by Mr. S. Kleinschmidt, extend over a period from August 1865 to May 1880. The number of days with auroræ in the year, reckoned from August to May, were:—

1865-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74
97	112	65	84	45	61	32	47	73

1874-75	75-76	76-77	77-78	78-79	79-80
97	97	104	69	100	75

"This series cannot, however, be accepted as giving the *exact* view of the relation between the varying frequency of the auroræ, because the state of the clouds would exercise a great influence on the visibility of auroræ. If thus the clouds vary greatly from one year to another, this circumstance would greatly reduce the number of auroræ. A closer study of the nebulous conditions at Godthaab, compared with the frequency of the auroræ, has caused me to consider that the number of auroræ decrease in proportion as the clouds increase in quantity. The above-recorded auroral totals must, therefore, be reduced to the same cloud unit, *i.e.* it must be calculated how great the number would have been had the nebulosity been the same every year. By this we obtain the values given under N. Under S. is given the relation between the sun-spots in the same year (July to June).

	1865-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73
N.	86·2	91·3	67·4	80·9	51·7	56·5	32·0	46·0
S.	23·5	6·1	18·3	60·1	107·0	133·5	98·6	89·4

	1873-74	74-75	75-76	76-77	77-78	78-79	79-80
N.	78·4	97·0	95·0	102·0	73·0	85·2	83·3
S.	51·7	32·1	11·6	13·5	6·8	2·2	16·3

"If the two series be compared it will be found that *the law of relation between the frequency of sun-spots and auroræ is reversed.* This fact will be still more apparent from Fig. 4, where both series of auroræ and sun-spots are shown graphically.

"The few series of observations which we possess from other Polar regions, and which I have been able to analyse, indicate, though incomplete, similar conditions.

"As the greater part of the Godthaab observations were made in the morning, I have not only used the auroral days for my researches—reckoned from noon to noon—but also examined evening and morning auroræ separately. The evening and morning auroræ lead, as regards the eleven-year period, to the same conclusion as the auroral days, *i.e.* that *the Aurora Borealis is scarcest under sun-spot maxima.*" . . .

"If we consider the relation between zenith and southern auroræ in the various years of the Godthaab researches, we obtain the interesting result that the percentages of zenith auroræ in the main follow those of the auroral frequencies, *i.e., that at the periods of maxima at Godthaab, the auroræ which fall in the zenith of this place or further north, are not only absolutely, but also relatively, more frequent than at the periods of minima.* And what deduction may be drawn from this? The deduction *that the auroral zone in the course of the eleven-year period makes a movement too, of such a nature that it lies further north when the sun-spots are in their minimum than in their maximum period.*

"If this result be compared with what I have already propounded as to the eleven-year period in the Arctic regions, the interesting explanation will be obtained of the phenomenon, that this period in Greenland and similarly-situated places shows a reverse course to that in more southern regions. *The auroral maximum, occurring in the temperate regions simultaneously with the sun-spot maximum, is due to the auroral zone being then in its southernmost position, which again causes an auroral minimum in the polar regions, and, in a reverse manner, the auroral zone has its northernmost position when the sun-spots are in the minimum, which then causes an auroral minimum in the temperate regions and a maximum one in those around the Pole.*"

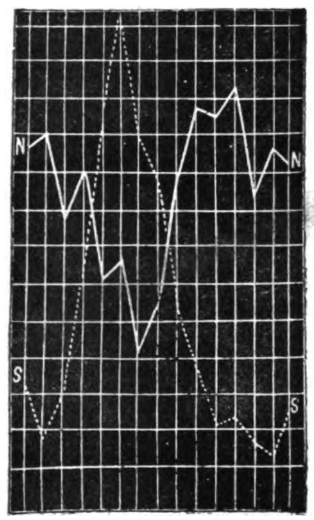


FIG. 4.—Comparison of auroral frequencies at Godthaab with sun-spots. N = Northern light frequencies; S = Spot frequencies.

These very beautiful results will show that there can be very little doubt about the movement of the auroral zone as a whole.

The next point on which much light is thrown by Mr. Tromholt's work is that the various appearances are in the main due to movements bringing auroral striæ in different relation to the spectator:—

"In one respect in particular my sojourn at Koutokæino was very instructive—viz. with regard to the understanding of the true shape and position, and the changes to which the aurora is apparently subjected when altering its elevation above the horizon. Partly through the frequency of the aurora, and partly by its appearance now in the north, now in the south, and now in the zenith, there were excellent opportunities of studying the modifications which the form suffered as it changed its position in relation to the observer.

"From this I came to the conclusion that the great many different forms referred to might certainly be reduced to a few fundamental ones. In most instances the aurora forms belts or zones, which stretch across the earth in the direction of the magnetic east-west, which zones are formed by a conglomeration of thin sheets of luminous matter ranged one behind the other, their direction being

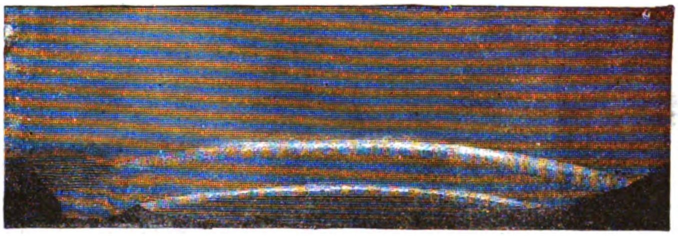
[1] "Under the Rays of the Aurora Borealis." By S. Tromholt. Edited by Carl Siewers. (London: Sampson Low and Co., 1885.) Continued from p. 276.

parallel with the inclination needle. The luminous matter in these sheets is either even, diffuse, or divided into streamers.

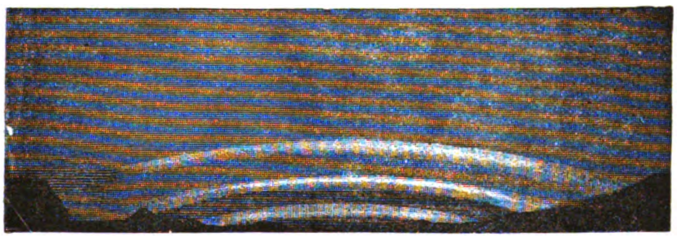
"Everything now depends on the position of the observer in relation to such a zone in order that it may appear in one form or the other. If he be very far from the aurora he will see an arc, diffuse or radiating, according to the nature of the luminous matter. If he approaches he will most probably see several distinct arcs, the phenomenon gathering more force and the colours more life; and when still nearer, the aurora will appear as a band, and, if the luminous matter be radiating and passes the magnetic zenith of the observer, he will behold the auroral corona."

He thus holds that a "band" is a near arc occupying a higher position in the sky:—

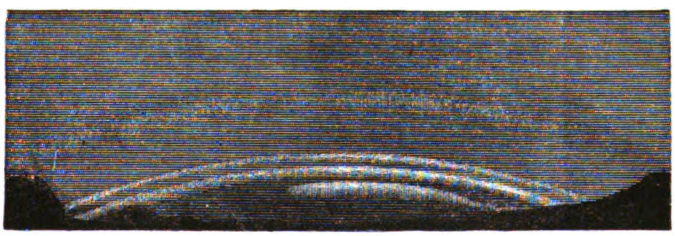
"The auroral band is oftenest seen in those parts of the globe which are considered to be the true home of the Aurora Borealis, but seldom, or hardly ever, in southern latitudes. What is chiefly characteristic of the band in opposition to the arc, although no sharp line of distinction can be drawn here either, is its great height above the horizon, but at what elevation it ceases to be band and becomes arc is naturally an arbitrary determination. The band, as well as the arc, may consist of equi-luminous matter, of streamers, and of so-called luminous clouds, and it is, to a higher degree than is the case with the arc, subject to the most violent changes of position, form, and motion. Particularly when the band consists of streamers it displays the richest variations and greatest beauty, the folds of the streaming drapery, the prismatic play of colour, and the light-waves, which with marvellous rapidity course through the graceful undulating rays, forming a spectacle of light, colour, and form which makes this variety of the Aurora Borealis the most charming of all.



A, at 7h. 20m.



B, at 7h. 33m.



C, at 8h. 10m.

FIG. 5.—Phases of an auroral arc, December 1, 1878.

"The perspective fundamental form of the arc, and also the band, may, in my opinion, be explained by the aurora forming one or several rings, or fragments of such, which, with the magnetic pole as centre, or, more correctly, with a point in the magnetic axis of the earth—viz. the straight line between the two magnetic poles—lie at a certain height above the earth's surface. On account of the great circumference of the earth, in proportion to the height of the aurora, only a small portion of such a ring would be visible at one time, and each observer only see his own portion, the situation of which in relation to *his* horizon and the zenith will depend on *his* position in relation to the auroral ring."

The auroral streamers are closely associated both with arcs and bands, an arc or band composed of streamers often forming the basis for a colonnade of streamers.

Before we proceed to the consideration of the corona, the following extracts concerning streamers and their apparent motions will be read with interest:—

"The streamers embrace a number of varieties, which have only one peculiarity in common—viz. that the direction is very nearly vertical, and that the length is always greater than the width. The length differs greatly, from 2° and 3° to 30° and 40° or more. The width is very difficult to estimate, on account of the constant motion; a single streamer thus may form only a slender thread of light, while others may have a width of from 10′ to 1°, or more. Short streamers form often, as I have mentioned above, bands or arcs. The long streamers gather generally in bunches, which may either remain isolated, or particularly when the aurora has previously formed an arc, stand parallel, in such a manner that the lower, intensest, ends nearly follow the track of the former arc. Bunches of streamers, standing high in the sky, are often fan-shaped, the broadest part pointing downwards. The intensest streamers have very clearly defined edges, but from these there are all sorts of variations down to the streak of light hardly visible. At the side of, and between very intense and defined streamers, the sky seems, by the contrast, unusually dark, and this may, perhaps, explain the *black* streamers which some observers claim to have seen.

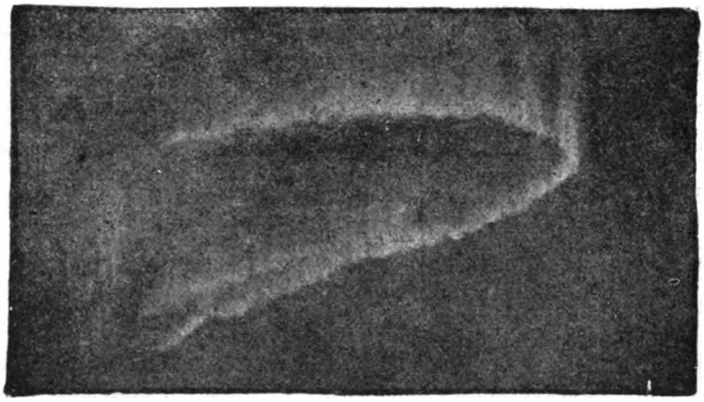


FIG. 6.—Aurora (Koutokæino).

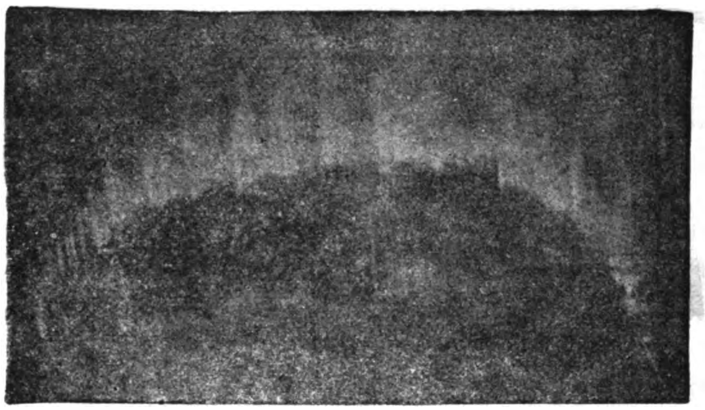


FIG. 7.—Streamers (Koutokæino).

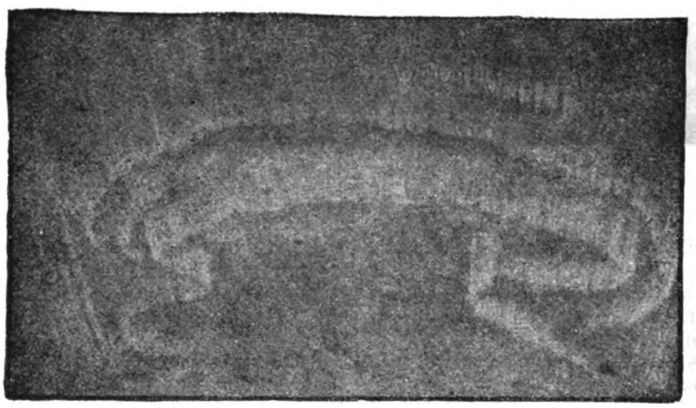


FIG. 8.—Bands and streamers (Koutokæino).

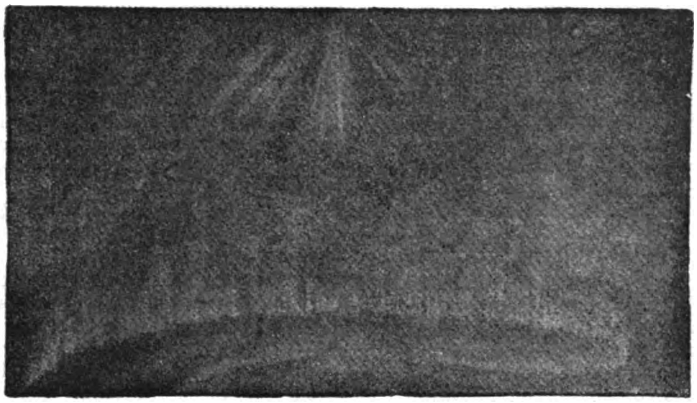
"The points of the streamers are usually faint and with no sharp line of demarcation. The stars shine through the streamers as through all other forms of the aurora, and it may, indeed, be a matter of doubt whether the strength of light of the aurora is ever great enough to outshine a bright star." . . .

"The motion of the streamers is twofold. First, longitudinally, as they strike upwards or downwards; and secondly, laterally, as they travel parallel either to the left or right. Sometimes this motion is slow, sometimes very quick, and particularly in the latter case the observer obtains the impression that the colonnade of streamers is furrowed transversely by waves of energy following in rapid succession, under the influence of which the streamers momentarily flare up. If this be the case, or the streamers really move, it is impossible to tell.

"The longitudinal course of the streamers is not apparently only, but in reality, very nearly vertical, as several facts prove that they point in the same direction as the magnetic inclination needle." . . . "In regions near the magnetic pole, where the magnetic inclination is greater, the streamers stand more perpendicularly than in more southern latitudes, where they form a smaller angle with the surface of the earth.

"Some students, as, for instance, Baron Nordenskjöld, have advanced the theory that the streamers do not occupy this position, but lie more parallel with the earth; and, indeed, when observing an apparently perpendicular streamer in the north, it may in reality form any angle with the horizon, and still seem to the eye to stand perpendicular. But from various circumstances it is clear that the direction of the streamers is, as I have stated above—viz. parallel with the inclination needle. This is, in fact, demonstrated not only by the streamers high in the sky, which form the upper part of the corona, but also by those which, under intense auroræ, stand either in the east or west, and which are then seen '*from the side*,' so to speak, *i.e.* they stand very nearly perpendicularly, as indicated to all appearances by the streamers seen to the north '*in front*.'"

The auroral *corona*, the grandest sight of all, is found at the instant a band or broken band forming a colonnade



A

B

Fig. 9.—Coronas (Koutokæino).

of streamers reaches the magnetic zenith in its progress from the north:—

"Quick as lightning streamers break forth at the same moment on the southern side of the magnetic zenith, and as the aurora travels further and further southwards, the corona becomes more and more complete. In northern regions, where the aurora frequently appears high in the sky, in a northerly or southerly direction, there is often an opportunity of seeing this form of the phenomenon, when a band of streamers passes the magnetic zenith in its course north or southwards. It is, however, not always that the aurora's passing of the zenith has the effect of producing the corona; it is seldom the case when a band constituted of diffuse luminous matter passes this point. It is, in fact, the streamers which create the corona." . . .

"If it be borne in mind that the course of the auroral streamers is identical with that of the magnetic inclination needle, it is easy to perceive the origin of the ordinary radiating aurora as well as the corona." . . .

"This form of the Aurora Borealis, which generally indicates, at all events in southern latitudes, the culmination of the aurora as regards splendour, colour, and development, is produced by the streamers shooting from every part of the sky towards a common point—viz. the magnetic zenith. With this point as centre they seem to radiate in every direction; some are very long, others short, while some form rays or bands one above the other. The heaven thereby assumes the appearance of a huge cupola, or tent of fire. In reality the streamers are all parallel; their appearance of radiating in all directions from a central point with various angles being due to perspective causes—viz. by the points of the streamers being further distant than the bases. It is the same perspective peculiarity which causes the lamps in a street or the trees in an avenue to appear to meet in the distance.

"The centre of the corona is sometimes dark—that is to say, the sky is seen between the streamers, at other times the central part is filled with luminous matter.

"It is not only the streamers which contribute to form the corona; on the contrary, all the forms of the aurora lend their beauty to produce this magnificent display. If to this is added that the Aurora Borealis in such moments develops its greatest strength, richest colour, and most intense light, it will be understood that the corona is that form of the phenomenon which possesses the greatest magnificence and most striking beauty."

With regard to the height of the aurora, a preliminary examination of the observations made in the plane Koutokæino-Bossekop gives from 50 to 100 miles, an average of 18 measurements giving 70·2 miles or 113 kilometres.

From this long article on auroræ, the reader must not think that our author is exclusively occupied with them. His two volumes are admirable examples of what books of travel should be, and it falls to the lot of few travellers to have such an interesting region to explore, or to have such an important piece of scientific work to accomplish.

THE BRITISH ASSOCIATION

OUR readers are aware that at the approaching meeting of the British Association it has been arranged to have discussions in Section A on kinetic theories of gases and on standards of white light. Prof. Crum Brown has consented to open the discussion on the kinetic theories, and has drawn up the following short abstract of points to which he proposes to allude. It would be convenient if persons desiring to take part in the discussion would forward their names, with, if possible, a short abstract, to the recorder, Prof. W. M. Hicks, Firth College, Sheffield.

Difficulties connected with the Dynamical Theory of Gases.—Prof. Crum Brown.

The Dynamical Theory of Gases appears at first sight to furnish a very complete explanation of all the properties of gases, both physical and chemical. When, however, we come to details, difficulties and apparent contradictions make their appearance. These difficulties have been pointed out from time to time, and some attempts have been made to show that they are not really fatal to the theory as usually stated; but it may be useful that some of them should be brought at this time before the section and regularly discussed.

I shall here merely mention some of these difficulties, as the explanations which have been given of them will be better supplied by others in the discussion.

1. *The difficulties connected with the doctrine, that energy communicated from without to a gas is equally shared among the whole of the degrees of freedom of the molecules.* This leads to a relation between the numbers of degrees of freedom and the ratio of the specific heat at constant pressure to that at constant volume. This ratio is for mercury gas almost exactly 5:3, from which it would appear that the molecules of mercury gas have not more than three degrees of freedom—in other words, that the whole energy of mercury gas is kinetic energy of translation of the molecules. But even if we assume that the molecules of mercury are spheres, perfectly smooth and perfectly rigid, the fact that mercury vapour has a spectrum points to some form of energy of a vibratory kind. Again, the gases, the molecules of which are supposed to consist of two atoms, have the ratio of the specific heats nearly equal to 7:5 (it seems always to be a little greater than this, which increases the difficulty). This points to five degrees of freedom of the molecule, which would be consistent with the hypothesis that these molecules consist of two smooth, undeformable spheres at a constant distance from each other, the five degrees of freedom being three of translation and two of rotation about two axes, any two at right angles to each other and at right angles to the axis of the molecule, that is, the line joining the centres of the two atoms. But here also we have spectra, and in addition the phenomena of dissociation lead to a belief that the firmness of the union of the two atoms diminishes as temperature rises, and it is difficult to reconcile this with a constant distance of the two atoms from one another in the molecule. Any variation in this distance would be a new degree of freedom in addition to the five allowed by the theory.

All attempts to reconcile chemical action and chemical equilibrium with dynamical conceptions seem to require the assumption of vibrations of the atoms in the molecule, under the influence of forces depending on the distances of the atoms from each other, and perhaps in addition to these, vibrations of the atoms as parts of the molecule, vibrations of the atoms themselves. In molecules, even of a comparatively simple kind, such considerations imply many degrees of freedom, certainly far more than the dynamical theory of gases as usually understood will admit.

2. *Difficulties connected with the doctrine that energy of each kind is distributed among the molecules according to some form of the law of probability.*

This implies that in a gas at any temperature there are molecules in the condition as to energy which is the average condition of the gas at any other temperature. That, for instance, at the ordinary atmospheric temperature there are molecules in the condition which is the average condition at a red heat.

This seems inconsistent with what is usually regarded as true, viz., that there are limiting conditions of temperature and pressures, on the one side of which certain chemical changes occur, while they do not occur at all on the other side. Thus at ordinary atmospheric temperatures and pressures, hydrogen and oxygen show no tendency to combine. At a red heat they combine almost completely. At ordinary temperatures phosphorus combines slowly with oxygen if the pressure of the oxygen is below a certain limit (dependent on the temperature), but apparently not at all if the pressure of the oxygen is above that limit. Many other cases might be mentioned, but these may suffice as instances. It is difficult to understand the existence of such definite sharp limits, if the energy is distributed among the molecules according to any asymptolic law. In such a case the rate of chemical action might be expected to diminish, but not to become zero.

I have brought forward these instances of apparent contradiction between the conclusions of the dynamical theory as usually stated, and observed facts in the hope that they may be cleared up. This may conceivably be done in two ways—either by showing that the facts have not been accurately observed, or that the conclusions have not been legitimately drawn from the theory.

NOTES

THE Iron and Steel Institute holds its summer meeting in Glasgow on September 1-5. The programme includes excursions down the Clyde and a visit to the Forth Bridge Works. The following is the list of papers down for reading:—On the iron trade of Scotland, by Mr. F. J. Rowan, Glasgow; on the rise and progress of the Scotch steel trade, by Mr. James Riley, Glasgow, Member of Council; on the present position and prospects of processes for the recovery of tar and ammonia from blast furnaces, by Mr. Wm. Jones, Langloan Ironworks, N.B.; on the structural features and working of the South Chicago blast furnaces, by Mr, F. W. Gordon, Philadelphia, and Mr.

E. C. Potter, Chicago, U.S.A.; on certain accessory products of the blast furnace, by Mr. T. Blair, Wingerworth Ironworks, Derbyshire; on a new form of cupola furnace, by Mr. James Riley, Glasgow; on a new form of pyrometer, by Mr. A. von Bergen, Middleton Ironworks, Darlington; on the ancient and modern methods of manufacturing tin-plates, by Mr. Philip W. Flower, Melyn Tinworks, Neath; on the manufacture of basic steel on the open hearth, by M. Pourcei, Bilbao, Spain; on the Forth Bridge, by Mr. Benjamin Baker, M.I.C.F., London.

THE International Telegraph Conference was opened at Berlin on Monday by Dr. Stephan, German Postmaster-General. No fewer than 33 States and 17 telegraph companies are represented, and about 72 delegates had already assembled to day. Dr. Stephan opened the sitting with an address, in which, in the name of the German Emperor, he bade the delegates welcome, and made some general observations on the rapid development of telegraphic science and communication, as well as on the desirability of placing the advantages of this science still more within the reach of all classes. On the motion of the English delegate, Mr. Patey, Dr. Stephan was elected President of the Conference, which then proceeded to appoint two committees—one for the consideration of tariff questions, the other for matters of technical administration. Dr. Stephan then thanked the Swiss Government for presiding so successfully over the International Telegraph Bureau (of Berne), and the British Government for duties it had undertaken since the last Conference at London (1875). He also adverted to the memory of several deceased members of that Conference, including Sir William Siemens.

AMONG those on whom the degree of LL.D. was conferred at the recent Graduation ceremonial of Edinburgh University are Prof. John Anderson, M.D., F.R.S., Superintendent of the Imperial Indian Museum of Calcutta, Professor of Comparative Anatomy in the Medical College of Calcutta, Fellow of Calcutta University; Dr. Johann Georg Bühler, Ph.D., C.I.E., Professor of Sanskrit in Vienna University; and M. Antoine d'Abbadie, Member of the Institute of France, well known for his writings in geology, astronomy, and Oriental matters.

ON any Tuesday, Thursday, or Saturday, until the end of September, persons of archæological tastes may visit the rooms of the Royal Archæological Institute, Oxford Mansions, near Regent Circus, to see the large and most interesting collection of antiquities which Mr. W. M. Flinders Petrie, working under the auspices of the Egypt Exploration Fund, has discovered at the Nebireh Mound, which is now established to be the site of the famous Greek City of Naucratis, and the cradle of Greek art. The thorough exploration has resulted in laying bare what was the earliest Greek settlement in Egypt, and in bringing to light archæological treasures beyond price. Innumerable objects of purely Greek art, statuettes, terra-cotta figures, painted vases, votive offerings, bronzes, sculptures have been found, together with an immense quantity of pottery in considerable variety. Naucratis was a city of potters, and Athenæus states that her ceramic productions were in great vogue around the shores of the Mediterranean. In the mound which covered the city potsherds were found in well-defined layers of different centuries, susceptible of exact classification, and as such forming an interesting chapter in the history of Greek art. The collection is particularly rich in the archaic variety of white faïence pottery, of which, prior to Mr. Petrie's labours, only three or four pieces were known to exist. He found bowls by the hundred. The connection of Greek pottery with that of Egypt is shown at every step, showing how the one descended by gradual steps from the other. The scarabœi, amulets, pictorial ornaments, deities, tiles, and other articles found in early Greek tombs all around the Mediterranean have been found amid the ruins of Naucratis in the very workshops where they were produced. The sites of several factories were brought to light, each containing many samples of their products. One of these was a Greek manufactory of scarabs for exportation, full of such blunders as foreigners would make in the hieroglyphs. In another part of the city what had evidently been a flourishing iron manufactory was unearthed, where every stage of production was carried on by Greek workmen, for ore, slag, and finished tools have all been found. The tools are principally chisels for working in wood, but there were also an axe, a hoe, a sickle, knives of various kinds, bodkins, and, what is a total novelty in archæological discoveries of this kind, fishhooks. There is satisfactory proof forthcoming that this scene of early Greek iron-working was in full vigour in the sixth century before Christ.

AT the monthly meeting of the Entomological Society of London, held on August 5, J. W. Dunning announced that a Royal Charter of Incorporation had been granted to the Society. It bears date July 20, 1885. The Ethnological Society was founded in 1833.

WE are glad to know that there is now a chance that the teaching of geography, which has been one of the blots of our ordinary English education from the many colleges downwards, will be put upon a proper scientific basis. At present it is usually made a task for the memory rather than an instrument of education. Messrs. Macmillan, in announcing a new series of Geographical Text Books, have the courage to state that "the first principles of geography, however, cannot be effectively taught from books. They must be enforced practically from familiar local illustrations." In a preliminary volume, therefore, the teacher is taught how to lay a solid geographical basis, founded upon the pupil's own personal experience. Throughout the series the fundamental idea will be to present the essential facts in such a way as will show their relationship to each other. The physical features will be connected with the climatology of a country, and both will be shown to affect the distribution of life, while the bearing of all these influences upon human history and commercial progress will be constantly kept in view. The boundaries of parishes and countries, the positions of towns and the diffusion of population, will be linked with their geographical explanation. A knowledge of the topography of a country, and of the local names by which it is expressed, will be shown to be the necessary accompaniment of an adequate knowledge of the history of the inhabitants. In short, it should be a constant aim to represent geography not as a series of numerical tables or a string of disconnected facts, but as a luminous description of the earth and its inhabitants, and of the causes that regulate the contrasts of scenery, climate, and life. Messrs. Macmillan have placed the editorship of the series in the hands of Mr. Archibald Geikie, F.R.S., Director-General of the Geological Survey of the United Kingdom, and have already secured the co-operation of Mr. H. W. Bates, F.R.S., Mr. Clements R. Markham, C.B., F.R.S., Mr. John Murray, Ph.D., F.R.S.E., Mr. E. B. Tylor, D.C.L., F.R.S., Mr. A. R. Wallace, LL.D., F.R.G.S., Rev. Edmond Warre, D.D., Head Master of Eton, Rev. J. E. C. Welldon, M.A., Head Master of Harrow, and others.

IT has been decided to withhold from publication the Report of Drs. Klein and Gibbes upon Dr. Koch's discoveries in relation to the germ theory of cholera, until the conclusions of a committee appointed by the Secretary of State for India with reference to that Report are also ready.

WE have received from Mr. Lawton, of Hull, a communication with regard to preventing collisions with icebergs. He has had frequent opportunity of noting the phenomena of echoes by means of steam-whistles, guns, fireworks, &c., and has received distinct echoes from various surfaces, some of which were not very promising. The sails of vessels and an approaching tug-boat, referred to by Prof. Graham Bell, are additional sources of sound-reflection, but Mr. Lawton thinks that the echo in the case of the latter must have come from some other surface than the bows of the boat, which, unless very bluff or square, would have a tendency to reflect the sound at right angles. If it be true that in Atlantic voyages the sound of the steam-whistle is echoed back by the fog itself, then, Mr. Lawton thinks, the echo from an iceberg enveloped in the fog would be much sharper, more abrupt, and easily distinguished from that returned by the fog, which, from its varying density and elasticity, would more resemble a prolonged rumble. The importance of this subject, the number of lives and amount of property at stake would point to the importance of having every reasonable theory tested by those most interested—viz. shipping companies, captains of steamers and sailing vessels crossing the Atlantic and those going to Australian and New Zealand by the Cape. In the present case this can be very easily done by means of the steam-whistle, ship's bell, guns, &c., in broad daylight near an iceberg; the circumstances, such as its size, bearing, and distance, the direction and force of the wind; and then it should be noted whether an echo is perceptible or not. Mr. Lawton appears to have gone to some trouble in bringing the subject to the notice of shipping companies concerned, and of describing the method of carrying out the few simple experiments needed to demonstrate the value of his theory, but adequate attention does not appear to have been given to his suggestions. We give them in a brief form here, in the hope that they may be fairly tested in the presence of an iceberg in daylight in such a manner as to enable shipmasters to estimate the practicability of the theory. He found that, during artillery practice near Hull, the opposite Lincolnshire coast, two miles off, returned echoes. There are no objects of greater height than a few cottages there, and it occurred to him the phenomenon of echoes might be utilised by vessels in iceberg regions with more safety than the temperature test, especially if the wind and current be from the ship towards the berg. Most icebergs will present numerous reflecting surfaces at right angles to any passing ship, and it is anticipated that these surfaces would echo a short but full blast of the steam-whistle at a sufficient distance, say one or two miles, for the ship's course to be slightly altered in case the berg was right ahead. If such a blast is blown in daylight in the presence of a berg for purposes of experiment, the distance and bearing of the berg, and the force and direction of the wind should be noted. If at the time a high sea or swell prevailed, the whistle should be blown when the ship is on the crest of the wave. As fog is a better conductor of sound than dry air, it is when an iceberg is enveloped in fog, as is often the case on the banks of Newfoundland, that Mr. Lawton's theory, if true, would be of any value, as it could not only indicate the distance of the berg approximately, but also its bearing from the ship.

THE Sadlers' Company have established four studentships, each of the annual value of 30*l*., and tenable for two years, at the Finsbury Technical College of the City and Guilds of London Institute. The studentships will be competed for at the entrance examination, to be held at the college on October 1, and are open to pupils above fourteen years of age who are attending or who have attended any public elementary school in the United Kingdom. The Court of the Salters' Company has agreed to raise their annual subscription to the Technical Institute from 525*l*. to 1000*l*.

DR. TRIMEN, director of the Royal Botanical Gardens of Ceylon, has just published a systematic catalogue of the flowering plants and ferns indigenous to or growing in Ceylon. The list gives the botanical, Singhalese, and Tamil names, and is a complete index to Thwaites's "Enumeratio Plantarum Zeylaniæ," but it differs from the latter work in the sequence of the families or natural orders. In addition to the flowering plants and ferns, Dr. Trimen has added five natural orders—viz. Rhizocarpeæ, Lycopodiaceæ, Isoeteæ, Selaginellaceæ, and Characeæ. The catalogue includes 156 natural orders, 1071 genera, and 3249 regular species, with 408 varieties, some of which may prove to be distinct species. The catalogue is issued as a number of the *Journal* of the Ceylon Branch of the Royal Asiatic Society.

THE weather in Southern Norway in June has been very remarkable, and we must go back to the year 1869 to find anything similar. The weather, early in the month, was very cold, the average being only 56°·5 F., while on the 11th the temperature fell to 35°·8 F., a temperature which has not before been registered in Christiania in June, at all events not since 1867. Towards the end of the month the temperature in Christiania was abnormally high, reaching, on the 28th, 79°·3 F. in the shade. The rainfall was only half of the normal quantity. As well in May as June, the weather was below the average for the whole country. At Röraas the temperature fell on June 2 to 26°·6. The information received of the weather in the north of Norway to the middle of July shows that the weather had till then been very cold, the highest temperature being only 44°·6 to 46°·8 F. in the day and below freezing-point at night. It is popularly supposed that this is due to the enormous ice masses which have this summer descended from the Polar regions on the American side right into the Gulf Stream, which has thereby become greatly cooled, a circumstance immensely influencing the weather in Norway. Seal-hunters returning to Tromsö from the White Sea and adjacent waters report that large masses of drift-ice are in motion towards the Norwegian shores; but there are as yet no reliable news from the Spitzbergen seas. On the other hand, we learn from captains who have returned from seal hunting on the east coast of Greenland and the sea north of Iceland that hardly any were caught, owing to the enormous ice-masses which are descending along the east coast of Greenland this summer, greatly in excess of previous years. It may be remembered that last year the reverse was the case here. Lieutenant Holm, who has been wintering on the east coast, reported that the sea was very free from ice even at the troublesome glacial promontory of Tuisortok, which has only once before been passed by Europeans, viz., Graah. It seems indeed that abnormal conditions prevail this summer throughout the Polar seas, and it will be of interest to learn what the state of the ice actually is north and north-east of Spitzbergen.

A VERY interesting exhibit at the Inventions Exhibition is that of "Brin Frères" for the illustration of their method of extracting oxygen and nitrogen from atmospheric air by the agency of barium oxide and peroxide. A description of the process is given in a small pamphlet, but the English requires a little correction in places to be clearly understandable. The process of oxygen extraction by means of baryta is now very old, but has never yet been made real practical use of, the baryta becoming inactive after some time. This is no doubt due to the absorption of carbonic acid by the baryta from the air. In this process air freed from carbonic acid and water by caustic soda is passed over barium oxide heated in iron retorts to a temperature not exceeding 600° C. The temperature is regulated by a pyrometer which regulates at the same time the supply of gas to the furnace. Under these conditions the oxygen of the air is absorbed by the baryta, peroxide of barium being formed. The nitrogen, which appears to be very pure, is collected separately for use in the production of ammonia. On heating the peroxide of barium to full redness pure oxygen is given off. At this stage of the process the retorts are evacuated by a powerful pump, so that the operation takes place in a vacuum or nearly so. The operations are continuous, and as long as the baryta is kept anhydrous and free from carbonic acid the same quantity will apparently last an indefinite time. The most interesting and perhaps the most useful part of this invention, or application, is the production of ammonia by a very direct process. The nitrogen obtained as above is passed over a mixture of baryta with carbon—charcoal—heated to some unknown temperature, about 300° C., certainly not higher. It is necessary, however, that the nitrogen be moist, a condition which is attained by passing it through water before it comes in contact with the mixture of baryta and charcoal. The product is really a carbonate of ammonia and not free ammonia, the water becoming decomposed under the conditions named, its hydrogen combining with the nitrogen and its oxygen forming carbonic acid. The ammonium compound seems to be formed in considerable amount, and the process should, when carried out on a large scale, be a valuable one.

A USEFUL summary of anthropological work accomplished during the year 1884 has just been issued by Prof. O. T. Mason, curator of the ethnological department, National Museum, Washington. Besides a copious bibliography of the subject, special notices and even extracts are given of the more important papers on ethnology, archæology, and other branches of anthropology that have appeared in the scientific periodicals of Europe and America. Thus detailed reference is made to the work of the British Association Anthropometrical Committee; to Prof. W. H. Flower's paper in the *Journal* of the Anthropological Institute on the size of the teeth as a racial characteristic; to Prof. A. H. Keane's ethnology of Egyptian Sudan, contributed to NATURE; to E. F. im Thurn's articles in *Timheri* on the natives of British Guiana; to Dr. Charles Rau's paper on "Prehistoric Fishing," in vol. xxv. of the Smithsonian Contributions to Knowledge; and to A. Chavero's great work on "Mexico à traves los Siglos," the first volume of which is completed, bringing the subject down to the arrival of the Spaniards. It is satisfactory to notice that the Philadelphia Academy of Sciences has created a chair of ethnology and archæology, to which Dr. Daniel G. Brinton has been appointed. The field of anthropology is now so extensively cultivated in the Old and New World that annual summaries of this sort have become indispensable.

THE Swedish Professor Warming has proceeded to Finmarken in order to study the Arctic flora on the Norwegian coast.

ON July 20 and 21 two terrible cyclones passed over the central part of Sweden, followed by rain and lightning. In several places hundreds of old trees were uprooted, and a clear road made in forests upwards of fifty yards wide. In one place a large wooden snowplough lying by the road was smashed to atoms. Fortunately no one was injured.

AT the University examination just concluded in Copenhagen there were seven lady candidates, all of whom passed, four gaining *precæteris*, two *laudabilis*, and one *haud illaudabilis*. Five of these ladies took the mathematics and natural science degrees, and only two the philological.

DURING the last two years several Celtic tumuli in the district of Geinberg, in Upper Austria, have been opened and found to contain valuable relics of prehistoric times. A few days ago a similar tumulus was discovered near Mattighofen, in the same neighbourhood, and among its contents was found a diadem of pure gold, richly carved in the well-known style of old Celtic art.

MR. DAVID DOUGLAS, of Edinburgh, has issued a new edition of the late Charles St. John's "Tour in Sutherlandshire," a fitting companion to the author's well-known "Wild Sports and Natural History of the Highlands." There is an interesting sketch of the author's life by his son, and a long appendix on the fauna of Sutherlandshire, by Mr. J. A. Harvie-Brown and Mr. S. E. Buckley.

MESSRS. CASSELL & CO. have issued the second part of vol. iv. of their "Encyclopædic Dictionary," extending from "Interlink" to "Melyris." As there is no editor's name on the title-page, we presume that Mr. Robert Hunter, who devised the work, and edited the early parts, is not now connected with it. A work of such minuteness as this ought to have had "Laramie" as a well-known geological term.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. S. G. Coles; a Persian Gazelle (*Gazella subgutterosa* ♂) from Persia, presented by Mr. John Stanley Cater; two Madagascar Porphyrios (*Porphyrio madagascariensis*) from the Gold Coast, West Africa, presented by Mr. E. North Newenham; a Cockateel (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mr. J. Ward; four Martinican Doves (*Zenaida martinicana*), a Moustache Ground Dove (*Geotrygon mystacea*), five Dominican Kestrels (*Tinnunculus dominicensis*), a Violaceus Night Heron (*Nycticorax violaceus*), two —— Colins (*Ortyx* —— ♂ ♂) from St. Kitt's, West Indies, presented by Dr. A. Boon, M.R.C.S.; a Common Viper (*Vipera berus*), British, presented by Mr. C. Smallman; a Ring-tailed Coati (*Nasua rufa*) from South America, a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited.

OUR ASTRONOMICAL COLUMN

OCCULTATIONS OF VESTA.—The minor planet Vesta will be twice occulted by the moon during the next autumn, and though observation of such a phenomenon is more a matter of curiosity than of astronomical utility, we may note the circumstances of each case. The first occultation will take place on October 27; the planet disappears before the moon is above the horizon at Greenwich and reappears at 7h. 50m. at 204°, less than ten minutes after the moon has risen. The second occultation occurs on November 23, the disappearance at 9h. 25m. on an angle of 28°, the reappearance at 9h. 46m. at 347° from north point, reckoning the angles as in the *Nautical Almanac*. At this time Vesta is near aphelion, and therefore will not be brighter than a star of the seventh magnitude.

ANTHELM'S NOVA OF 1670.—Mr. G. Knott has lately had under observation the small star situated close to the position of the star in Vulpecula discovered by Anthelm in June 1670; the star is No. 1814 of the Greenwich Catalogue for 1872. From comparisons made between July 10 and 20, Mr. Knott found it about 10¾ or 11 mag., and equal to a star following it 12 seconds, and 4'·5 to the north. It was estimated of the same brightness in August 1872, but a magnitude brighter in April 1852. In 1861, when it was 12m., Mr. Baxendell remarked that "no adjustment of the focus would bring the star up to a sharp point on the night of June 1," and a week earlier Mr. Hind had noticed "a hazy ill-defined appearance about it, which is not perceptible in other stars in the same field of view."

A rigorous reduction of Picard's observations of Anthelm's star, which are printed in Lemonnier's "Histoire Céleste," gives its place for 1670·0—

R.A. 19h. 34m. 5·33s. ... Decl. + 26° 31' 41"·5,

the right ascension being the more uncertain element and liable to an error of quite two seconds. Bringing this place up to the beginning of 1872·0 we have—

R.A. 19h. 42m. 21·60s. ... Decl. + 26° 59' 45"·4,

which differs − 3·81s. in right ascension and − 33"·1 in declination from the Greenwich catalogued position.

In the *Journal des Savans*, 1671, the new star is said to have followed β Cygni on the meridian by 16m. 44s., which would give its right ascension in precise agreement with the Greenwich observations of the small star No. 1814.

THE CINCINNATI OBSERVATORY.—The eighth part of the publications of this Observatory has been circulated, and contains the observations of comets made in the year 1883. It is noteworthy as presenting a pretty complete report on the phenomena of Pons' periodical comet of 1812 at its reappearance: the features of the tail were particularly studied, and the discussion of the observations, based upon the theory of Dr. Bredichin, has been found to add confirmation to that theory; they are best satisfied with a value of $1 - \mu$, a little less than 2·5, corresponding to his second type; and this value nearly accords with that inferred by Dr. Bredichin himself in his memoir, "Les syndynames et les synchrones de la comète Pons-Brooks (1883-84)," from a large number of observations by different observers. Thirteen plates form part of this publication, affording highly interesting details on the physical aspect of the comet from October 30, 1883, to January 26, 1884. The drawings were partly made with the 11-inch refractor, and partly with the finder of 2½ inches aperture, and an opera glass. On January 13 the comet was equal in brightness to α Pegasi.

The Cincinnati Observatory is now under the direction of Mr. J. G. Porter. The observations contained in the publication last issued were made by Mr. H. C. Wilson while in temporary charge.

TEMPEL'S COMET, 1867 II.—Dr. Schur searched for this comet unsuccessfully with the great refractor at Strassburg on many evenings in March and April: M. Gautier's calculations showed that the chance of observing the comet at this return to perihelion was but small. The next return, in the spring of 1892, will take place under much more advantageous conditions.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *AUGUST* 16–22

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 16

Sun rises, 4h. 49m.; souths, 12h. 4m. 1·0s.; sets, 19h. 19m.; decl. on meridian, 13° 37′ N.: Sidereal Time at Sunset, 17h. 1m.

Moon (at First Quarter on August 17) rises, 12h. 3m.; souths, 17h. 10m.; sets, 22h. 10m.; decl. on meridian, 12° 21′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 18 ...	13 30 ...	19 42 ...	1 32 N.
Venus ...	7 24 ...	13 50 ...	20 16 ...	4 25 N.
Mars ...	0 46 ...	9 4 ...	17 22 ...	23 38 N.
Jupiter ...	6 27 ...	13 12 ...	19 57 ...	8 15 N.
Saturn ...	0 32 ...	8 41 ...	16 50 ...	22 28 N.

Occultations of Stars by the Moon

August	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
20 ...	B.A.C. 6287 ...	6 ...	23 39 ...	0 35* ...	165 272
21 ...	B.A.C. 6292 ...	6 ...	0 8 ...	1 15 ...	115 328
22 ...	ρ' Sagittarii ...	4 ...	0 35 ...	1 39 ...	157 291

* Occurs on the following day.

The Occultations of Stars are such as are ible at reenwich.

August	h.	
19 ...	11 ...	Mercury stationary.

GEOGRAPHICAL NOTES

THE Dutch journals contain an account of the Dutch scientific expedition, in March and April last, to examine the upper course of the Surinam River. The members are well satisfied with the result. Their success was due in great part to the rainy season not setting in till towards the end of the journey. They were thus enabled to examine the rocks along the course, which in periods of high water are hidden from view. Their first station was Phaedra on the left bank of the Surinam; the next the Tafra Rocks which lie in the middle of the stream. Here they were forced to leave their steamer and continue in a fishing-boat. At Bergendal they took the height of the neighbouring Blue Mountain, which they ascended, and from which they had a view of the various mountain chains of Surinam. In general the mountains of this region are covered with trees, but the Blue Mountain is quite bare. Near the mouth of the Sara creek the travellers first met some villages of the bush negroes. At Toledo, a negro village, they came to the end of their forward journey. On the return they visited gold fields near Broko Pondo, where they made themselves acquainted with the native methods of washing the gold. From a geological point of view the expedition was fortunate; but the rapid travelling and short stoppages prevented much being done by the zoologist. Professor Martin has made a collection of the rocks in various parts of the Surinam.

WRITING from Ciudad-Bolivar in May, M. Chaffanjon continues his report to the Paris Grographical Society (the first party which we have already referred to) on his exploration of the Orinoco. Since the date of his last letter he made a journey with two Indians of the Arigua tribe up the Caura River to its source. He passed freely through the territory of various tribes, such as the Arebatos, Panares, and others who are notorious for their cruelty, and he obtained from their chiefs a mass of curious information respecting their manners and religious beliefs. In an endeavour to obtained a complete skeleton, he was surprised by a band of Indians, who attacked himself and his followers. He escaped with great difficulty, and accompanied only by one of his guides reached the Caura, and continued his journey, in which he was much impeded by the rains. He was also able to visit and study the Yaruros and Mapayes tribes.

THE last *Bulletin* of the Royal Geographical Society of Belgium (1885, No. 3) contains a paper by the secretary on the Congo question, describing the explorations made in the basin between 1485 and 1877, the formation of the International Association, the creation of the Free State, and finally a description of the basin. M. Lancaster continues his notes on four months' journeyings in Texas, and M. Fontaine contributes a general paper on the geography, productions, trade, &c., of Dutch Guiana.

DR. HAACKE and Dr. Bernays are zoologist and surgeon respectively to the Australian expedition to New Guinea, to which we have already referred. The main objects of the expedition are stated to be to ascertain and fix the geographical features of New Guinea, and the nature of its fauna, flora, geology, and climate. It has been decided to make if possible the Aird river the base of operations.

AT a late meeting of the Geographical Society of Rio de Janeiro M. Alcenar Œraripe read a paper on geographical neology and neography. He referred to the necessity of introducing into geography reforms consisting mainly of the creation of new names and of uniform orthography. His remarks, though of universal application, had especial reference to Brazil. He concluded by suggesting the appointment of a commission to examine the following questions:—(1) Should there be a geographical neology for Brazil—that is to say, a nomenclature for places in the empire in which the repetition of the same name for different places would be avoided by substituting other names? (2) Should there be a geographical neography, or correction of the orthography of geographical names in such a way that the spelling would in all cases be uniform? (3) Assuming these two questions to be answered in the affirmative, how would these reforms be best carried out? The questions were referred to a commission for its report.

THE current number of *Petermann's Mittheilungen* contains a project for a new political map of Africa, with some observations on the principles of political geography, by Prof. Ratzel. This is accompanied by a double map of Africa. In one part the continent is coloured according to the prevailing occupations of the population—agriculture, agriculture with cattle-breeding, pastoral, and the chase; in the second it is coloured according to the people who form states—*e.g.* Arabs, independent Negroes, Zulus, &c. Dr. Stange writes on the orometry of the Thüringer Wald. The most important paper in the number is that by Dr. Radde, entitled "A Physico-Geographical Sketch of Talysch in the North-Western Elburz," which was originally written for an entomological work being brought out by the Grand Duke Nicholas.

THE last number of the *Mittheilungen* of the Geographical Society of Vienna contains a statement by Dr. Le Monnier with regard to the arrangements for the Austrian Expedition to the Congo; a sketch of the results of Danish explorations in Greenland by A. Rink; the conclusion of Dr. Breitenstein's paper on Borneo, and the recent letters of Colonel Prjevalsky. Dr. Breitenstein's account of Borneo is of great interest. He points out that in this great island may be studied in succession almost every stage of human development from the lowest to the highest. It is not sixty miles, for example, from Pengaron, where European machinery is employed in the coal mines, to Punun or Olo Ott, where the people are almost quite naked, and where their only protection from the weather is a grass hut here and there. It is hardly a hundred miles between Banjermassin, where Eurpean war-vessels and Krupp guns keep the Dyaks in check, and the kampong of the Prince of Murong which is protected by a thin palisade, from the top of which the heads of those captured in raids look down on the traveller. In this narrow district we have a kaleidoscopic picture of all the steps of human civilization.

AT the last meeting of the Geographical Society of Paris, M. du Caillaud read a note on the fortress of Camlo in Annam, to which the attack on the French at Hué has just given some importance; M. de Lesseps referred to soundings recently made at Gabes with a view to establishing a fort there; M. Rouire, who has recently returned from a scientific mission to Tunis, recounted his explorations in the regions between Kairwan, Susa, Hammanet, and Lake Felbiah. M. Delaplanch also read an account of a journey which he made through the centre of Persia, from Resch on the Caspian to Teheran.

DR. P. L. SCLATER suggests "Torresia" as an appropriate name for British New Guinea.

IN the *Bollettino* of the Italian Geographical Society for July, Sig. Buonfanti publishes a reply to the doubts of Herr G. A. Krause on his journey from Tripoli across the Sahara and Western Sudan to the coast of Guinea. The writer, whose letter is dated May 6, on board the *Corisco* at Banana, states that documentary proofs of the trip cannot be given till his arrival in Brussels, where the papers lie under lock and key in charge of Prof. du Fief. They include, he says, correspondence already forwarded to two American journals from Tripoli, Murzuk, &c., besides translations of safe-conducts and firmans received from the Sultans of Bornu and Socoto, and of a letter from the Sheikh [*sic*] of Timbuktu, the originals of which will be forthcoming. There are also accounts, invoices, &c., of Maltese dealers, certificates of sea-captains, certificates of missionaries, and so forth. He explains that Herr Krause heard nothing of his movements at Lagos, because he reached the coast not at that place, but at Portonuovo, some 45 miles further west. For the same reason nothing was known of him in the Yoruba country, which lies 200 miles to the east of Dagomba, Bagouza, Dahomeh, and the other districts through which he travelled.

THE Vienna Geographical Society has received good news of Dr. Oscar Lenz's African exploring expedition, which, on July 17, had reached Monrovia, the capital of Liberia. The next news will be from the Cameroons.

THE death is announced from Sydney of Thomas Boyd, the first white man to cross the Murray river, and the last surviving member of Hume and Hovell's exploring party. He was eighty-eight years of age, and had lived in great poverty for some years prior to his death.

MEASUREMENT OF EVAPORATION

I SEND a brief sketch of an instrument which I have just made for the measuring of evaporation from a water surface. The figures and letters refer to the accompanying drawings:—

Fig. 1, A.—Tank-mine, 20 in. × 10 in., standing in a large tank 60 in. × 40 in. The sides are double, a space one-tenth of an inch being between the walls and opening all around inner wall (*a*) with an outflow-pipe (Figs. 3, 4, G) let into bottom. Tank filled as Fig. 4, and refilled every three or four hours, the amount poured in being carefully measured.

Fig. 1, A, B, C.—Complete instrument. A, evaporating-tank; B, reservoir filled with water to (*n*); (*h*) a graduated glass coil, by which water pouring out through tap (*l*) is registered. Pressure upon tap regulated by (*i*) a tube and funnel buoyed up by (*k*). Water flows from B to A through a perforated, semicircular chamber (*e*), which makes water spread over the entire surface of tank. Overplus flows over at (*f*) down (*c*, *d'*) into reservoir C, similar to B in fittings. Then loss from B − gain in C = the evaporation from A. This arrangement intended chiefly for experimentation upon running water, removes the necessity for refilling the tank, although good results can be attained even then.

Fig. 2.—Tank from above. (*a*) space between walls; (*b*) inflow-pipe from B; (*e*) perforated chamber or rose; (*d*) outflow-pipe.

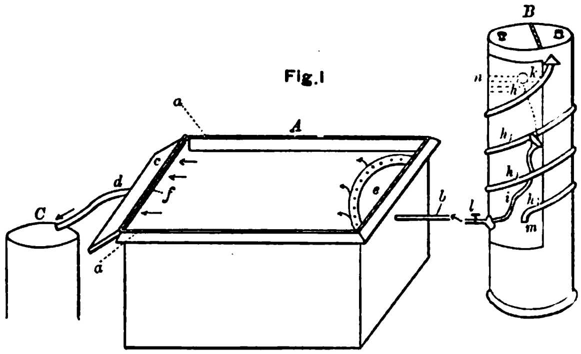
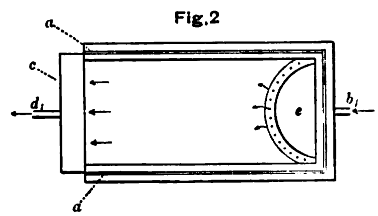


Fig. 3.—End of tank; letters as before. The outer wall in part cut away to show chamber (*a*) with emptying-pipe (*g*).

Fig. 4.—Transverse section: (*o o*), walls; (*a*), space; *g*, pipe; *p*, strengtheners. Height of water also represented.

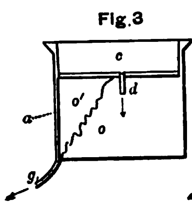
The following points are worthy of notice:—

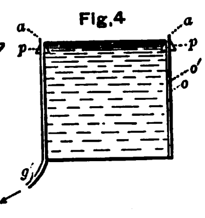


(1) The level of the water can be kept constant by regulating the flow from the tap *l* (Fig. 1, B).

(2) Error arising from splashing out of water, when heavy wind blowing, removed, the displaced water flows down (as Fig. 2), and through pipe *g* (Fig. 3), and is collected in a small measured vessel.

(3) Error arising from rainfall similarly corrected; rain falling into tank A, for greater part flows off at *f*, and is collected in C; when very heavy, flows also into *a*, and is collected as mentioned above. Then, the amount of rainfall being known from the rain-gauge, the following simple process gives the evaporation:—x = rainfall in cubic cents.; y = water in reservoirs; $x - y$ = evaporation in cubic cents.





GEORGE HASLAM
Trinity College, Toronto

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE following candidates have been successful in the competition for the Whitworth Scholarships, 1885, in the Science and Art Department, South Kensington:—Thomas Clarkson, age 20, engineer, Manchester, 200*l*.; Hugh O. Bennie, 20, engineer, Glasgow, 150*l*.; Robert H. Unsworth, 20, engineer, Pendleton, near Manchester, 150*l*.; Harold M. Martin, 21, engineer, Gateshead, 150*l.*; William T. Calderwood, 25, mechanical draughtsman, Glasgow, and John Richards, 22, blacksmith, Cardiff, equal, 150*l.* each; Ernest R. Dolby, 23, engineer, Leeds, 150*l.*; James Rorison, 21, engine fitter, Paisley, 150*l.*; Arthur J. Moulton, 20, engineer apprentice, Preston, 150*l.*; William McNeill, 22, mechanic, Birmingham, 100*l.*; George W. Moreton, 24, fitter, Crewe, 100*l.*; Stephen E. Mallinson, 24, assistant analyst, London, 100*l.*; Henry C. Jenkins, 23, engineer and millwright, London, 100*l.*; Robert Smith, 24, engineer, Glasgow, 100*l.*; Thomas W. Nash, 21, engineer, London, 100*l.*; Henry F. W. Burstall, 19, engineer apprentice, London, 100*l.*; Arthur J. Stopher, 22, mechanical engineer, Nottingham, 100*l.*; Sidney H. Wells, 19, marine engineer apprentice, London, 100*l.*; George Milnes, 24, fitter, Charlton, Kent, 100*l.*; Henry Begbey, 22, engineer, Old Charlton, Kent, 100*l.*; John Goodman, 23, engineer, Brighton, 100*l.*; Mark H. Crummie, 21, mechanical engineer, Hull, 100*l.*; Oliver Marsh, 22, fitter and turner, Crewe, 100*l.*; Thomas Galbraith, 23, pattern maker, Manchester, 100*l.*; Joseph H. Bowles, 23, engine fitter, Stratford, 100*l.*

SCIENTIFIC SERIALS

American Journal of Science, June.—Notes on American earthquakes, with a summary of the seismic disturbances recorded in North and South America and adjacent waters during the year 1884, by C. G. Rockwood, jun.—Taconic rocks and stratigraphy (continued): V. metamorphism and mineral constitution in the Taconic region, gradational from west to east and from north to south, by James D. Dana.—Notes on the possible age of some of the Mesozoic rocks of the Queen Charlotte Islands and British Columbia, by J. F. Whiteaves.—Crystallised Tiemannite and metacinnabarite, by Samuel L. Penfield. To the paper is appended a note by Prof. J. E. Clayton on the occurrence of Tiemannite in a mine 200 miles south of Salt Lake City.—On the gahnite occurring in the Davis Mines of Rowe, Massachusetts.—The genealogy and age of the species in the southern Old Tertiaries, by Dr. Otto Meyer.—On some specimens of meteoric iron from Trinity County, California, by Charles Upham Shepard. The analysis yielded: iron, 88·810; nickel, 7·278; cobalt, 0·172; phosphorus, 0·120.—The Potsdam group east of the Blue Ridge at Balcony Falls, Virginia, by H. D. Campbell.—Geology of the sea-bottom in the approaches to New York Bay, by A. Lindenkohl.—Additional notes on the Kettle-Holes of the Wood's Holl region, Massachusetts, by B. F. Koons.—Cause of the apparently perfect cleavage in American sphene (titanite), by G. H. Williams.

American Journal of Science, July.—Contributions to meteorology. Twenty-first paper: direction and velocity of movement of areas of low pressure, by Prof. Elias Loomis. The paper is accompanied by numerous tables showing the average direction of storm tracts, the comparative tracts of storm and atmospheric currents over the Atlantic and United States, the progress of storm centres in Europe.—Note on some Palæozoic Pteropods, by Charles D. Walcott. With some hesitation the writer includes in the Pteropod group such organisms as Conularia, Hyolithes, Coleolus, Salterella, Pterotheca, as well as Matthevia, which is here chiefly dealt with. This peculiar shell, which he so names in honour of Mr. G. F. Matthew, is, however, so distinct from all described forms of Pteropoda that a new family Matthevidæ, is proposed to receive the one genus now known.—A determination of the B.A. unit in terms of the mechanical equivalent of heat, by Lawrence B. Fletcher. The experimental work here described was completed in 1881, and forms the subject of a thesis submitted to the Johns Hopkins University in that year. In the present paper a more accurate method of calculating the currents from the deflection-curves is used, and some of the other calculations have been revised. But in other respects the results of the two papers are substantially the same. The experiment consists of simultaneous thermal and electrical measurements of the energy expended by a current in a coil of wire immersed in a calorimeter. The result depends upon the values of the mechanical equivalent and the unit of resistance, and gives a determination of either in terms of an assumed value of the other.—Cause of irregularities in the action of galvanic batteries, by Hammond V. Hayes and John Trowbridge. Here is investigated the phenomenon known as "endosmose," that is, the action by which the electric current carries whatever comes in its way from the positive to the negative electrode.—On the sensitiveness of the eye to colours of a low degree of saturation, by Dr. Edward L. Nichols.—A study of thermometers intended to measure temperatures from 100° to 300° C., by O. T. Sherman.—Notice of a new Limuloid crustacean from the Devonian formations of Erie County, Pennsylvania, by Henry Shaler Williams. This specimen, provisionally identified with Prestwichia, would appear to throw back the range of that group to an earlier period than hitherto reported. The earliest previously-discovered Prestwichia occurs in the Carboniferous formations.—Gerhardtite and artificial basic cupric nitrates, by H. L. Wells and S. L. Penfield. The mineral here described under the name of Gerhardtite was first identified as a new species by Prof. Geo. J. Brush, who found it among a lot of copper minerals from the United Verde Copper Mines, Jerome, Arizona. Its specific gravity is 3·426; hardness, 2; colour, dark green; streak, light green; transparent; crystals, orthorhombic.—On the occurrence of fayalite in the lithophyses of obsidian and rhyolite in the Yellowstone National Park, by Joseph P. Iddings.—The genealogy and age of the species in the Southern Old Tertiary. Part 2. The age of the Vicksburg and Jackson Beds, by Dr. Otto Meyer.—On the probable occurrence of the great Welsh Paradoxides (*P. davidis*) in America, by Geo. F. Matthew. This largest and most remarkable species of Paradoxides occurring in the primordial fauna of Europe was first discovered about twenty years ago by Dr. Henry Hicks near St. David's, Wales, and subsequently (1869) in Sweden. But its presence has only recently been suspected in America, where specimens of large species appear to occur both in the Cambrian slate at Saint John, New Brunswick, and in a hard silico-calcareous shale at Highland's Cove, Trinity Bay, Newfoundland.

Bulletin of the Philosophical Society of Washington, vol. vii.—Besides the usual reports of the officers of the Society, this volume contains a learned address by the President (Mr. James C. Welling) on the atomic philosophy, physical and metaphysical; abstracts, among other, of papers by Mr. W. H. Dale, on recent advances in our knowledge of limpets; by Mr. Russell, on the existing glaciers of the High Sierra of California; by Prof. Kerr, on the mica mines of North Carolina; by Mr. Riley, on recent advances in economic entomology, in which the part which insects play in the economy of nature, and particularly their influence in American agriculture, were discussed. Mr. Burnett explained why the eyes of animals shine in the dark. It is not due, he says, to phosphorescence, as has been commonly supposed, but to light reflected from the bottom of the eye, which light is diffused on account of the hypermetropic condition that is the rule in the lower animals. Mr. Johnson writes on some eccentricities of ocean currents, compiled from the records of the Lighthouse Board; Mr. Clarke on the periodic law of chemical elements; Mr. Hazen, on the recent sun-glows; Mr. Russell, on deposits of volcanic dust in the great basin; Mr. Gilbert, on the diversion of water-courses by the rotation of the earth; Mr. Doolittle, on music and the chemical elements; Mr. Bates, on the physical basis of phenomena (which is printed in full). Mr. Gilbert presented a plan for the subject, bibliography of North American geological literature; Mr. Matthews, in a paper bearing the title of natural naturalists, combated the notion that savages are versed only in the knowledge of animals and plants which contribute to their wants. The writer found that Indians have a comprehensive knowledge of animals and plants; as a class the Indians "are incomparably superior to the average white man, or to the white man who has not made zoology or botany a subject of study." The Indian also is as good a generaliser and classifier as his Caucasian brother. Several speakers who followed agreed in this conclusion.—Mr. Dutton has a paper on the volcanoes and lava fields of New Mexico.—The following are among the principal papers in the Mathematical Section: Mr. Gilbert, on the problem of the Knight's tour; Mr. Farquhar, on empirical formulæ for the diminution of amplitude of a freely oscillating pendulum; Mr. Hall, on the formulæ for computing the position of a satellite (which is printed in full); Mr. Kummel, on the quadric transformation of elliptic integrals, combined with the algorithm of the arithmetico-geometric mean.

Bulletin de l'Académie Royale de Belgique, May.—M. Ch. Fievez, on the influence of magnetism on the characters of the spectral rays. The increase of the luminous intensity of the spark and its spectrum is attributed to the action of magnetism on the luminous rays themselves. To elucidate this question the author limits his attention to the effect of magnetism in presence of the luminous and caloric movement apart from the electric spark and through the medium of the ponderable matter alone. For this purpose he studies the effect of magnetism on the spectra of the flames of sodium, potassium, lithium, and thallium raised successively to increased temperatures by the introduction of oxygen. From the results of his experiments he concludes that magnetism acts directly on the luminous rays, but abstains from any theory to explain the identity of the effects of magnetism and heat on the rays.—M. A. Swaen, on the development of the first blood corpuscles in the blastoderm of *Torpedo ocellata*. The results are given of studies made last year at the zoological station of Naples on the evolution of the folicules and the formation of the blood-vessels of this organism.—Note on the geology of the Tristan da Cunha islands, by A. F. Renard. A summary description is given of the typical rocks collected by the naturalists of the *Challenger* expedition.—State of the vegetation at Spa and Liége on April 20, and at Longchamps (Waremme) on April 21, 1885, with comparative tables, by G. Dewalque and Baron E. de Salys Longchamps.—Essay on the mechanical theory of the surface-tension of the evaporation and ebullition of liquids, by G. Van der Mensbrugghe. In this first communication on the subject the author restricts his remarks to the question of the probable cause of surface-tension.—On the movements of the brain in the dog, by Léon Fredericq. Three distinct pulsations, corresponding respectively to the beating of the heart, to the respiratory action, and to the vaso-motor periods, are determined and illustrated with numerous tracings and diagrams.—Note on the carboniferous formations of Morvan, by A. Julien. The carboniferous schists, in contact with the older quartzose and azoic schists, run mainly north and south with a thickness ranging from 150 to 300 metres. Fossiliferous beds are rare, and the fossils, a list of which is given, generally in a very imperfect state.—A Royal Library in Assyria in the seventh century B.C., by M. Lamy. A detailed account of the explorations at Nineveh since the discoveries of Layard and Botta, including a description of the Royal Library, concludes with a history of the successful efforts made by Assyriologists to interpret the cuneiform writings.

Rendiconti del Reale Istituto Lombardo, June 25.—The conflict between Julius Cæsar and the Senate (B.C. 51-49), by Prof. J. Gentile.—The Italian Criminal Code: preventive justice and offences against the police, by Dr. Raffaele Nulli.—On the conditions of resistance of elastic bodies, by Prof. E. Beltrami.—On the floral dimorphism of *Jasminum revolutum*, Sims, by Prof. R. Pirotta.—Integration of the differential equation $\Delta^2 u = o$ in any of Riemann's areas, by Prof. Giulio Ascoli.—Meterological observations made at the Brera Observatory, Milan, during the month of June.

Gazetta Chimica Italiana, Palermo, 1885.—Note on diamidoximethyltriphenilmethan, by G. Mazzara and G. Possetto.—On the relations existing between the refrangent power and chemical constitution of organic compounds, by B. Nasini and O. Bernheimer.—Synthesis of phenilcinnamenilacrilic acid and of diphenildiethylene, by O. Rebuffet.—Relation between the atomic weight and physiological functions of the chemical elements, by Fausto Sestini.—On the monobromo- and bibromopyromucic acids, by H. B. Hill.—Reply to the foregoing, by F. Canzoneri and V. Oliveri.

Rivista Scientifico-Industriale, June 15-30.—The total eclipse of the moon, October 4-5, 1884, by Prof. Carlo Marangoni.—Experiments on the extraction of the juice of tobacco and of other plants, by A. Pezzolato.—On the fossil land Articulata of the Palæozoic formations, by P. Bargagli.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 27.—M. Daubrée in the chair.—Discussion on the great gyratory movements of the atmosphere (continued), by M. H. Faye. The question whether these atmospheric movements are ascending or descending was compared by the author to the old astronomical argument regarding diurnal motion. Attribute it to the earth, and all becomes clear; attribute it to the stars, and you become involved in the contradictions by which the progress of science was retarded for twenty centuries.—A reply to M. Faye's communication, by M. Mascart. To the objection that the hypothesis of an ascending volume of air fails to explain the rotation of cyclones and tornadoes the author replies that if the wind in the northern hemisphere converges towards a centre of attraction it must turn to the right in consequence of the known influence of the earth's motion; hence the mass of air brought into play must revolve to the left. Thus the direction of the phenomenon is easily explained, and it follows that for a descending column of air the rotation must be reversed.—On isomery in the aromatic series: the oxybenzoic acids, their heat of formation and transformation, by MM. Berthelot and Werner.—Note on the anatomy and nomenclature of Dental, by M. de Lacaze-Duthiers. For the meaningless terms "Scaphopod" and "Cirribranch" the author proposes to substitute that of "Solenoconch" for this group of mollusks.—Observations of Barnard's comet made at the 14-inch equatorial of the Bordeaux Observatory, by MM. G. Rayet.—Elements and ephemerides of Barnard's comet deduced from the observations of July 12, 16, and 20, made at the Observatory of Nice, by M. Charlois. On presenting this paper M. Faye drew attention to the fact that the axis of the planet's orbit lies nearly in a line with the ecliptic, consequently with the planes of the orbits of the large planets. Hence, notwithstanding its inclination of 80° this planet may still be periodicaly like most of those offering the same peculiarity.—Summary of the solar observations made during the second quarter of the year 1885, by M. P. Tacchini. From these observations it appears that the solar spots and protuberances were more numerous in the second than in the first quarter of the year. In June protuberances were observed eight times which attained or reached a height of two minutes.—Observations regarding M. E. Hénard's note on the sixteen systems of the planes of the regular convex icasohedral, by M. Em. Berbier.—Note on Riemann's function $\zeta(s)$, by M. Bourguet.—On the equilibrium of a fluid mass animated by a rotatory movement, by M. H. Poincaré.—Note on the differentials of the functions of several independent variables, by M. E. Goursat.—New condensing hygrometer; its use in regulating capillary hygrometers, by M. G. Sire.—Note on the reciprocal transformation of the two varieties (prismatic and octahedric) of sulphur, by M. D. Gernez.—On a new method of volumetric analysis applicable for testing the bioxides of manganese, by M. Paul Charpentier. This method is based on the use of the alkaline sulphocyanides, and avoids certain tedious processes and sources of error presented by the methods of analysis hitherto employed. Its chief advantage is the extreme sensibility of the reaction, which enables the analyst to detect the presence of 1-3,000,000th part of iron.—Heat of formation of the alkaline alcoholates, by M. de Forcrand.—Note on the peptonate of iron, by M. Maurice Robin.—On three new compounds of rhodium, by M. Camille Vincent. These substances are:—(1) chlororhodate of mono-methylammonium, which takes the form of long, slender prisms grouped around a common centre; (2) chlororhodate of dimethylammonium deposited in the form of large efflorescent prisms of a deep garnet-red colour; (3) chlororhodate of trimethylammonium precipitated by slow evaporation in the form of long garnet-red prisms very soluble in water.—Origin and mode of formation of certain ores of manganese; their fundamental relations to the baryta associated with them, by M. Dieulafait.—On a new phase in the evolution of the reticular rhizopods, by M. de Folin. In this new state these organisms assume the appearance of small, hard pebbles, from which it is often difficult to distinguish them. The circumstance suggests the creation of a new genus, Lithozoa, of which there would appear to be several species.—Note on Megaloscopy, by M. Larrey. The author explains the optical principle by which he has been guided in the construction of a series of instruments for the inspection of the stomach, vessica, and other internal parts of the system.—Observations of the solar corona made on Mount Etna early in the month of July; reappearance of the crepuscular lights, by M. P. Tacchini. The author observed in a deep blue sky the sun encircled by a white aureole concentric with a magnificent copper-coloured corona, which near the horizon was transformed to a larger but less clearly defined arc. Since July 2 he noticed the reappearance of the red crepuscular phenomena and of the great arc at sunset and sunrise. Although less intense than those of 1883-84, he considers that their reappearance after such a long interruption shows they cannot be referred to the Krakatoa explosion.—On the cosmic origin of the crepuscular lights, by M. José L. Landerer. The author argues that these effects are due more probably to the Biela-Gambart comet than to Krakatoa. The longitude (246°) of the ascending nucleus nearly coincided with that of the earth on June 1, when the afterglows again began to acquire great intensity.

August 3.—M. Bouley, President, in the chair.—The death of M. Henri Milne-Edwards, who died on July 29, was announced by the President, who remarked that a great loss was sustained by the Academy in the person of the illustrious Member of the Section for Anatomy and Zoology, one of the greatest *savants* who had shed lustre on French science.—Discourses pronounced at the obsequies of M. Milne-Edwards, by M. A. De Quatrefages, in the name of the Academy of Sciences, by M. Fremy, Director of the Museum of Natural History, by M. de Lacaze-Duthiers, in the name of the Paris Faculty of Sciences.—On the oxalic acid present in vegetation; methods of analysis, by MM. Berthelot and André.—Researches on the effects of direct electric excitation on the glands, by M. Vulpian.—Frictionless reflection, on a plane, of the elastic displacements in a body of any form and contexture, by M. X. Kretz.—Letter addressed to the Perpetual Secretary on the subject of vaccination against cholera, by Dr. J. Ferran. In reference to this letter M. Vulpian expressed his regret on the part of the Commission that the writer had misunderstood the meaning of the note inserted in the last issue of the *Comptes Rendus*. What was asked was not Dr. Ferran's statistics now promised, but the official returns of the Spanish authorities. In a question of this sort, affecting as it did all humanity, it was hoped that the Spanish Government would consider it a point of honour to give forthwith all possible information regarding the value of Dr. Ferran's method of preventive vaccination.—Note on an asymptotic law in the theory of numbers, by M. Stieltjes.—On the "herpolhodie" in the case of any surface of the second degree, by M. de Sparre.—On the employment of alternative electric currents for the measurements of the resistance of fluids, by MM. Bouty and Foussereau.—Note on the formation of the crystallised hydrate of zinc, by M. J. Ville.—On the hexabromide of benzine, by M. J. Meunier.—Heat of formation of the picrates. From the tables accompanying the paper the author shows that the anhydrous picrates of magnesium and copper are formed with an insignificant loss of energy in the components, while the picrate of zinc even absorbs a little heat. Hence the latter will yield more useful results than the former under the influence of the same oxydant.—Note on the essence of citron, by MM. G. Bouchardat and J. Lafont.—On the form of the larva of *Dorocidaris papillata*, by M. Henri Prouho.—On the digestive tubes, the corpus Bojani, reproductive organs, and eggs of Fissurella (*F. gibba* and *F. reticulata*), by M. L. Boutan.—On the hydrocarbonated reserves of mushrooms, by M. Léo Errera. The author's researches show an unexpected parallelism, from the standpoint of physiological chemistry, between the germination of mushrooms and that of the higher order of plants.—On the comparative evolution of sexuality in the individual and the species, by M. F. Laulanié.—Influence of sunshine on the vitality of various species of Micrococcus, by M. E. Duclaux.—Comparative studies of leprosy; its pathological anatomy, by M. Henri Leloir.—Researches on poisoning by sulphuretted hydrogen, by MM. P. Brouardel and Paul Loye.—Note on a Cetacean (*Hyperoodon rostratus*) stranded at Rosendael, near Dunkirk, on July 24, by MM. Pouchet and Beauregard.—Remarks on some electric lights constructed by M. G. Trouvé for the purposes of naturalists, chemists, microscopists, &c. (one illustration), by M. de Lacaze-Duthiers.

Berlin

Physical Society, June 26.—Dr. König produced a new apparatus for the measurement of the modulus of elasticity, which was constructed according to the suggestions of Herr von Helmholtz, and was utilised in the Institute for measurements of elasticity. The modulus of elasticity was determined by loading in the middle a bar of the substance to be examined, resting both ends on firm supports. The flexion which set in was measured by means of the cathetometer, and, its value being introduced into the formula of the elasticity theory, furnished the modulus of elasticity. A source of error in these measurements arose from the circumstance that the bar resting on edges was in part pressed in and sank, as a whole. This depression was the greater as the loading was greater, and it added to the magnitude of the flexion. To avoid this disturbance in the account Prof. Kirchhoff, in 1859, placed horizontal mirrors on the two ends of the bar, and, by means of telescope and scale, observed at each side the change in situation of each mirror, a change which occurred in consequence of the flexion under the loading in the middle, and which produced on both sides an opposite displacement of the scale. The sinking of the bar on account of the pressure on the edges, and even a slanting position on the part of the whole bar exercised no influence in these measurements. The apparatus suggested by Prof. von Helmholtz developed this principle still further. It had two perpendicular mirrors with the reflecting surface directed inwards at the two ends of the bar; on one side stood a scale, on the other a telescope. The image of the scale fell on the opposite mirror, then on the second mirror, and thence into the telescope. If now the bar were loaded so that flexion occurred, then the image in the telescope became displaced to the extent corresponding with the angular changes of the two mirrors. By glancing therefore into the telescope the whole amount of flexion might be very rapidly and conveniently measured and the loading altered at pleasure; the commencement of the elastic after-effect might likewise be directly observed with great facility. In the Institute a series of measurements with this apparatus had been executed by two experimenters, measurements which yielded values agreeing with a fair degree of precision. In the case of cylindrical bars differences presented themselves according as the bar was examined in one direction or in the direction perpendicular thereto. In the case of rolled brass the difference amounted to as high as from 2 to 2½ per cent.; in the case of cast brass the difference was inappreciable. Bars of cast iron likewise showed differences of only ½ per mill. Dr. König followed this up with a proposal to measure Poisson's constants—that is, the relation of the longitudinal increase to the decrease of the transverse section. The measurement should be carried out as in the experiments of Prof. Kirchhoff, only, instead of the horizontal mirrors and two telescopes, two parallel mirrors inclined at an angle of 45° should be used at the two ends of the bar with one telescope, thus enabling the moduli of elasticity and of torsion to be measured, the relation of which furnished Poisson's constants.

CONTENTS

THURSDAY, AUGUST 20, 1885

PROFESSOR STOKES ON LIGHT

Burnett Lectures, Second Course. On Light as a Means of Investigation. By G. G. Stokes. (London: Macmillan and Co., 1885.)

THE interest raised by the first series of these lectures is fully sustained by this second instalment, though the subject-matter is of a very different order. *Then*, the main question was the nature of light itself; *now*, we are led to deal chiefly with the uses of light as an instrument for indirect exploration. It is one of the most amazing results of modern science that the nature of mechanisms, too minute or too distant to be studied directly with the help of the microscope or the telescope, can be thus, in part at least, revealed to reason. This depends on the fact that a ray of light, like a human being, bears about with it indications alike of its origin and of its history; and can be made to tell whence it sprang and through what vicissitudes it has passed.

The lecturer begins by pointing out that this indirect use of light already forms an extensive subject; and he then specially selects for discussion half-a-dozen important branches of it. Many readers will, we fear, be disappointed when they find that *Dispersion* (whether ordinary or anomalous) is not included in this list. It is tantalising to feel that we are not (for the present at least) to have the opinion of the author on the classical researches of Cauchy, or on the more recent speculations of Sellmeier, Helmholtz, and W. Thomson. It would, however, be unjustifiable to construe this omission into an indirect assertion that we do not yet know for certain *what* Dispersion tells us:—though the parts of his wide subject which Prof. Stokes has selected for discussion are, each and all, such as give indications of a definitely interpretable character.

The first of these is Absorption. Here we have the explanation of the colours of bodies; the testing ray having gone in, and come out "shorn." This leads to the application of the prism in the immediate discrimination of various solutions which, to the unaided eye, appear to have the same colour. It is shown how, by a mere glance, the chemist may often be saved from fruitless toil, occasionally from grave error.

From the study of what rays are absorbed, the transition is an easy and natural one to the study of *what becomes of them* when they are absorbed. Here we have heating, chemical changes, phosphorescence, &c. The remainder of the lecture is devoted to an exceedingly interesting treatment of the beautiful subject of fluorescence.

The second lecture begins with Rotation of the Plane of Polarisation of light by various liquids, with its important application to saccharimetry. Then we have Faraday's discovery of the corresponding phenomenon produced in the magnetic field, with its application in the discrimination of various classes of isomeric compounds. But the author, true to his system of mentioning practical applications only, omits all reference to quartz under the first of these heads and to gases under the second. And he does not even allude to the interesting questions recently raised as to the form of the general wave-surface in these curious circumstances.

Then comes the "still vexed" question of the history of Spectrum Analysis. The present view of it must, of course, be carefully read:—it is much too long to be here extracted in full, and to condense would be to mutilate it. Of course the claims of the author himself are the only ones to which scant justice is done. But the President of the *British Association* of 1871 fortunately gave, in his opening address, the means of filling this *lacuna*. Just as the Gravitation-theory of an early Lucasian Professor was publicly taught in Edinburgh University before it became familiar among scientific men, so the present Lucasian Professor's suggestions for the analysis of the solar atmosphere, by means of the dark lines in the spectrum, were publicly explained in the University of Glasgow for *eight successive years* before the subject became generally known through the prompt and wide-spread publicity given to the papers of Bunsen and Kirchhoff! The following are Sir William Thomson's words of 1871:—"It is much to be regretted that this great generalisation was not published to the world twenty years ago . . . because we might now be [*sic*] in possession of the inconceivable riches of astronomical results which we expect from the next ten years' investigation by spectrum analysis, had Stokes given his theory to the world when it first occurred to him."

The third lecture is devoted to the information which spectrum analysis affords as to the chemical composition of the sun's atmosphere, and its physical condition; the classification of stars, the constitution of nebulæ, and the nature of comets. Those who still maintain that the temperature of the sun's body is comparatively moderate are very summarily dealt with. Then follows a passage describing, in homely language fitted to be understanded of all, the state of the sun's atmosphere. This is specially noteworthy, as showing how efficiently a Master can impress on his readers the most vivid ideas without requiring to use any but the simplest of language.

The remarks on the nebulæ and on comets will be read with great avidity; and, by the majority of readers, with some surprise. For it is stated that the planetary nebulæ, "making abstraction of the stellar points, consist of glowing gas." And of comets we find:—"There can no longer be any doubt that the nucleus consists, in its inner portions at least, of vapour of some kind, and we must add incandescent vapour . . ." An ingenious suggestion as to the source of this incandescence is introduced as the "green-house theory." The nucleus is supposed to be surrounded by an envelope of some kind, transparent to the higher but opaque to the lower forms of radiation. Thus solar heat can get freely at the nucleus, but cannot escape until it has raised the nucleus (in part at least) to incandescence. The coma and tail are formed by the condensation of small quantities of this vapour, so that they are mere mists of excessive tenuity. Herschel's suggestion, that the development of the tail is due to electric repulsion exerted by a charge on the sun, is spoken of with approval; and the production of the requisite charge of the mist-particles is regarded as a concomitant of condensation. Nothing, however, is said as to the opposite charge which the comet itself must receive, nor of the peculiar effects which would arise from this cause:—whether in the form of a modification of the shape of the comet's head, or of a modification of its orbit and period due to a constantly increasing attraction exerted by the sun upon a constantly diminishing mass.

Of course, if this novel theory can stand the test of a full comparison with facts, it will have established its claim to become part of science. But it is hard to take leave of the simple old ideal comet:—the swarm of cosmical brickbats:—something imposing because formidable; and to see it replaced by what is, in comparison, a mere phantom, owing its singular appearance to the complexity of the physical properties it possesses and the recondite transformations perpetually taking place in its interior. The old idea of a comet's constitution was not only formidable, but was capable of explaining so much, and of effecting this by means so simple and so natural, that one almost felt it deserved to be well-founded! The new idea makes it resemble the huge but barely palpable 'Efreet of the *Arabian Nights*, who could condense himself so as to enter the bottle of brass with the seal of Suleymán the son of Dáood!

It is much to be desired that more detail had been bestowed on the nebulæ. As nothing is said about the origin of their incandescence, we must take for granted that it is supposed to be due to gravitation. A few rough numerical assumptions as to dimensions, total mass, &c., and the consequent thermal condition at each stage of condensation, would have formed materials for a most instructive explanatory note.

The last lecture deals with solar protuberances; the (so-called) Döppler's principle, and the results of its application; and, finally, with the body of the sun. The explanation given of the peculiar and rapidly changing structure of the sun's apparent disc, which is so well shown in Janssen's splendid photographs, reminds us of a suggestion made several years ago:—viz. that a succession of instantaneous photographs should be taken, at short intervals, of so homely an object as a basin of very hot "beef-tea," which has been agitated so as to bring the flocculent matter fully into suspension, and is then left to itself as nearly as possible free from rotation.

The passages in the present volume which, taken by themselves, would indicate the ulterior object of the lectures are not numerous, and nowhere bear the appearance of having been inserted for a purpose, so naturally do they arise as comments on what has just been discussed.

We wish the Author as high a measure of success in his final effort, the most arduous of the three, as he has already attained in the others:—it would be preposterous to wish him a higher. The series will then form an exceedingly valuable contribution to a class of literature in which marked success is scarcely attained once per generation, and is justly valued in proportion to its rarity.

P. G. TAIT

AGRICULTURAL EXPERIMENTS

Review of Agricultural Experiments by the Right Hon. Sir Thomas Dyke Acland. (London: Clowes and Co., 1885.)

THIS purports to be a critical review with suggestions, and is actually an attack upon the objects, aims, and results of the Sussex Association for the Improvement of Agriculture. The writer brings a long experience and a good business faculty to bear upon the working of a scientific organisation, and with some success so far as these instruments may be used as tests of the value of a delicate task requiring very special knowledge. The attitude of mind of the reviewer of these experimental results is one of scepticism. This he does not scruple to express in such terms as "we all felt rather sceptical," and "we suspected," and "I have made in all four visits to Sussex to endeavour to get at the truth." Again, "Well, thought I, this must be a queer kind of farming, perhaps I shall enlarge my experience. I think I have made out since that the local experience, however practical, may be the better of a little expansion." With such introductory remarks we can hardly look for the cold judicial criticism that commands attention and carries conviction.

The inquiries of the Sussex Association have been directed to very practical questions, viz.:—

What do roots (turnips, mangolds, &c.) require?

What do wheat and other cereals require?

What does grass or pasture require?

These objects Sir Thomas Acland appears to view in two opposite and irreconcilable ways. First, he seems to doubt the possibility of these questions being solved by experimental processes. Secondly, he appears to consider that they have all been answered long since. He thus discounts the value of the Sussex results from two points of view, each of which is destructive of the other. It is true that the leading facts constituting the answers to the above important questions have now been firmly established for many years, and that these answers were known almost a generation ago to such leading men as the late Philip Pusey, and all more recent scientific agriculturists. The value of such stations as that known as the Sussex Association consists in its power of impressing and verifying such facts, as well as in discovering new ones, and we think, under Mr. Jamieson's able guidance both of these objects are being accomplished. Among new ideas promulgated by the Sussex Association is that which is paragraphed by Sir Thomas Acland under the heading, "Battle of the Phosphates." Mr. Jamieson's contributions upon this important subject are passed over with something akin to contempt, and yet (however distasteful his conclusions may be to manufacturers of "superphosphates") his results remain unrefuted, and the most recent experiments at Woburn point, on the whole, to similar conclusions. The establishment of the value of "insoluble" phosphatic minerals reduced to a fine state of division is due in a great measure to Mr. Jamieson, and he has incurred no little unfriendly criticism on account of this new doctrine, which touches the pockets of certain strong interests. This is altogether the leading truth brought out and fought for by Mr. Jamieson, and yet it is dismissed by Sir Thomas Dyke Acland in a manner which appears to the present writer as simple superciliousness.

One could scarcely expect to read sixty-four pages of printed matter from the pen of Sir Thomas Dyke Acland without finding grain as well as "chaff." We therefore wish to set forth the useful criticisms which the Sussex Association would do well to notice. First, then, there is the fallacious method adopted in endeavouring to translate field results into money values. Not content with leaving the number of bushels per plot and pounds of straw increase to the judgment of the reader, an effort has been made to put a value upon these increased quantities. In valuing wheat at 5*s.* per bushel and straw at 2*l.* per ton the compilers of the report made a great mistake, of which their critic has not been slow to avail himself. Here he "shells" them unmercifully and effectually, especially as the straw at 2*l.* per ton turns out to be the chief item for turning loss into profit.

This is, however, entirely an artificial value, the result of restricted supply, and Sir Thomas is perfectly justified in dismissing the item entirely by compounding it with the cost of the farmyard manure, letting straw and manure mutually discharge each other's claims.

Another point successfully urged is the smallness of the plots. What possible reliance can be placed upon plots 112th of an acre in which pounds per plot are at once alleged to represent hundredweights per acre. The multiplication of unavoidable errors, and the exaggerations of extremely local differences in the soil itself, are simply fearful to think of. The larger the area the better. If acre-plots could be used so much the better, and 10-acre plots would be better still—the only limit in size being, to our mind, convenience. But 112th parts of acres must induce a feeling of distrust in the breasts of those who are practically acquainted with land. The sources of error may be enumerated as follows:—imperfect distribution, unavoidable waste in distribution, minute differences in the soil, irregular germination of the seed, partial insect attacks, direct accidental injuries or the reverse (as, for example, an animal trespassing upon a plot, or a horse dropping his dung upon it), errors in weighing, errors in severance from the ground, and other unavoidable difficulties which belong to the carrying out of field experiments,—all of these errors are magnified in the case of small plots, and minimised by the use of large ones. In these directions the criticisms made by Sir Thomas Acland are valuable: but we should like to have seen a greater sympathy with an honest effort, and less anxiety to hold up any results of value as stale, antiquated, and unnecessary.

Any one who has lived as long as Sir Thomas Dyke Acland must know that the proclamation of things old as things new is not confined to agricultural chemists, and he should be more ready to accept as inevitable the *dictum* of the wise man, that "the thing that hath been, it is that which shall be; and that which is done is that which shall be done."

THE NEW EDITION OF "YARRELL'S BRITISH BIRDS"

A History of British Birds. By the late William Yarrell, V.P.L.S., F.Z.S. Fourth Edition, Revised to the End of the Second Volume by Alfred Newton, M.A., F.R.S., continued by Howard Saunders, F.L.S., F.Z.S. Parts xx.-xxx. (London: Van Voorst.)

THE students of British birds have at last received the two final numbers of the new edition of Yarrell's celebrated work on their favourite subject, which was commenced as long ago as 1871. Fourteen years, it must be acknowledged, is a long time to wait, but on the other hand the subscribers to the new "Yarrell" have in compensation of the delay not what would be called in ordinary parlance a new edition, but what is, in fact, a complete and exhaustive summary of the present state of our knowledge of this subject, prepared by two of the greatest living authorities on British ornithology.

The two first volumes of the fourth edition of "Yarrell's British Birds," which were brought to a conclusion by Prof. Newton in 1882, were devoted to the birds of prey, the passerine birds, and the picarians. In June of that year Mr. Saunders undertook to finish the work, "not willingly nor with a light heart," but, as he tells us, "after considerable pressure and at much personal sacrifice." Forewarned by what had previously occurred, Mr. Van Voorst insisted that time must be part of the "essence of the contract," and stipulated with the new editor for the completion of the third and fourth volumes by June 1885, which, after allowing for six months' leave of absence, gave Mr. Saunders only two years and a half to prepare his account of nearly two hundred species. It cannot be denied that this was somewhat severe upon the new editor, and that, considering the pressure brought to bear upon him, the mode in which he has completed his task within the time assigned to him, deserves our highest compliments.

As has been already pointed out the so-called new "Yarrell" is, in fact, a new work. The vast amount of knowledge of British birds and their distribution acquired during the forty-two years which have elapsed since Yarrell's original work first appeared, rendered it absolutely necessary that such should be the case. It would have been much better, in our opinion, to have discarded the name of Yarrell altogether, and to have employed the leading ornithologist of the period to write a new work on British birds. But as Mr. Van Voorst, doubtless for sufficient reasons, preferred to retain the time-honoured name of Yarrell on the title-page, the new "editors" as they call themselves have, we think, surmounted the difficulties of their position with singular success. Where practicable, we are told, the original phraseology has been followed with due modifications, the opening words of the sentences have been preserved, and extracts from the authors and correspondents quoted by Yarrell have been retained. "This work of selection and adaptation has," we can well believe, "entailed severe labour." It is obvious, in fact, that it would have been a much simpler task to write most of the articles new from the beginning than to adapt those prepared by the original author fifty years ago to present use. The former plan would also, we think, have been more satisfactory to the reader, who between the "author" and the two "editors" and the friends and correspondents of each of them, is in many cases likely to be misled as to the real authority quoted for a particular statement.

While, as we have already said, the general execution of the "new Yarrell" merits our entire commendation, the systematic arrangement—an unsuccessful effort at a compromise between the old fashion and the new—does not seem to deserve equal praise. No doubt the order adopted by first editor for the three groups treated of in the first two volumes placed the second editor in a difficulty. But we cannot think that Mr. Saunders was thereby justified in relegating the Steganopodes, Herodiones and Anseres to the end of the series. With these groups he should have begun the second volume, not finished the third. At the same time it must be borne in mind that the primary object was not a strictly orthodox classification, but a good and readable "History of British Birds," and this object has, we think, been attained.

OUR BOOK SHELF

Melting and Boiling-Point Data. By T. Carnelley, D.Sc., F.C.S. Vol. I. (London: Harrison and Sons, 1885.)

THIS is a very large and important work, and one which cannot fail to be useful to the scientific chemist. It is divided into several parts, and contains, or rather consists of, tables of the elements, inorganic and organic compounds, their constitutional and empiric formulæ, melting- and boiling-points, and the authority and references to the journals, &c., in which the data are given.

The compilation of a work of this nature necessitates an enormous amount of labour and care, which in this case seems to have been expended, for misprints or misquotations appear to be absent.

It is the only one of the kind in English, although there are several German works of the same class, notably one by Richter, but of carbon compounds only. The only fault possible to find with a book like this, designed for use in the laboratory more than anywhere else, is its large size.

The present volume, the author tells us, contains 19,000 data, melting- and boiling-points, and with the second volume there is to be a total of about 50,000 data of this kind.

American Journal of Mathematics, Pure and Applied. Published under the auspices of the Johns Hopkins University. Vol. vii. Parts 2, 3, 4. (Baltimore: Isaac Friedenwald, January to July, 1885.)

THE first sixty-seven pages of Part 2 carry on Prof. Cayley's lectures on the abelian and theta functions, before the Johns Hopkins University (see NATURE, vol. xxxi. p. 189) to "the end of Chapter VII." Other papers in this part are "Solution of Solvable Irreducible Quintic Equations, without the Aid of a Resolvent Sextic," by G. P. Young (the same writer furnishes to Part III. "Solvable Irreducible Equations of Prime Degrees"), and "Notes on the Quintic," by J. C. Glashan. Mr. C. S. Peirce commences an article "On the Algebra of Logic," which runs into Part III.; it is in part concerned with a discussion of De Morgan's logic of relatives. M. Poincaré contributes a paper of fifty-six pages, "Sur les Equations linéaires aux Différentielles Ordinaires et aux Différences Finies." Capt Macmahon adds a short "Second Paper on Perpetuants." The Associate-editor, Dr. Craig, likewise briefly writes "On a Certain Class of Linear Differential Equations." Other short items in this part are: "Prüfung grösserer Zahlen auf ihre Eigenschaft als Primzahlen," by P. Seelhoff; and "Sur les Nombres de Bernoulli" (following up a paper entitled "Some Notes on the Numbers of Bernoulli and Euler," by G. S. Ely, in vol. v.), by Prof. Teixeira, of Coimbra.

The first thirty-four pages of Part IV. are taken up with a paper by Mr. A. Buchheim entitled "A Memoir on Biquaternions," in which the author carries on his investigations in a field first opened up by Clifford. In it he aims at giving "a tolerably complete development of Clifford's calculus." Mr. J. Hammond carries on his labours on the lines of some recent papers by Cayley and Sylvester, by contributing a memoir "On the Syzygies of the Binary Sextic and their Relations." Prof. W. Woolsey Johnson writes "On a Formula of Reduction for Alternants of the Third Order," and "On the Calculation of the Operators of Alternants of the Fourth Order." Short notes are communicated by F. Franklin "On the Theorem $e^{ix} = \cos x + i \sin x$," and a "Proof of a Theorem of Tchebycheff's on Definite Integrals;" and W. E. Story supplies a paper on "The Addition Theorem for Elliptic Functions." The remaining article is an additional Bibliography of the kind of which the *Journal* has now published some three or four most useful specimens. On this occasion Messrs. Nixon and Fields have compiled eleven pages of "Bibliography of Linear Differential Equations." All such lists, if fairly complete, are bound to be most useful. The authors solicit corrections of and addenda to the list for future publication.

A Guide to the Universal Gallery of the British Museum (Natural History). By L. Fletcher. (Printed by order of the Trustees.)

THIS excellent little guidebook is worthy of the highest praise. It is a good deal more than a book which tells you the primary facts respecting the objects in the cases, inasmuch as it contains a simple and elementary introduction to the study of minerals. For such a purpose the principal crystallographic, physical, and chemical characters should be explained, and the way in which these characters serve as a means of classification should be shown. Mr. Fletcher has done this excellently. He shows how the science of crystallography grew by the discoveries of Steno, Romé de l'Isle, Haüy, and others to its present state, in which it serves as a most, if not the most, important element in the discrimination of minerals. The way in which Brewster's discoveries in crystal-optics confirmed the results of crystallographic investigation is pointed out; and a brief sketch of the progress of chemistry from the days of alchemy is also given.

This all leads up naturally to the ultimate purpose—that of classification, which is so essential in the proper display of a mineral collection. Finally, in the detailed account of the minerals in the Museum attention is specially directed to the more unique specimens.

Die Spaltpilze. Von Dr. W. Zopf. 3rd Edition. (Breslau, 1885.)

THIS, the third edition, differs in no essential respect from its predecessors. Zopf still adheres to the original proposition of Von Nägeli, that the various forms of schyzomycetes are not permanent species (Cohn), but various stages in the development of the same organism. This proposition is derived from observations of the morphological characters only, and is not based on sufficiently exact methods of *pure cultivation.*

The sections treating of the physiology and chemistry of the bacteria will be found very valuable. A complete and alphabetically-arranged bibliography at the end of the work is the best as yet published. E. KLEIN

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Evolution of Phanerogams

MUCH as I dislike controversy occasions arise when it must be faced; and Mr. Starkie Gardner's notice of the two new volumes by MM. Marion and Saporta (p. 289) calls for a reply. Personally I am obliged by Mr. Gardner's obvious desire to do justice to my views; but he must excuse me if I say that some of the "main facts" on which he relies are, like similar ones employed by the two French writers, charmingly independent of anything that I can find existing in nature.

Through the kindness of my accomplished friend, the Marquis of Saporta, I received copies of his two volumes as soon as they were published. On perusing his descriptions of the carboniferous plants I found numerous statements with which I could not agree. Some of these statements refer to questions of facts; others to inferences drawn from real or imaginary facts. Having long enjoyed the valued privilege of a correspondence with my distinguished friend I sent to him a lengthy criticism of parts of his new volume which I thought to be seriously misleading; either because matters of fact were so exhibited as to convey erroneous impressions, and hence, practically, to become not facts—or because they were made to justify conclusions which the facts themselves, rightly stated, would not do. At the same time I gave my correspondent warning that I might have to correct what I regarded as his erroneous or misleading statements.

Mr. Gardner's article leads me to fulfil this announcement sooner than I intended, since he, in turn, has so far countenanced some of what I regard as the errors of the two French palæontologists as to make them his own. Like Mr. Gardner, M. Saporta had previously pointed out to me that the aim and object of his volumes did not necessarily involve interference with matters that have so long been in dispute between M. Rénault, M. Grand'-Eury, and myself. To this I could only reply that in his new work he had repeatedly shown his acceptance of views of these two palæontologists involving both facts and inferences, which I believe to be seriously erroneous. The space which NATURE can afford me will not suffice fully to review all of what I regard as the objectionable parts of the two volumes under consideration, but I may be allowed to make some comments, including some extracts from my letter to M. Saporta, indicating the nature of my objections both to his conclusions and to the comments made upon them by Mr. Gardner.

The latter gentleman makes one statement which I cannot endorse. Because MM. Rénault, Grand'-Eury, and Saporta all adopt the views of M. Brongniart he thinks it hardly possible that they can all be mistaken. This argument cuts both ways—Mr. Gardner applies it to the subject of Calamites *versus* Calamadendron. On this subject I may retort that when such men as Schimper, Weiss, Stur, and perhaps my prolonged investigation of the subject justifies my adding myself, take an opposite view of the matter in debate, it may possibly be equally impossible that we, with our vast array of specimens in our cabinets, should all be mistaken! This *argumentum ad hominem* therefore falls to the ground. I may be allowed to wonder that it should ever have been advanced.

The first point to which I would call attention shows that such men as those quoted may blunder and have blundered. I now refer to the subject of the relations of Lepidodendron and Sigillaria to each other and to the rest of the plant world. That I have for many years insisted upon the cryptogamic character of, and the close affinity existing between, both these genera is well known; and equally so, that many of the French palæontologists have followed M. A. Brongniart in regarding the Lepidodendra as Lycopodiaceous plants whose stems contain no exogenous vascular cylinder, whilst all those plants that possessed such a cylinder (a product of a Cambium layer) which they believed to be the case with Sigillariæ must, *de facto*, be Gymnosperms. That this dispute has now been settled in my favour by an important recent discovery does not seem to be known to Mr. Gardner. M. Zeiller has obtained strobili of Sigillaria which have settled the matter even in the opinion of most of the Parisian botanists. Those strobili contain spores, not seeds. This discovery demonstrates the cryptogamic character of Sigillaria, and deals a final blow at the Gymnospermous hypothesis held by the four observers in whose combined infallibility Mr. Gardner expresses such confidence.

My first friendly complaint against the authors of the "Evolution of the Phanerogams" is that they disregard proven facts when such facts inconveniently oppose their theories. *Imprimis*, they became aware of M. Zeiller's important discovery whilst their volumes were passing through the Press. Though this is a sufficient reason for only noticing it in a footnote, it does not justify their very slight recognition of its bearing upon so many pages of their arguments, of which it effectually disposes. It absolutely establishes the fact that *some* Sigillariæ, at least, are *not* Gymnosperms but Cryptogams; which fact, superadded to the many identities of structure in Sigillaria and Lepidodendron, which I have repeatedly shown to exist, renders it increasingly probable that the above statement is applicable to *all* Sigillariæ. At least, it now throws upon the opponents of that statement the onus of proving the contrary to be true, which they have not done.

Several years ago the late Mr. Binney described what he believed to be two plants—the *Lepidodendron vasculare* and the *Sigillaria vascularis*. That the only difference between these two was the possession, by the latter, of an exogenous zone, not seen in the former, was recognised by Mr. Binney. I have shown in a way, which I claim to be unanswerable, that these are one and the same plant which the external and internal characteristics alike demonstrate to be a Lepidodendron. Hence I complain to M. Saporta, "You continue to speak of *Sigillaria* vascularis. I reply that there is no such plant; and to speak of the *Lepidodendron* under that name, after all that I have done in illustration of its organisation, is unfair to me, besides seeming to support M. Rénault's absurd conclusion that an exogenous or centrifugal zone is incompatible with the possibility of a plant possessing such a zone being a Lepidodendron." I then state "further, after enumerating M. Rénault's three supposed types of Lepidodendron, from which he excludes all possibility of the existence of an exogenous zone, you say, 'ce sont les traits *essentiels* des types caulinaires Lepidodendroides.'

"I reply in language as strong as I can possibly use that this is not true. The development of an exogenous zone in the more advanced stages of a Lepidodendron's life is the rule rather than the exception."

After citing numerous proofs of this statement I say in reference to Sigillaria: "It is further a mistake to say that 'ces tiges nous sont principalement connues par les Sigillaria elegans et spinulosa.' We possess the vascular axis of the Sigillaria figured in my Memoir II., Fig. 39. This axis is identical in the minutest details of its organisation with those of the Diploxyloid Lepidodendra, and I have sections of Sigillaria reniformis which are, in structure, equally Lepidodendroid, I ask, therefore, what are the 'diversités appréciables' to what you refer on p. 23, and what ground have you for saying that this double fibro-ligneous region is 'sans analogie avec ce qui existe dans les tiges connues des Lepidodendrées'?"

On this part of the disputed questions I must object to a statement made by Mr. Gardner, in which he says that the structure of Lepidodendron "presents nothing unusual to Cryptogams." Surely a thick *exogenously developed* cylinder of scalariform vessels, arranged in radiating laminæ, separated by true medullary rays, the entire structure being produced by a Cambium zone, is very unusual in Cryptogams. Mr. Gardner then proceeds, as M. Saporta would do, to describe a contrast which has no real existence. "But in Sigillaria, a plant strongly resembling it in nearly every other respect, we find a radiating vascular or woody zone in the cellular stem with unmistakable exogenous growth. It is richly supplied with medullary rays, and, Prof. Williamson allows, presents clear evidence of interruptions to growth succeeded by periods of renewed vital activity." I allow, and never have allowed anything of the kind,[1] if this means my admission that something exists in Sigillaria that does not exist in most Lepidodendra. Mr. Gardner further represents me as believing that "the typical Lepidodendron never produced a ligneous zone." I believe the reverse of this; viz. that a development of such a zone sooner or later was characteristic of most Lepidodendra. True there are some Lepidodendra in which I have not yet discovered such a zone; but I am far from supposing that even in them such a zone will not ultimately be discovered. Anyhow the *typical* Lepidodendron can no longer be regarded as one from which this zone is absent. Mr. Gardner, after the passages quoted above, says: "In Diploxylon there is a further development, the woody zone being made up of an inner or medullary vascular cylinder either interrupted or continuous, composed of large scalariform vessels without definite order, and an outer cylinder of scalariform vessels of smaller size arranged in radiating fasciculi." What does this "further development" mean? This description is simply that of *every* exogenous Lycopodiaceous axis found in the coal measures, whether of Lepidodendron or of Sigillaria. Diploxylon, *as a genus*, has no longer any existence. The term is now useful only as an adjective descriptive of a condition of growth common alike to Lepidodendron and to Sigillaria, as well as to several other genera of Carboniferous plants. Unless I misunderstand Mr.

[1] I may here observe that conspicuous or even visible interruptions to growth are very rare amongst these coal plants. They are only very *conspicuous* in my genus Amyelon; but we also find traces of them in Stigmarian roots and in Lygenodendron. Generally these Carboniferous stems suggest the reverse of changing seasons or periodic interruptions of growth.

Gardner, he here employs words designed to suggest distinctions of organisation between Sigillaria and Lepidodendron, the existence of which I altogether deny.

M. Saporta appears to accept, without demur, statements made by M. Renault respecting Stigmaria ficoides which I emphatically reject. These statements are reactionary in the highest degree. If true they would compel us to cast overboard much of the work done during the last half century by Logan, Binney, Sir William Dawson, and a host of other observers; work, the reality of which, along with the conclusions drawn from it, was unhesitatingly accepted even by Brongniart himself. Such statements, if proven to be true, would involve a rejection of all modern views respecting the origin of coal and a return to the worthless hypotheses that were believed in half a century ago. On this subject I will at present only say that such views are absolutely irreconcilable with well-known facts. Should these views be allowed to pass unrefuted, as Sir William Dawson has properly observed, "some one will be required to rescue from total ruin the results of our labours."[1] I will at present say no more respecting these Stigmarian heresies, since I shall have to deal with them more seriously in a work now in hand for the Palæontographical Society.

Mr. Gardner makes one more statement respecting these Lycopodiaceæ that is unsupported by any evidence which my rich cabinet can supply. He say that "during growth the woody or exogenous zone increased for a certain period, but that this was quickly arrested by the absorption or destruction in some way of the Cambium layer. The *subsequent* increase in diameter took place mainly in the cortical system, and to it the growth and solidity of the stem was principally due. The exogenous element in the oldest known trees is thus seen to have been transitory and subordinate, for had it persisted indefinitely the continued generation of fresh layers or new rings of growth would have produced true Dicotyledonous stems." In the first place we have no evidence whatever of the correctness of Mr. Gardner's statement. That the vascular axis of each of these Lycopodiaceous stems was small in proportion to the diameter of its bark is undoubtedly true, and it was equally probable that the growth in the thickness of that axis was slow; but I know no facts indicating that such growth ever ceased. The diameter of each vascular axis bears about the same proportion to that of the bark, whether the stems are large or small, young or old. Hence we may fairly infer that the cortex and vascular cylinders alike continued to grow *pari passu* so long as each plant continued to live. Anyhow, I know of no facts suggesting a different conclusion.

Respecting the relation of Calamite to Calamodendron, Mr. Gardner says my evidence as to their identity is negative rather than positive. If he will honour me with a visit I think I can soon convince him that this is a mistake, and would only add that there is little possibility and no probability of Mr. Gardner's suggestions being true, viz., that I have "*not come across an undoubted Calamite*," and that such may be common in France though absent from our British deposits. We have them by thousands. What I insist upon is that they differ in no respect from the so-called Calamodendra, the supposed differences being merely due to conditions of preservation. That as soon as we get Calamites with any portion of their internal organisation preserved, they all prove themselves to be Calamodendra. And that even when their internal organisation is not preserved the marking on the surface of their thin carbonaceous covering itself demonstrates that identity. The volumes of MM. Marion and Saporta contain other statements to which, as I have informed my friend, I cannot give my assent; but what I now put on record suffices to show the general nature of the points on which we disagree. M. Zeiller's discovery has settled the questions of the existence of exogenous Cryptogams in the minds of most men—even of several of those who hitherto believed in the accuracy of Brongniart's hypothesis. Patient and persevering investigation will, in time, demonstrate which of us is right in reference to other debated questions. Meanwhile the continuance of co-operation and mutual kindly feeling, notwithstanding our differences of opinion, must be important factors in the attainment of certainty.

Manchester, July 31 W. C. WILLIAMSON

Grisebach's "Vegetation of the Earth"

IN No. 823 of your valued paper is an article by Mr. W. Botting Hemsley on the new edition of Grisebach's "Vegetation der Erde," closing with a reproof to editor and publisher for offering the public an old book as new. For my part I have to say that it was my strong desire to have a really new edition of Grisebach's classical work, which was no longer to be had in the booksellers, by one of our geographical botanists of the first rank. This, however, proved unattainable. Seeing I was bound by contract to the family of Grisebach, and the son of the deceased, Dr. Edward Grisebach, German Consul in Milan, insisted on bringing out the "new" edition himself, all entreaties, representations, and explanations were of no avail. He declared he would never trust the work of his father to other hands and that he felt himself called upon to prepare a new and improved edition. I had therefore but the alternative of seeing the work completely disappear or committing the task of a new edition to the hands of Dr. E. Grisebach, and I think no one will reproach me for choosing the first. At the worst I could only look forward to the new edition being a nearly unchanged copy of the old work (what in point of fact it is), and this seemed to me a far less evil than the complete disappearance of the work, an opinion which friendly and competent judges shared with me. W. ENGELMANN

Leipzig, August 10

[1] Address to the American Association for the Advancement of Science, p. 22, 1883.

A Singular Case of Mimicry

HAVING often read in the pages of NATURE of several cases of protection by simulation (or mimicry), I beg to mention one which has recently come under my own observation, and which, I think, ought to be registered.

I refer to a small insect which I found in a state of larva, and of a white colour, whose back (only) was covered with a layer of moss, and whose movements in this condition were so natural and rapid, that one could immediately perceive that it was the natural *modus vivendi* of the insect. The layer of moss was firmly attached to the body, and completely covered it. I made the experiment several times of placing it on its back, feet uppermost, on a sheet of paper placed on a table. After a few movements the insect, without disturbing the moss, returned to its normal position by making certain movements which resembled those of an acrobat, who, lying on his back, makes use of his hands, and, by a backward somersault, returns to his feet. The little creature is so completely disguised by this layer of moss that, on placing it on the trunk of a tree covered by the same moss, its movements are with difficulty perceived, as the moss in movement may easily be confounded with the moss of the tree. An insect or larva under these conditions could, only with great difficulty, be recognised by its natural enemies (those animals which prey on it).

I send you the specimen to which I refer, the only one I have met with, and which may, during the voyage (of thirty days more or less), die on the way, or pass through some transformation. At all events, you will be able to see the protecting cape, and determine the species, larva or insect, which it protects.

Porto-Alegre, Brazil GRACIANO A. DE AZAMBUJA

[The larva has apparently passed into the pupa stage during the voyage, and has closed the lower side of its protective covering with a silken web. If the perfect insect should emerge, we will endeavour to ascertain its name.—ED.]

Solid Electrolytes

HAVING been for some months occupied with the electrical behaviour of the compounds of copper, silver, and lead with tellurium, selenium, and sulphur, I can confirm the observation communicated to your pages by Mr. Bidwell as to the behaviour of sulphide of copper. He has constructed a primary cell with solid sulphides for the electrolytes. The smallness of the electromotive force which he has obtained is entirely due to the close proximity of copper and silver in the thermochemical series in respect to their heats of combination with sulphur. The theoretical electromotive force should be only ·05 volt.

Let me add to Mr. Bidwell's observation one of my own. If a piece of sulphide of copper is placed between platinum electrodes, a current of electricity from a battery can be passed freely through it, as it is a good conductor. But if after a time the battery is removed and the platinum electrodes are connected with a galvanometer, a current is observed. The solid sulphide between two platinum plates constitutes, therefore, a secondary cell or accumulator capable of being charged and discharged.

SILVANUS P. THOMPSON

Finsbury Technical College, August 17

Preventing Collisions with Icebergs

ALTHOUGH it is, I believe, ascertained that fogs are often higbly athermanous, I would, at the same time, like to ask whether a thermal radiation method might not serve to show the presence of a large mass of ice in the neighbourhood of a ship. I venture to make the suggestion, as I know of no experiments on the degree of athermancy possessed by fogs, as tested by such an instrument as the bolometer of Prof. Langley. The use of this instrument, or even of the thermopile, in conjunction with a large reflector and an alarm circuit closed by galvanometer deflection, might be worth trial by any one possessing the opportunity. J. JOLY

Engineering School, Trinity College, Dublin, August

Monkeys and Water

Is it a usual thing for monkeys, either in captivity or in their native condition, to take freely to the water? Some relations of mine have a small monkey that was brought to them from Java, and which is a great pet. One day it was thought that he should be bathed, and he was put on the edge of the bath. In a little while he hung down from the edge by a foot and hand, and drank the water, and then, plunging in, he swam backwards and forwards under the water, with his eyes open, with great enjoyment.

After the first time he was frequently bathed, and a day or two ago I saw him go through the performance. It was very pretty to see how he enjoyed it, swimming under the water and diving away from a hand put down to take him; then going head over heels at the bottom and lying on his back to bite playfully at a finger; then he would run about on all-fours with his head held out of the water, and then go under again: and after it all, when he was taken out and dried with a towel, he lay wrapped up in a shawl, sleeping comfortable and happy. I should like to know whether he is an exception to the rule in his love of the water. JERRY BARRETT

15, Avenue Road, Regent's Park, August 6

A Correction

I HAVE very stupidly made it appear in my note on pitcher plants, printed in last week's NATURE (p. 341), that Dr. McBride was President of the Linnean Society in 1815. I ought to have written, "In 1815 the then President of the Linnean Society read a communication from Dr. James McBride," &c. I suppose Sir James Edward Smith was at that time President of the Linnean Society, and that Dr. McBride never was. W. WATSON

August 15

A MODEL UNIVERSITY

THE following information for applicants for admission to the Johns Hopkins University, printed in the University Circulars in response to letters, we are sure will be read with interest and profit:—

How was the University Founded?—The Johns Hopkins University was instituted by the munificence of a citizen of Baltimore, Johns Hopkins, who bequeathed the most of his large estate for the establishment of a University and a Hospital. The foundation of the University is a capital, in land and stocks, estimated in value at more than 3,000,000 dollars; the capital of the Hospital is not less in amount. The University was incorporated under the laws of the State of Maryland, August 24, 1867, and it was opened for instruction in September, 1876. The Philosophical Faculty (of Letters and Science) is now organised. A medical department will soon be instituted.

In what is Instruction Given?—Systematic instruction is offered in English, Anglo-Saxon, German, French, Italian, Spanish, Latin, Greek, Sanskrit, Hebrew, Arabic, and in other languages and literatures; in pure and applied mathematics; in chemistry (inorganic and organic) with laboratory work; in physics (including mechanics, light, heat, sound, electricity, magnetism, &c.), with laboratory work; in biology (including physiology and morphology) with laboratory work; in mineralogy and geology; in ancient and modern history; in physical geography; in political economy and in the elements of international law; in logic, ethics, psychology, pedagogics, &c. Occasional courses of lectures are also given upon special themes in literature, science, history, archæology, art, &c.

To whom is this Instruction offered?—To all young men who are prepared to profit by it and who will conform to the simple regulations which are established by the authorities. Graduate, Undergraduate, and Special Students are received.

Those who have not already received an academic degree, should aim to secure one by pursuing a liberal and prolonged course of study, at the close of which the degree of Bachelor of Arts will be conferred. Those who may be prevented from seeking this degree will nevertheless be welcomed to the University, provided that they are in earnest and are mature enough in years, attainments, and character to profit by the advantages which are here afforded. Others who have already taken their first degree are encouraged to go forward in advanced lines of work, and for them unusual facilities are provided. Young men who are to pursue the study of law, medicine, or theology, or who have entered upon professional lives, and others who expect to become teachers, if they desire to become proficient in literature and science, have easy access to the class-rooms and laboratories. The degree of Doctor of Philosophy may be obtained, after three years of advanced study, by those who have met the required conditions.

How is this Instruction given?—By all the methods which experience has shown to be useful—varying according to the preferences of the teachers, the subjects taught, and the number of scholars. There are recitations, lectures, conferences, prolonged courses in laboratories, exercises in special libraries, personal counsel, study of nature out of doors. The usual four-year classes are not maintained, but in all the principal subjects taught there are beginners, intermediate students, and advanced workers; so that every scholar is assigned to that position in each section of the University which will yield him the greatest advantages. He may be far advanced in one subject and only a beginner in another. This result is only secured by the engagement of a large staff of teachers.

What are the Laboratory and Library Facilities?—The scientific laboratories are three in number. They are open throughout the day and are fully equipped. For chemistry there is a special building arranged for about ninety workers, and well adapted to all kinds of chemical and mineralogical work. A large building has been recently constructed for a biological laboratory, with complete arrangements for physiological and morphological work. The physical department is furnished with apparatus selected both for demonstration and investigation, and especially valuable for researches in electricity, magnetism, light, and heat. The construction of a new building for a physical laboratory is now under way.

The library includes over 26,000 bound volumes, and 650 serials are regularly received. It is open thirteen hours daily. The library of the Peabody Institute, with 80,000 volumes, and the other Baltimore libraries, are of easy access. Washington is so near that the Library of Congress, the National Museum, and the other libraries and museums of the capital may be readily visited.

What are the Necessary Expenses of a Student?—The charge for tuition in all departments (including the use of the library, and without any extra charges except for materials consumed in the laboratories), is 100 dollars per annum, payable one-half October 1, and the other half February 1.

Young men living in any part of Baltimore, or in the immediate vicinity, can lodge at home, as the first lessons are given at 9 a.m. daily, and there is rarely any required exercise as late as 5 p.m. Young men from a distance can readily find rooms and good board either in private dwellings or in boarding houses. It is possible to secure accommodations (room and board) for 5 or 6 dollars per week, and for a sum between 6 and 10 dollars per week it is still easier to be suited. The other necessary expenses of life are moderate.

Are there any Scholarships?—In accordance with the request of the founder of the University, twenty Hopkins scholarships, giving free tuition, are annually conferred upon matriculated undergraduate students from Maryland, Virginia, and North Carolina. In addition to these scholarships, eighteen honorary Hopkins scholarships, yielding 250 dollars and free tuition, are offered to those collegiate students from the three States above-named who pass the matriculation examinations with the most credit. Two scholarships giving free tuition are also open to matriculated students from the district of Columbia. Twenty scholarships yielding 200 dollars, and twenty fellowships yielding 500 dollars are annually open to graduate students.

What Special Opportunities are offered to University Students?—Advanced and graduate students are received with or without reference to their being candidates for a degree, and they are permitted to attend such lectures and exercises as they may select. They are not examined for admission to the University, but each instructor satisfies himself of the attainments of all who wish to follow his guidance before admitting them to his classes.

Systematic courses of instruction, varying every year, are announced in the annual programme. The professors are free to give personal counsel and instruction to those who seek it; books and instruments adapted to investigation and advanced work have been liberally provided; the system of Fellowships secures the presence of twenty special students imbued with the University spirit, most of them looking forward to academic careers; seminaries limited to a few advanced students under the guidance of a director have been organised in various subjects; societies devoted to philology, to mathematical, physical, and natural science, to metaphysics, to history and political science, and to archæology, afford opportunities for the presentation of memoirs and original communications, and there are also clubs for the reading and discussion of biological, physical, and chemical papers; during the year courses of lectures are given by resident and non-resident professors on topics to which they have given special attention; the libraries of the Peabody Institute and Maryland Historical Society, founded for the advantage of scholars, are easily accessible; the issuing, under the auspices of the trustees, of publications devoted to mathematics, chemistry, philology, biology, and history brings the University into advantageous connection with other foundations; special libraries connected with the seminaries bring the most important works within easy reach of the student, and the University reading-room, which is constantly open, is liberally supplied with new and with standard books and with the literary and scientific journals of this and other lands.

On what Conditions is the Degree of Doctor of Philosophy Conferred?—The degree of Doctor of Philosophy and Master of Arts is conferred upon candidates who (after having taken their first degree) have pursued University studies, for three years, under approved conditions, have passed the required examinations and presented a satisfactory thesis. At least the last year of study must be spent in this University.

How are the Fellowships Awarded?—Twenty fellowships are annually open to competition, each yielding five hundred dollars and exempting the holder from all charges for tuition. A statement of the rules governing the awards will be sent if requested. Applications for the next year must reach the University before May 1, 1886.

Is there what is commonly known as a College Course? There are seven parallel courses, by following any one of which a matriculated student may attain the degree of Bachelor of Arts. This plan combines the advantages of choice and restriction. From the variety of courses laid down, the scholar elects that which he prefers; having made his choice he finds a definite sequence of studies provided for him. The University marks out for those who elect a classical course, such a plan for the reading of Latin and Greek authors, sometimes with a teacher and sometimes privately, as will enable all who follow it to excel in these studies, while it requires that they should also learn to read French and German, and pursue during one year a course in science. It likewise provides a training which is mainly scientific, enabling the student to concentrate his attention chiefly on chemistry, or biology, or mathematics, or physics; but with these studies he must combine the study of languages, history, and philosophy.

Every matriculated student is expected to follow, under the guidance of an adviser to whom he is specially assigned, one of these prescribed courses which are fully described in the Register. Some elect the classical course. Others may concentrate their main attention upon the higher branches of mathematics. Courses are arranged also for those who wish to devote themselves chiefly to chemistry and physics. For those who expect at a later day to take up the study of medicine, there is a special course marked out, in which biology is the dominant subject. Arrangements are also made in other courses for the study of history and political science and of the modern languages and literatures.

What is required for Admission to the College Courses? —Undergraduates who wish to enter, either as matriculates, candidates for matriculation, students in the preliminary medical course, or as special students, must begin by satisfying the University that they have been thoroughly taught the English studies which are usual in good high schools, academies, and private schools, including a knowledge of arithmetic (with the metric system); geography, physical and political; the outlines of the history of the United States; English grammar and composition. The candidate for matriculation must also pass an examination in—

(1) Latin; (2) Greek (or French and German); (3) mathematics (algebra, geometry, trigonometry, analytical geometry); (4) English; (5) history; (6) natural science. Those who do not intend to follow the classical course may offer French and German instead of Greek. A student may be admitted, under certain circumstances, without matriculation.

Can a Student be aided in Completing his Studies for Matriculation?—If a student at his admission passes in a considerable part of the matriculation requirements he may postpone the remainder for a time. If he is well up in algebra and geometry he may join the University classes in trigonometry and analytical geometry; if he is a good scholar in Latin and Greek, but has not read all the authors requisite for matriculation, he may receive instruction in these authors from the University; if he has not already acquired the elements of French and German he will be aided in doing so, in order that he may enter the courses here provided.

THE HARVARD PHOTOMETRY[1]

WE have waited for the second part of this very remarkable volume completing the Harvard Photometry, rather than examine the separate portions piecemeal. There can be no doubt that its appearance is associated with an epoch in the general progress of astronomical science, coincident nearly with the other

[1] Constituting Parts 1 and 2 of vol. xiv. of the *Annals* of the Astronomica Observatory of Harvard College. (1885.)

corresponding advances in connection with the spectroscope and sidereal photography. The three combined constitute a distinct feature in the more modern methods, by which we are gradually becoming better acquainted with the infinite remote. So soon as molecular physics shall have made, as is promised, a like advance, then the infinite minute also will be brought more distinctly within the human ken.

With regard to the Harvard volume on Sidereal Photometry, without unreservedly conceding to it all the accuracy to which it lays claim, it must be gratefully acknowledged that it provides astronomers with a consistent and valuable catalogue of stellar lustre which, in a complete form, had not hitherto existed. It dispenses with the too often unreliable and discordant estimates of the past, and replaces them by scientific measures possessing, to say the least, considerable precision.

The two parts of the volume contain together no less than 512 closely-printed pages, many of them abounding with models of condensation, and constituting in themselves a remarkable instance of sustained and successful scientific labour. They embrace not only the general history of the subject to which the volume refers, but they at the same time combine elaborate criticism and valuable comparisons of the results of preceding labourers in the same field.

In the first part there is given a description of the meridian photometer, with which the measures of comparative lustre of the stars are obtained. In it are most ingeniously combined the more valuable and least dangerous devices which are found in the instruments devised by Sir John Herschel, Steinheil, and Zöllner. Taken as a whole, the instrument may be properly regarded not only as ingenious but as original. Roughly speaking, it consists of two contiguous telescopes placed horizontally nearly in the meridian, each of the object-glasses being armed with a reflecting prism, so that the light from Polaris and any other star may be brought into the same field of view, after having passed through a double-image prism. The images are then viewed through a Nicol prism, and, by means well known to physicists, the light of the one star is reduced by a measurable amount until it is adjudged to be equal to that of the other star.

We trust we may be pardoned if we suggest that this construction of the instrument may possibly be too complicated to admit of that amount of precision in the measures which could be desired, and which might be obtained by simpler means. In fact, it appears from the volume itself, that at the commencement of operations, it was necessary to abandon the results of several months' work with it; and although an improvement in the use of it was subsequently adopted, we think there still remain traces of the possibly inherent difficulty of precise adjustment. The rapidity also with which the equalisation of brightness of each star with that of Polaris is made, seems hardly consistent with the requisite precision. It is to be inferred from the volume itself that as many as forty-eight final determinations, each consisting of four equalisations of the light of a star with that of Polaris, are frequently completed within the hour, in addition to the consumption of time required for finding and identifying the successive stars and adjusting them in the field of view. But, we cannot doubt, this point has been well considered by the Harvard astronomers themselves.

In the determination of the magnitude of a star, it is the usual practice to rest content, generally, with the mean of three determinations. Each determination is made on a different night, and consists of the mean of four equalisations of the lustre of the particular star compared with that of Polaris in the field of the photometer. We venture to think that the general limitation to three only is too restricted for the purposes of accuracy. The reason for this opinion is derived from the fact that on examining the numerous cases in which as many as fifteen determinations of magnitude are made on as many nights, it is very frequently, and in fact generally, possible to find three consecutive determinations which would of themselves, in the mean, lead to a magnitude widely different from that ultimately assigned. Yet these three consecutive sets furnish no circumstance of inter-discordance among themselves which could lead to suspicion, and which might, consistently with the usual practice, have finally settled the magnitude of the star in question. We regard this not as hypercriticism, but as being the only sufficient means at hand for the examination of accuracy furnished by the volume itself.

Independently of the several catalogues containing the results of three years' unremitting labour and persevering skill, the volume abounds with the intercomparison and reduction to one scale of the work achieved in a similar direction by many preceding astronomers. The result is that astronomers who are desirous of information on the subject of stellar brightness, will probably not be disappointed if they turn to the pages of the Harvard Photometry. Combined with a memoir by Prof. Pritchard, contained in vol. xlvii. of the *Memoirs* of the Royal Astronomical Society, it is perhaps not too much to say that all that is known upon the subject up to the present date will be found easily accessible to the student.

Towards the conclusion of the volume Prof. Pickering has drawn up a very important table, which, though short, must have given him very considerable labour to compute. It contains in one summary a critical comparison of the average results of all the principal catalogues of stellar magnitude hitherto published. The Harvard Photometry is taken as the basis of the comparison, and the difference between the mean or total results of each catalogue and that of the Harvard volume is given. From the inspection of Table lxxxiii. it appears that, taken as a whole, the Harvard measures indicate in the mean a brightness of the stars compared greater than that indicated by the estimates in the *Durchmusterung* of ·14 mag., brighter than the mean of the Uranometria Nova of Argelander by ·10 mag.; of Heis by ·12 mag.; and of Houzeau by ·11 mag. These differences, it will be observed, are all in one direction, and might appear to indicate that there is a generic difference between estimates of star magnitude by the unaided eye, and measures carefully made with a photometer such as is the meridian photometer at Harvard College, because all the estimates are apparently fainter than the measures. But this can scarcely be the true explanation, since the photometric measures also of Seidel, Zöllner, and Peirce indicate, like the eye estimates, a brightness less than that of the American determinations. Moreover, the photometric measures made by Prof. Pritchard at Oxford agree in the mean of the whole, very closely with the eye estimates in the *Durchmusterung* and the other catalogues. But, whatever the significance of this fact may be, it cannot be doubted that the Harvard volume will ever remain a most valuable addition to our knowledge in an important branch of astronomical science.

U.S. INDUSTRIAL STATISTICS[1]

TO all who study anxiously social science, this is a very promising publication; its indirect testimony to the advantages of Republican institutions will be weightier to any reflective man than the eloquent tirades that are so usually bestowed upon them. It defines its object to be the stimulation and assistance of the wage-worker in his endeavour to reach a higher position. Its information respecting working men is all taken from their own contributions, a dozen pages of small print being filled with verbatim quotations from the replies of workpeople in every trade in the State, who give such

[1] "Sixth Annual Report of the Bureau of Statistics of Labour and Industries of New Jersey," 1883." Trenton: New Jersey, 1883.

varied accounts of themselves that the independence of the testimony cannot be doubted. That its work is popular is indicated by the wish expressed by one of them that "there should be a National Bureau." Factory legislation is printed in it (even 1884 legislation, although the printer's date is 1883!); the factory inspector has become a popular institution, and much testimony is borne to the smaller hardship of factory laws uniformly than loosely enforced. The more educated and more prosperous workmen are, the more ambitious and aspiring they become, and we seem on the eve of their blending with their masters when complaints are made, as here, that many of their fellow-workmen are satisfied with *only* 66 shillings a week wages; and a caution is held forth to such not to spend their money in foolishly aping the rich.

Yet, though the teacher here is no longer one of the fatherly governments of the old world using his paternal authority for the good of a rather refractory son, yet the teaching is most satisfactorily similar. Drunkenness could not be set forth as the prevailing cause of pauperism among the men or the evil of a lack of artistic taste among the masters in more vivid or unqualified terms than they are here. The sad combination of progress and poverty is bewailed, but we fear that co-operation urged here as its remedy too much overlooks the control of fashion and its effect upon supply and demand. A most practical power put in the hands of this Bureau is that of examining the accounts of co-operative companies. Any five members of a company may require such an examination.

The principal industries of New Jersey are taken, and, after full statistics of their amount, prosperity and prospects, with the wages earned by each class of workers, an interesting account is given, commencing with a short history of the methods, improvements, and general position of the trade in the United States and in other countries, and their experience compared. Any one casting about for an occupation in which he could take a satisfactory part would find in this "Book of Trades" much to supply the information first required, and much to encourage him. Among them we find a review of the silk trade, which, under the ægis of 60 per cent. duty, has made the wealthy city of Paterson; of glass-making, which at present does not extend much beyond window glass and bottles; of the cultivation of sorghum, still in its infancy in New Jersey; and of the pottery trade—after its account of which it performs the very useful function of a publication like this of appealing to such a trade to take the steps necessary for raising their standard of art. An appeal is made, not from a Government department, or from an interfering *clique* as South Kensington is occasionally regarded as being, but by the organ of his late fellow-workers, that the maker of one of those large fortunes so common in America will, for his country's glory and their help, found a technical school; while hands are led to feel that intellectual training and not mechanical energy alone is wanted. The idea is shown here also to be making its way that the school should be made the basis of technical as well as of mental training; that the dextrous use of the body should form part of the school, as well as of the playground, teaching. More than this, it is felt that they should not be two so distinct branches of education as in past days, and that the members and muscles of the body, as well as the brain, should receive elementary instruction at the school, and that the former should be placed more deliberately under the control of the latter. It is felt in America that

"The cultured mind
The skilful hand"

ought naturally to go together, and not that one should be the usual mark of the absence of the other; that, therefore, a mechanic should not mean little more than a machine, but a mechanician, able to understand, make or repair the giant body that is using its limbs to save his exertions, and therefore a man more on a level with other men whose time has been given to the cultivation of their minds only, and more justified in insisting upon their equality with the latter. It is urged in this Report that elementary technical knowledge valuable to all the New Jersey trades may be given in ordinary schools; that technical learning is popular, frequently most so to boys who are slow at books; and that successful manual occupation improves the morality of the worst of such boys.

A very favourable notice of the Reformatory school at Coldwater; a sad tale of jail arrangements, and of methods of keeping the poor, all lead to discussions of economical difficulties felt long ago in England, not by any means avoided in America, and showing how little forms of government can modify human nature. A more hopeful view of that is afforded by the account, illustrated with three engravings and three plans, of a working-man's Institute at Millville. At this one establishment, which seems to have cost little more than 4000*l*., are combined, besides large grounds used for field sports, bicycling, &c., a gymnasium and baths in charge of a barber in the basement, while on the ground floor are a conversation room hung round with maps and supplied with musical instruments on which performances are given, where also lectures are delivered, discussions held, and games of skill played. Side by side with it is a library and reading-room. Up stairs are four class-rooms and a large hall seating 500 persons, besides a gallery over the rear half of it. At the other end of it is a stage with two dressing-rooms and other necessary adjuncts. This room is used on Sundays as well as on weekdays by various societies—a choral class among others—and is a convenient source of revenue.

It is impossible to lay down our Report without feeling that if each department of its work is by itself of little importance, it will doubtless be a useful agent in making every inhabitant of New Jersey and of the United States a more intelligent worker at his trade or surveyor of the economies around him.

PIERCING THE ISTHMUS OF PANAMA[1]

THREE years ago the work of cutting through the Panama isthmus had barely commenced. The equatorial forests on the neck of land, 73 kilometres long, which marked the axis of the future interoceanic canal, had hardly been laid bare. The traveller who followed the primitive road met here and there some groups of cabins, with roofs of branches on poles, marking the site of a sounding or the improvised dwellings of a portion of the operators. Culebra, Emperador, Corosita, and Gamboa, which are now full of activity, were then almost desert, and on the coast of Colon alone the excavator traced in the marshy plains of Gatun his great track. The contrast to-day is great: a long file of workshops covers the space between the Atlantic and the Pacific. Twenty thousand workmen toil on the Cordillera, making the deep cutting for the canal. Side by side with this army, another more powerful army of colossal machines, excavators, dredges, locomotives, waggons, all the materials for transport, thousands of pairs of wheels, hundreds of kilometres of rails, mountains of coal, and shiploads of dynamite. Among the twenty-five workshops of the peninsula the attention is chiefly attracted to two points: the great rocky cutting at Culebra, which is to penetrate to a depth of 120 metres into the Cordillera, and the dam of the Chagres at Gamboa. At Culebra the previsions of M. de Lesseps have been realised: the mountainous mass which the canal will traverse is, for the most part, composed of rocks which are not very hard; repeated soundings by means of diamond perforators have shown that down to a

[1] Abstract from *La Nature*.

considerable depth the rock takes the form of schists in horizontal strata. There is no doubt that it can be cut through with rapidity; it is a matter of perforation, either by mining and ordinary explosives, or by shafts with larger quantities of some explosive to displace great masses. Here 30,000 cubic metres of rock have been displaced by an explosion of dynamite; and unquestionably this colossal channel connecting two seas may be executed by simple methods and with economy.

At the end of the great cutting of Culebra, 6 kilometres from Emperador, is the great workshop for the dam across the Chagres. This gigantic basin, containing about 1,000,000,000 cubic metres of water, the surface of which is 60 metres above the water of the canal, has a bank, the content of which is 7,000,000 cubic metres. The volume of water kept in by this exceeds a hundredfold that of any reservoir in the world. By means of this work inundations in the river are prevented, currents impeding navigation and introducing rough water into the canal are avoided, and there is no fear of the accumulation of alluvion in the bed. By regulating the flow of the Chagres and of the neighbouring streams, the dam at Gamboa assures the regular service of the canal. The method of constructing this work of proportions without precedent in the annals of public works is a very simple one. From the great cutting at Culebra, near Gamboa, and the neighbouring cuttings, about 50,000,000 cubic metres of rock are removed, while only about 7,000,000 are required for the Chagres dam, and therefore the work is one of transport only—a colossal one, it is true. Even the site of the dam is formed naturally by the disposition of the bed of the torrent, which is contracted at this place between the hills of Obispo and Santa. Cruz, which are distant about 150 metres from each other, and on which will rest the front wall of the great reservoir. Behind this first barrier will be thrown, as they are taken from the Cordillera, the 7,000,000 metres of rock, and the dam will be complete. The originality of the project is that, strictly speaking, there is no masonry at all in this enormous mass of rock of all sizes and shapes; the accumulation alone gives the mass firmness. The plan given here enables us to follow the sinuous course of the Chagres River. Like all torrents, and especially all torrents in equatorial regions, it is subject to considerable variations in its flow, and to enormous and violent floods. In winter its flow is 1600 cubic metres per second, while in spring it is barely 13 metres. Its tributaries, or *rios*, are of the same character—the rio Trinidad and the rio Gatuncillo have a flow in winter of 400 cubic metres. It would be impossible to divert these impetuous masses of water into the canal without producing currents and deposits and impeding the navigation. The overflow of exceptional floods will be conducted to the sea by secondary water courses. These latter, which vary in breadth from 8 to 12, and even to 40 metres near the Atlantic, are easily made by utilising the portions of the bed of the river situated on the same bank, and connecting them by appropriate trenches. The enormous reserve behind the dam will flow regularly in this new bed. Of course, the bed of the canal will be completely protected from these deviating waters, in the trenches by the slopes of the latter, and in the lower parts by banks which will soon be covered by a vigorous and indestructible tropical vegetation. With the construction of this reservoir, assured by the clearings from the cutting, and the water regulated and controlled by these courses, the work, like that of the cutting at Culebra, is only one of time. One objection which was raised when the public became acquainted with the almost incredible magnitude of the work, in which a reservoir becomes a great lake, was that this latter might itself be filled up with the alluvial deposits, which it was constructed to keep out of the canal. It is true that in its tropical floods the Chagres carries along a large quantity of alluvion; but this, which would be an insuperable obstacle in the canal, becomes a secondary consideration in the reservoir. It has been calculated by the chief engineer to the work that the Chagres can bring into the lake in *a thousand years* 30,000,000 cubic metres of alluvion, while the cubic content of the lake is 1,000,000,000 cubic metres.

Culebra and the dam at Gamboa have always been the two principal points, the main obstacles to the canal. But there are thirty-five other principal working stations, all connected with the railway between Colon and Panama. As the illustration shows, they are sufficiently near to each other to be considered uninterrupted. Fifty excavators and ten dredges work at the canal. Up to the twenty-fifth kilometre we meet with dredges, at first at Colon for the port, then at Gatun. As far as the Panama Plain there are more than sixty excavators. In the three workshops at Culebra are now installed the contractors who cut the canal from Amsterdam to the North Sea. At Corosal, at the sixtieth kilometre, the great port for access to the canal from the Pacific is to be placed, and there the great American dredges work in the swampy ground. It has been calculated that the work done up to the present is half that required to complete the undertaking, and that this new maritime route to the East will be opened in 1888.

The work stands at present in this position: it involves in all the movement of about 100,000,000 cubic metres of rocks of varying consistency. Of this, 70,000,000 are to be raised, according to the contracts, in successive instalments in 1885, 1886, and 1887. The remaining 30,000,000, which form the actual canal, will be raised at the expiration of this time either by the same contractors or by new ones. Knowing the amount already raised, the contract periods for raising a certain other quantity and the amount remaining to be done at the end of the present contracts, we can, by a sum in simple proportion, calculate when the whole should be completed. In 1888 it should be ready for traffic. This simple programme could only be applied to a work so colossal after a long and laborious period of minute study and preparation. The period of installation is always the most important in all these vast enterprises: the study and command of the appropriate material, the reception, testing, arrangement of the machines, the construction of the workshops, accommodation for the workmen, &c.; it is only when all these have been completed, when all have been made ready for work and tested, that the real work can commence, and that progress becomes sensible. This period of installation lasted, for example, in the case of the St. Gothard tunnel, for fifteen months; but the Panama canal calls for ten times more capital than the tunnel, it is executed in a country which has first to be cleared of a luxuriant tropical jungle, thousands of miles away from all industrial centres. The preparation for this gigantic work under these circumstances was a most important fraction of the work, and it is the opinion of competent men that what has actually been done during the installation period now brought to a close is equivalent to half of the work necessary to achieve the canal. In the case of the Suez Canal, 70,000,000 cubic metres had to be raised; of these, 50,000,000 were raised in two years after the apparatus had been put in working order. Seventy million cubic metres must be raised by the drags and excavators of the twenty-one principal contractors; 18,000,000 are to be raised by August 1 of the current year. These 21 contracts represent an outlay of about 240,000,000 francs, of which 65,000,000 have been tendered by French contractors; 55,000,000 by Americans; 20,000,000 by Italian, Swiss, Swedish, and natives, and 90,000,000 by an Anglo-Dutch Company. All nations are working therefore at the task. The French contractors are at work at the cutting at Emperador; the Anglo-Dutch Company has to remove 13,000,000 cubic metres in the great cutting at Culebra. Practically the whole isthmus is being attacked simultaneously. Fig. 4 represents the work at the station of Emperador. It is connected by rails, on which locomotives run with other stations, and with the Colon-Panama Railway. The material taken out is conveyed to the great dam, which is to keep in the water of the Chagres River. The cutting at Emperador is 200 metres wide in certain places. Next to this comes the great station of Culebra. These two stations are represented in the accompanying sketches. While all this work of dredging and excavating, making cuttings and embankments is going on at the canal, the two ports of entry on the Atlantic and the Pacific are being constructed. At Colon, powerful dredging works are opened. A pier, protected on the western side by a mole, has been built, on which a new town, Christopher Columbus, is growing. On it are placed the workshops, stores, railway stations, &c. All the constructions are connected with the rail-

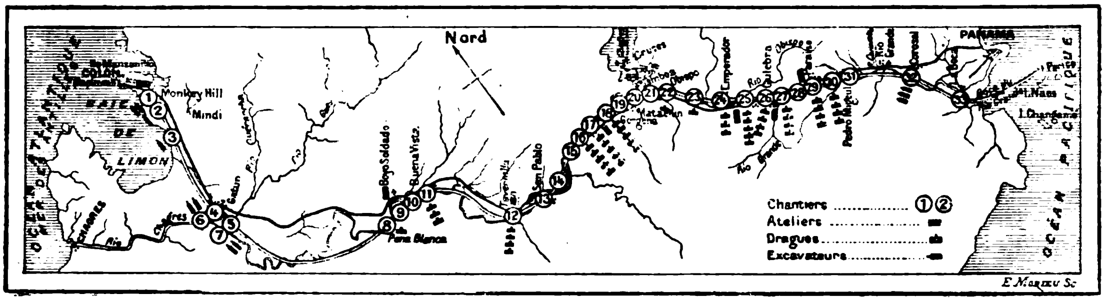


FIG. 1.—Line of Canal and works in course of execution. 1, 2, dredgings of the Port of Colon; 3, 4, 5, dredgings between Colon and Gatun; 6, 7, deviation of Rio Trinidad at Gatun; 8, dockyard of Pena Blanca; 9, 10, embankment of Bohio Saldado; 11, Buena Vista; 12, Tavernilla; 13, 14, San Pablo; 15, 16, 17, Gorgona; 18, 19, Matachin; 20, Gamboa embankment—the great dam; 21, Cerosita; 22, Upper Obispo; 23, the Obispo; 24, Emperador; 25, El Lirio; 26, 27, 28 La Culebra; 29, 30, Paraiso; 31, Pedro Miguel; 32, Corosal; 33, Boca Grande.

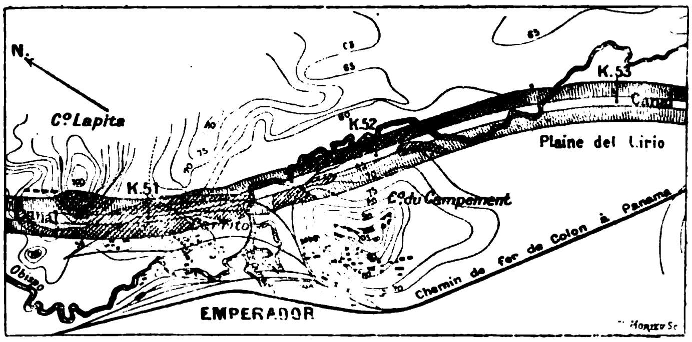


FIG. 2.—Emperador Docks.

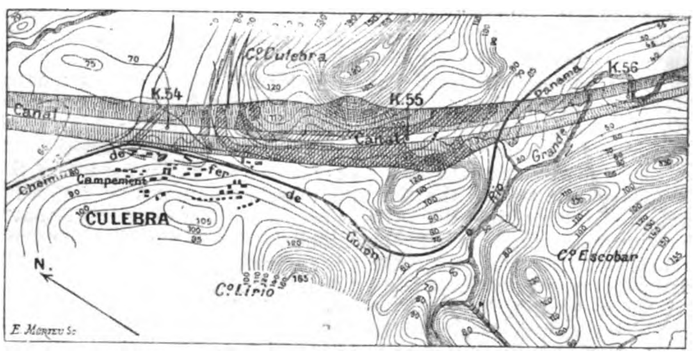


FIG. 3.—Culebra Docks.

way across the isthmus by a series of branches. Vessels drawing any amount of water can discharge at the wharf projecting into the sea, and completely protected from the wind. On the Pacific coast, the creation of a port at the mouth of the Rio Grande presents no technical difficulties, and six dredges are now at work making a channel 100 metres in width to the sea. A special organisation has been created to deal with the vast material, its employment, and repair. The isthmus has been divided into three sections, with a centre at Matachin, at the foot of the great embankment and the cutting. Here all the material is concentrated, all the repairs executed, and all the machinery put in working order. The railway of the isthmus is now the property of the Canal Company, and facilitates greatly this movement of the machinery on which the regular working of the various sections depends. By its means each working station is in communication with the central one and with every other.

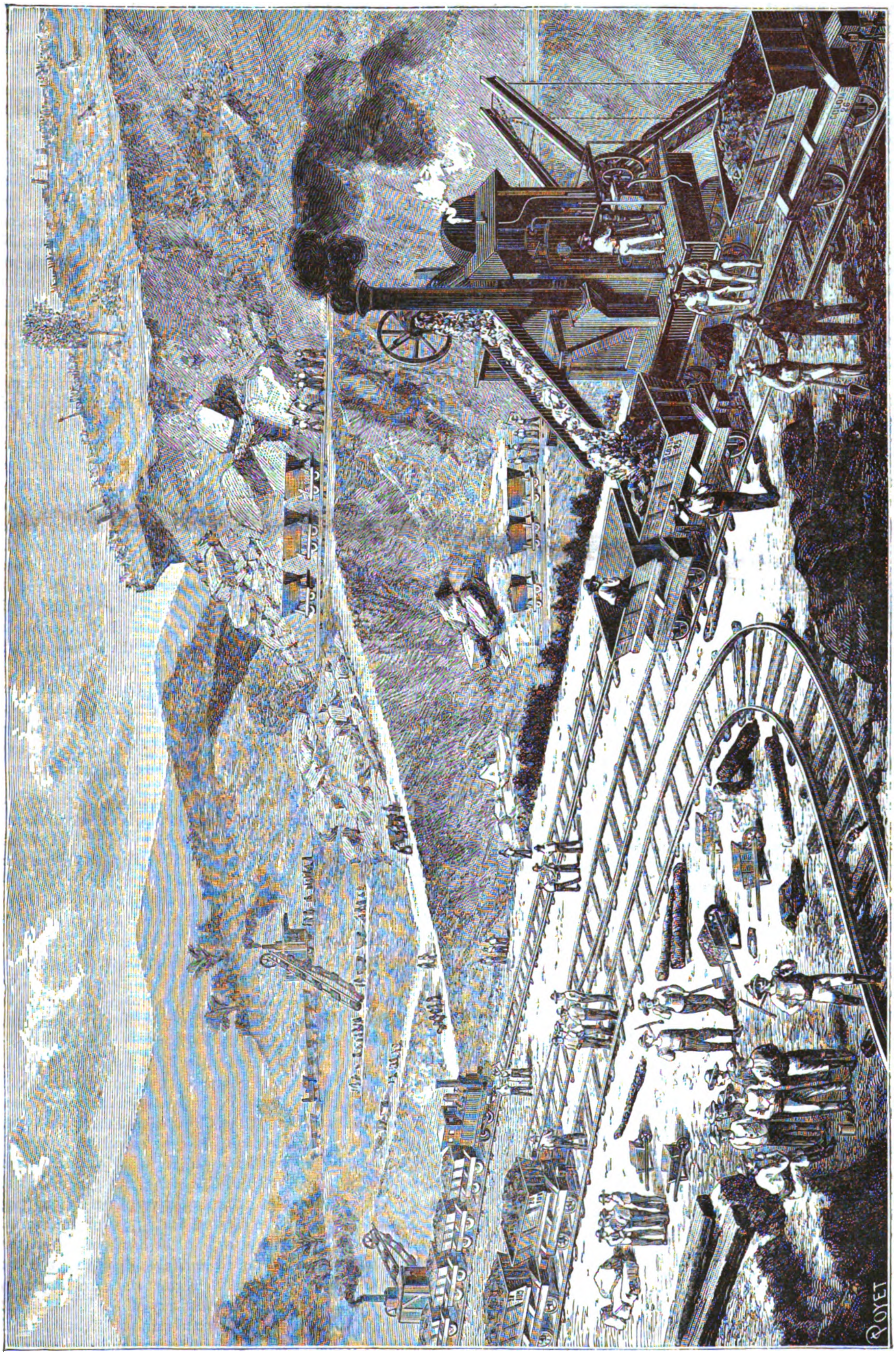


FIG. 4.—Excavations at Emperador Docks

To sum up, more than two-thirds of the work of making the canal is now in execution, under formal engagements with contractors. The problem of the canal has been solved in principle. The period of installation or preparation has been succeeded by one of execution, based on a definitive programme, accepted by those who must carry it out, the Company itself maintaining an attitude of rigorous surveillance.

NOTES

THE fifty-eighth meeting of the German Association of Naturalists and Physicians will this year meet at Strassburg. Notices of communications and abstracts of papers should be sent to Herr J. Stilling. The meeting will commence on Thursday, September 17, and terminate on September 23.

THE local committee of the American Association has issued its second circular containing the general programme of the meeting at Ann Arbor. The meeting will be called to order on Wednesday, August 26, at 10 a.m., when Prof. Lesley will resign the chair to President-elect Prof. Newton of New Haven, and the usual addresses of welcome will be delivered. In the evening Prof. Lesley will give his presidential address. On Thursday evening the citizens of Ann Arbor will tender a reception at the Court House, and on Friday it is probable that a lawn party will be given on the University grounds. On Saturday a long excursion, as previously announced, will take place; on Monday a short excursion for the members of the Botanical Club has been planned, probably to the Tamarack swamp, one of the detached spots common in Southern Michigan where a northern flora has lingered under favourable conditions through the various climatic changes of later geologic times. It is probable that similar trips to points of local interest may be arranged for some of the sections. The chairman of Section C announces that the following subjects have been chosen for discussion: first, what is the best initiatory course of work for students entering upon laboratory practice? second, to what extent is a knowledge of molecular physics necessary for one who would teach theoretical chemistry? In the discussion in Section D, mechanical science, of the best method of teaching mechanical engineering, in order that what is read and said may be to the point, the following classification should be observed: (*a*) schools of mechanical engineering; (*b*) mechanic art schools for the education of superintendents, foremen, &c.; (*c*) manual training-schools. The distinction between "mechanical laboratory practice" and "shop practice" should also be made and appreciated.

THERE seems to be no doubt that Sir Nathaniel Barnaby is about to close his connection with the Admiralty as Director of Naval Construction. We shall be interested to see in what manner the new Government fills up the vacancy, and what treatment they give Sir Nathaniel's successor, who, it is rumoured, may be Mr. W. H. White. As is known, Mr. White some time ago resigned his connection with the Admiralty for a far more lucrative post in Sir W. Armstrong's works. "But there is a difficulty in the way," as the *Pall Mall Gazette* puts it. "Private firms can pay, and do pay, their chief constructors twice, three, and four times as much as the Admiralty. Perhaps Mr. White may consent to sacrifice some thousands a year for the honour and glory of serving his country, but the time will come when scientific skill, like other commodities, will have to be purchased at the Admiralty at its market rate." Perhaps a Conservative Government will show itself more alive to this aspect of the post than its Liberal predecessor.

DR. PAGENSTECHER, of Hamburg, has just described a new form of Frugivorous Bats from a specimen transmitted to the Natural History Museum of that city by Herr H. Soyaux, of Gaboon. *Megaloglossus woermanni*, as this new mammal is proposed to be called, is remarkable as belonging to the long-tongued division of the Pteropine Bats, which was not previously known to occur anywhere within the Æthiopian region. *Megaloglossus* is closely allied to *Macroglossus* and *Melonycteris*, and in some characters is intermediate between these two genera. In its dentition it also exactly resembles them.

WE are informed by Dr. G. A. Guldberg, of the University of Christiania, that the fishery of rorquals or fin-whales (*Balænoptera*) established at Vadö in East Finmarken, for commercial purposes, continues to be turned to good account for scientific investigation. This year Dr. R. Collett, the well-known Norwegian naturalist, is visiting the place, and has already made many interesting observations upon the structure and habits of Rudolphi's whale (*Balænoptera borealis*), which has been captured in considerable numbers during the latter part of July, although the great blue whale (*B. sibbaldii*), generally so numerous, has not yet been seen upon the coast. This is attributed to the absence of the *Thyssanopoda inermis*, a small crustacean on which the blue whale feeds. Rudolphi's whale is called "seje" or "cod" whale by the Norwegians, as it appears on the coast at the same time as that fish, but its food is also a crustacean of a still smaller species than that which is the chief nourishment of its gigantic relative. It usually visits the coasts of Finmark between the months of May and August, and has lately been taken several times on the east coast of Great Britain (Firth of Forth, 1872; River Crouch, Essex, November 1883; mouth of the Humber, September 1884). Dr. Guldberg gives its average length as 40 feet, but says it sometimes attains 50 feet. Its shape is more elegant than that of the commoner species, *B. musculus*, which it otherwise resembles. Its colour is black, and does not show the bluish tint seen in the latter species and in *B. sibbaldii*. The sides are spotted with white, and the under parts are white with a faint reddish tinge. A new use to which the whales killed at Vadö have been lately put is tinning their flesh, which is said to be wholesome, and to find great favour in Catholic countries, where, being fish according to the zoology of the Church, it is allowed to be eaten on fast days.

WE have received the annual report for the past year of Prof. Spencer Baird, Secretary of the Smithsonian Institution. It includes an account of the work performed by the Institution itself, as well as that of the branches of the public service placed by Congress under its charge, namely, the National Museum and the Bureau of Ethnology. A sketch of the work of the United States Fish Commission and of the Geological Survey is added. We observe that the additions to the Museum are described as unexampled in extent, consequent partly upon the labours of the Geological Survey, of the Ethnological Bureau, of the first Commission, and of numerous miscellaneous explorations, both public and private. These various explorations are briefly described. Amongst the forthcoming publications is one on the Botany of North America, by Prof. Asa Gray, part II. of which is in the press. It comprises the Gamopetalous orders from *Caprifoliaceæ* to *Compositæ* inclusive. An enumeration by the author indicates that of the *Caprifoliaceæ* there are 8 genera and 47 species; of *Rubiaceæ*, 26 genera and 86 species; of *Valerianaceæ*, 2 genera and 22 species; of *Dipsacaceæ*, 1 genus and 2 species (naturalised); of *Compositæ*, 237 genera and 1610 species. It will form an octavo volume of nearly 500 pages. The geological map of the United States, commenced in 1883, has been completed and placed in the hands of the engraver. It was found, after collating all available data, that the knowledge acquired is not sufficient to warrant the extension of geological colours over the entire territory of the United States. Accordingly, California, Oregon, and parts of Montana, Idaho, Nevada, Arizona, Utah, New Mexico, and Texas remain uncoloured. This map will be issued in two editions within a few months. The first edition will be coloured in accordance with the scheme previously adopted and published by the Survey. It will form one of the plates of the Fifth Annual Report of the Survey, and a brief explanatory statement will accompany it. A second edition, with complete explanatory text, will be issued as a bulletin. In this edition the map will be printed in duplicate, one copy coloured in accordance with the published scheme, the other with a scheme now under consideration.

IT is reported from America that Cotopaxi in Ecuador began a serious eruption before daylight on July 23. Streams of lava, with ashes and stones, overwhelmed part of Chimbo, situated near Cotopaxi, and one hundred houses were destroyed. Reports from Guayaquil state that the eruption began at 1 a.m., sounding like incessant discharges of heavy artillery, shaking the earth and rattling windows and doors. At times there was a continuous roar. Guayaquil is 130 miles from Cotopaxi.

ACCORDING to a telegram from St. Petersburg to Scandinavian journals, dated August 4, severe earthquakes have taken place at Tashkend and Wernoje in Russia. In Pishek every house suffered, and the new settlements Sukuluk and Belowodsk were destroyed. In the latter place the church fell in. It is stated that fifty-four persons were killed and sixty injured. The shocks continued to be felt several days, and there are great fissures in the earth.

ACCORDING to a telegram from Simla, shocks of earthquake are again being felt in Cashmere.

THE Anthropological Congress which is shortly to be held at Rome will have a curious feature in a collection of seven hundred skulls of criminals, numbered and classified. To these will be added the photographs of 3000 and the brains of more than 150 convicts, thousands of autographs, poems, sketches, and special instruments, the work of criminals, an album containing a record of 700 observations, physical and moral, on 500 criminals and on 300 ordinary men. There will also be graphic maps of crime in Europe with reference to meteorology, food, institutions, suicide, &c.; tables of the stature of criminals in relation to the length of the arms, and of crime in towns compared to that in the country. M. Bertillon will exhibit the graphic curves of 23,000 *recidivistes* examined in twelve parts of the body and the practical results obtained. Photographs of Russian political and other criminals, especially of those from Moscow, and wax masks of a large number of celebrated criminals, will also be exhibited. All the notabilities in the science of criminal anthropology will take part in the Congress.

THE death is announced from Copenhagen of the eminent Danish archæologist, Prof. Worsaae.

A SUPPLEMENT to the *London Gazette* of August 12 gives a list of Jury Awards to the exhibitors at the International Inventions Exhibition.

THERE are now to be seen at the Inventions Exhibition Aquarium some specimens of the black bass, indigenous to the principal rivers and lakes of Canada and the United States of America, where they are found in abundance. This species is very difficult to rear in the waters of our country, and the manner in which they have become naturalised to their sphere of existence at the aquarium referred to is certainly remarkable. Their introduction to the waters of this country is extremely undesirable on account of their voracity, but they provide excellent sport to the angler.

IN regard to the introduction of the catfish to English waters by the National Fish Culture Association, which is discouraged on account of the voracity of this species, Prof. Baird, the United States Commissioner of Fish and Fisheries, writes to state that the catfish is an unmolesting animal and does not exclusively prefer live food to other kinds. The professor considers much advantage would accrue from their acclimatisation in our waters. The Association referred to has carefully noted their proclivities in the ponds where they are now located and experimented upon their food and at present cannot disprove Prof. Baird's assertion.

PROF. S. NEWCOMB, of Washington, is at present visiting Stockholm, as the guest of Prof. Hugo Gyldén, Astronomer Royal of Sweden. Prof. Newcomb proceeds to Pulkowa in order to visit the Imperial Observatory.

AT about midnight on July 29 a remarkable phenomenon was seen at Jönköping (Sweden), over lake Wettern. A strong luminosity was suddenly seen in the north, where some very peculiar clouds—looking like icebergs—were seen almost to touch the water. From these clouds electrical discharges continually proceeded, imparting to them a bluish, phosphorescent light, somewhat ruddy near the water and intensely yellow at their sides. It seemed like a constant discharge of fireworks from the lake. It was remarkable that the light—as is generally the case with an electrical discharge in the atmosphere—did not assume the form of bunches of streamers, but at one time flared up intensely and at others formed narrow bands across the clouds. Above the latter there was a faint bluish reflection. The lake lay as calm as a mirror, and though an optical illusion was uncommon in these parts, the western shore seemed close to the town, while the eastern disappeared in the clouds. Except the electricity-laden clouds in the north the sky was clear, stars shone, and the full moon was bright. Below the latter the sky seemed faintly red, compared with the intense electric light. At Katrineholm the same phenomenon was seen in the north-east. Here an intense glare was seen above a cloud, assuming the appearance of two gigantic lustrous trees, which remained thus for half an hour, when it changed into a variety of forms. There was no noise accompanying the phenomenon, which lasted in both places for about one hour. It is not probable that the phenomenon could have been of auroral nature on account of the brightness under a full moon.

M. CAMBRELENT, Inspector of Public Works, has made a report to the Agricultural Society of France on the subject of the dunes in the *landes* of Gascony. These sand-hills cover a surface of more than 85,000 hectares; they are more than 80 metres high and 5 to 6 kilometres wide. Before a method of arresting these was discovered they were being constantly pushed inland by the winds, invading and covering fields, villages, and even burying churches up to their towers. In 1780 Brémontier sought to render them immovable by planting them, after many experiments designed to develop a primary vegetation. His work has been continued with perseverance, and it is only recently that it has been completed, and these 85,000 hectares, which menaced all the country adjoining, have become covered with a rich forest vegetation which has fixed the dunes in one place. A great public danger has been converted into a large forest. But this work, which renders permanent, dunes already existing, has not prevented the sea from throwing up on the coast new sand day by day, which forms dunes, which in their turn invade the permanent dunes. After having fixed the old sand-hills, the problem was to prevent the formation of new ones. To solve this it was decided to construct a dune above high water, in which all the conditions of the movable dunes would be reversed. The form given to the latter by the wind is such that on the side of the sea they present a gentle slope, which the sand can mount easily as on an inclined plane, in order to fall down a steep decline. It is by the gentle slopes forming a series of inclined planes that the sand moves forward. The formation of the new dune was encouraged, but it was directed in such a manner that it had a steep slope on the side of the sea. To secure this a wooden palisade was erected about 120 metres away from the sea, all along the shore. The sand first struck against this in its progress, and fell at its foot, a portion of it escaping through the interstices left between the planks. The latter was carried some distance by the force of the wind, and fell, forming slight slopes, while the sand which fell at the foot of the palisade on the side near the sea formed a steep incline. Soon this reached the top of the palisade, and then the planks were drawn up by means of a special implement to the needed height, and the formation continued as before, the slope on the side of the sea growing steeper, while the other got more and more gentle. Ultimately the dune reaches such a height (generally 10 to 12 metres) that the sand can no longer get over it, and it is definitely arrested between the barrier and the sea. It falls back on the shore, unable to advance, until contrary winds come and blow it out to sea again. To fix the sand on the other side of the barrier, the *Arundo arenaria* is planted. The roots penetrate to a depth of 4 or 5 metres, and the plant always keeps its head above the increasing sand. The results obtained by this new dune (says M. Chambrelent) have been complete. The most violent storms have not been able to carry the sand over it; the latter has fallen back on the shore innocuous, and the advance of the inexhaustible sand coming from the sea has been absolutely arrested.

THE additions to the Zoological Society's Gardens during the past week include a Common Camel (*Camelus dromedarius* ♂) from Egypt, presented by Major Frank Graves; a Shag (*Phalacrocorax graculus*), from Ireland, presented by Capt. F. H. Salvin; a Common Stoat (*Mustela erminea*), British, presented by Mr. H. Hanauer; a Common Chameleon (*Chamæleon vulgaris*), from North Africa, deposited; a Spotted-tailed Dasyure (*Dasyure maculata* ♂), two Yellow-footed Rock Kangaroos (*Petrogale xanthopus* ♂ ♀), from South Australia, received in exchange; a Coquerel's Lemur (*Cheirogaleus coquereli*), an Elliot's Pheasant (*Phasianus ellioti*), a Bar-tailed Pheasant (*Phasianus reevesi*), four Long-fronted Gerbilles (*Gerbillus longifrons*), bred in the Menagerie.

GEOGRAPHICAL NOTES

M. VIOLET D'AOUEST read a note at a late meeting of the Geographical Society of Paris on aërial formations on the soil. Referring to Richthofen's discovery of a vast aërial formation of loess in China, M. d'Aouest described "meteoric formations" which he had himself examined in Mexico. In 1857 he made a communication on this subject to the Society; he found in the flanks of the most elevated mountains argillaceous deposits, which could not be attributed to decomposition of the rocks there, or to the alluvion deposited by rivers, or by the rain. He referred them after investigation to atmospheric currents. In the day the winds raised the particles from the plains and carried them at night to the hills, depositing them there. In course of time these deposits had reached a thickness of thirty to fifty and in places a hundred metres. The upper part, which was generally finer, stopped at the limit of herbaceous vegetation, for beyond this there was nothing to retain the particles, which were carried down by rains, glaciers, snow, or winds to the lower part. Fifteen years later he heard of Richthofen's publication on the subject, and Col. Prjevalsky during his late journeys in Thibet states that analogous aërial deposits are now being formed under the influence of powerful winds which prevail at these altitudes. Subsequently M. d'Aouest met Baron Richthofen and discussed the subject with him, when the latter stated that these formations exist in Europe, adding that it was singular how men, unknown to and far removed from each other, could be led to make the same discoveries in wholly different regions. M. d'Aouest now intends publishing a translation of Richthofen's monograph on the subject, with a supplement of his own containing a number of important documents which he has collected on these deposits. He thinks he will be able to explain loess and argillaceous deposits, the origin of which has hitherto been regarded as problematical, by this theory.

THE *Bollettino* of the Italian Geographical Society for July prints two inedited letters of early Italian adventurers in South America, recently brought to light in the Archives of Florence and Modena. The longer and more important, dated Dec. 24, 1534, is addressed from Valenzuela (Venezuela) by a certain Tomaso Fiaschi to his brother in Florence. After mentioning the preparatory arrangements made for an expedition of 800 men organised for the purpose of seeking gold in the Orinoco basin, the writer—one of the party—describes the country, the appearance and customs of its inhabitants, the nature of the soil, its climate, animal and vegetable productions. The success of the enterprise, which, nevertheless is known to have ended in failure, is anticipated, because the natives "are so bestial and have so little understanding that they think man and horse one and the same thing, and have so much dread of said horses that they die of fear, and one horseman is worth a thousand Indians, and they also greatly dread the blunderbusses, as to them a strange thing it seems to see men dying and not not know from what; so that if they were a hundred and saw four or six of them die, all would take to flight like beasts. And so we shall go to said conquest in the name of God." Further on the men are said to take "one or two wives as best seems to them, and when they don't like them they leave them and take others, and the brother the sister, though true it is mother does not take son, but there are places where they heed nothing and are like the beasts, and worship the sun and moon. And they have a kind of cotton with which they make beautiful things to their fancy, as cloths, which the women wear in front and certain *camach* (hammocks), in which they sleep, which are the length of a man, and are attached to two stakes in their houses. Here no *grano* (wheat?) nor wine is made, but instead of grano they have a certain thing which they call *maize*, which they sow the whole year, and which springs up and grows high in two months; and likewise they sow certain *ceca*, which they call *patatta*, and it has a very large *barba* (root), and said barba is cooked in the ashes, and it has the same taste as the chestnut, &c."

A PROJECT for the compilation of a detailed topography of Italy during the Roman domination will engage the attention of the Italian Historical Congress which meets at Turin next month.

A REUTER telegram from Brussels, dated August 12, says that, according to a message from Madeira in the *Indépendance Belge*, the Marquis Buonfanti, the celebrated explorer, and M. Casman, chief of the Equator station, have died on the Upper Congo.

THE current number (Band xii. Nos. 5 and 6) of the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* contains a paper by Herr Bandelier on the border lands of the United States and Mexico, in which he describes the territories of New Mexico and Arizona and the Mexican States of Sonora and Chihuahua, their climate, hydrography, topography, flora, fauna, ethnography, antiquities, &c. These subjects are touched rapidly and somewhat superficially, as Herr Bandelier delivered a lecture rather than read a paper. Dr. Hettner referred to his travels in the United States of Columbia. Our geographical knowledge of this region, he said, depends almost wholly on the surveys and description of the Italian Codazzi and the travels of Dr. Reiss and Dr. Stübel, who visited Columbia in 1867 and 1868 with the special purpose of studying the volcanoes. They visited the southern portion, and therefore Dr. Hettner decided, after having investigated the neighbourhood of Bogotá, crossed the Central Cordilleras, and visited the Cauca valley, to direct his journeys to the Eastern Cordilleras, and to study the States of Cundinamarca, Boyacá, and Santander. He had intended originally to include Western Venezuela as far as Carácas in the undertaking, but this had to be ultimately abandoned. The paper gives a brief description of the country and its people, based on these journeys. Dr. Boas describes his journey in Baffin Land in 1883-84. This paper is accompanied by a map showing the outline of the coast of Cumberland Sound and the west coast of Davis Straits according to the English Admiralty charts and to the new survey of Dr. Boas. The discrepancies are very numerous and in some cases very considerable. Herr Wagner contributes a brief sketch of the life and geographical work of the late Prof. Zöppritz.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *AUGUST* 23-29

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 23

Sun rises, 5h. 0m.; souths, 12h. 2m. 22·7s.; sets, 19h. 5m.; decl. on meridian, 11° 19′ N.: Sidereal Time at Sunset, 17h. 14m.

Moon (Full on August 25) rises, 17h. 49m.; souths, 22h. 40m.; sets, 3h. 38m.*; decl. on meridian, 13° 55′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	6 54 ...	13 1 ...	19 8 ...	0 41 N.
Venus ...	7 46 ...	13 54 ...	20 2 ...	0 50 N.
Mars ...	0 41 ...	8 56 ...	17 11 ...	23 18 N.
Jupiter ...	6 8 ...	12 50 ...	19 32 ...	7 41 N.
Saturn ...	0 8 ...	8 17 ...	16 26 ...	22 26 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

August	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
26 ...	67 Aquarii ...	6 ...	5 9 ...	6 9 ...	151 325
27 ...	B.A.C. 8365 ...	6½ ...	20 48	near approach ...	162 —

The Occultations of Stars are such as are visible at Greenwich.

August	h.	
27 ...	11 ...	Mercury in conjunction with and 6° 1′ south of Jupiter.

THE MOTOR CENTRES OF THE BRAIN AND THE MECHANISM OF THE WILL[1]

Feeling deeply as I do the responsibility I have incurred in undertaking to address you to-night, I desire to express my regret that I cannot instead share with you the pleasure of listening to the distinguished man who has been prevented by a most painful bereavement from addressing you to-night.

My subject being the mechanism of the will, it might be asked, "What has a surgeon to do with psychology?" To which I would answer, "Everything." For without sheltering myself behind Mr. Jonathan Hutchinson's trite saying that "a surgeon should be a physician who knows how to use his hands," I would remind you that pure science has proved so good a foster-mother to surgery, that diseases of the brain which were formerly considered to be hopeless, are now brought within a measurable distance of the knife, and therefore a step nearer towards cure. Again, I would remind you that surgeons rather than physicians see the experiments which so-called Nature is always providing for us,—experiments which, though horribly clumsy, do on rare occasions, as I shall presently show you to-night, lend us powerful aid in attempting to solve the most obscure problems ever presented to the scientist.

The title I have chosen may possibly be objected to as too comprehensive; but until we are ready to admit a new terminology we must employ the old in order to convey our meaning intelligibly, although there may be coupled therewith the risk of expressing more than we desire. Thus when I speak of the mechanism of the will and the motor centres of the brain, I do not intend (as indeed must be obvious) to discuss the existence of the so-called freedom of the will, or the source of our consciousness of voluntary power.

I shall rather describe to you first the general plan of the mechanism which conveys information to our brain, the thinking organ; next the arrangement of those parts in it which are concerned with voluntary phenomena; and finally I shall seek to show by means of experiment that the consciousness of our existing as single beings, the consciousness of our possessing but one will as people say, while at the same time we know that we possess a double nervous system, is due to the fact that pure volition is dependent entirely on the exercise of the attention which connotes the idea of singleness. Consequently that it is impossible to carry out two totally distinct ideas at one and the same moment of time, when the attention must of course be fully engaged upon each.

[1] Lecture at the Royal Institution of Great Britain by Victor Horsley, F.R.C.S.

I fear that in making my argument consecutive, I shall have to pass over very well-beaten paths, and so I must ask your patience for a few moments while I make good my premisses.

The nervous system, which in man is composed of brain, spinal cord, nerves, and nerve-endings, is arranged upon the simplest plan, although the details of the same become highly complex when we arrive at the top of the brain.

At the same time, while we have this simple plan of structure, we find that there is also a fundamental mode of action of the same—a mode which is a simple exposition of the principle, no effect without a cause—a mode of action which is known as the phenomenon of simple reflex action.

The general plan of the whole nervous system is illustrated by this model. Imbedded in the tissues all over the body, or highly specialised and grouped together in separate organs, such as the eye or ear, we find large numbers of nerve-endings,—that is, small lumps of protoplasm from which a nerve-fibre leads away to the spinal cord and so up to the brain.

These nerve-endings are designed for the reception of the different kinds of vibration by which energy presents itself to us. As the largest example of these nerve-endings, let me here show you one of the so-called Pacinian bodies, or more correctly, Marshall's corpuscles, for Mr. John Marshall discovered these bodies in England before Pacini published his observations in Italy. Here you see one of these small oval bodies arranged on the ends of one of the nerves of the fingers, and here you see the nerve-fibre ending in the little protoplasmic bulb which is protected by a number of concentric sheaths.

Pressure or any form of irritation of this body at the end of the nerve-fibre causes a stream of nerve-energy to travel through the spinal cord to the brain, and so we become conscious that something is happening to the finger.

Here in this section of the sensitive membrane of the back of the eye, the retina, you see a similar arrangement, only more complicated,—namely, nerve-fibres leading away from small protoplasmic masses which possess the property of absorbing light and transforming it into nerve-energy. It is this transformation of nerve-energy into heat, light, pressure, &c., which it seems to me should alone be called a sensation, irrespective of consciousness. And in fact we habitually say we *feel* a sensation. The terms "feeling" and "sensation," however, are frequently used as interchangeable expressions, although, as I shall show you directly, "feeling" is the conscious disturbance of a sensory centre in the surface of the brain, and in fact feeling is the conscious perception of sensations. This distinction between feeling and sensation, if dogmatic, will save us from dispute as to the meaning of the word "sensation"; and further, the distinction is one, as I have just shown, which is justified by custom.

Now the nerve fibre which conveys the energy of the sensation is a round thread of protoplasm which in all probability connects the nerve-ending with a sensory corpuscle in the spinal cord. These nerve-fibres running in nerves are white, whereas, as you know, protoplasm is gray. They are white because each is insulated from its fellow by a white sheath of fatty substance, just as we protect telegraph wires with coatings. It is not stretching analogy too far to say that nerve-force may probably escape unless properly insulated.

In consequence of the fibres being covered with these white sheaths, they form what is called the white matter of the brain; while the nerve centres are grayish, and therefore form what is called the grey matter of the brain, so that the grey matter receives and records the messages conveyed to it by the white insulated fibres.

From the sensory corpuscle, which is a small mass of protoplasm provided with branches connecting it to neighbouring corpuscles, the nerve energy, if adequate, passes along a junction thread of protoplasm to a much larger corpuscle, which is called a motor corpuscle, and the energy of which, when liberated by the nerve impulse from the sensory corpuscle, is capable of exciting muscles into active contraction. These two corpuscles form what is called a nerve centre.

Not only are the motor corpuscles fewer as well as much larger than the sensory ones, but also the nerve fibres which go out from them are larger too. In fact it would seem as if we had another close analogy to electrical phenomena; for here, where we want a sudden discharge of a considerable intensity of nerve force, we find to hand a large accumulator mechanism and a large conductor, the resistance of which may justly be supposed to be low. Finally, the motor nerve-fibre terminates in a protoplasmic mass which is firmly united to a muscle fibre, and which enables the muscle fibre to contract and so cause movement of one or more muscles. Now, with this idea of the general plan on which the whole nervous system is constructed, you will understand that muscular action, *i.e.* movement, will occur in proportion to (1) the intensity of the stimulation of the sensory corpuscle; and (2) the resistance in the different channels. When a simple flow through the whole apparatus occurs, it is called a simple reflex action, and this was discovered in England by Dr. Marshall Hall.

To recapitulate: a nerve centre, theoretically speaking, we find to consist of a sensory corpuscle on the one hand and a motor corpuscle on the other, both these being united by junction threads or commissures. To such a centre come sensations or impressions from the nerve-endings, and from such a centre go out impulses which set the muscles in action.

I have dwelt thus at length on this most elementary point, because it appears to me that, in consequence of the rapidity with which function is being demonstrated to be definitely localised in various portions of the cerebral hemispheres, we are in danger of losing sight of Dr. Hughlings Jackson's grand generalisations on nerve function, and that we are gradually inclining to the belief that the function of each part is very distinct, and therefore can most readily act without disturbing another part.

In fact, we are perhaps drifting towards the quicksands of spontaneity, and disregarding entirely the facts of every-day life which show that every cycle of nerve action includes a disturbance of the sensory side as well as the active motor agency. Did we in fact admit the possibility of the motor corpuscle acting *per se*, and in the absence of any sensory stimulation we should again be placed in the position of believing that an effect could be produced in the absence of a cause.

For these reasons such a centre has been termed kinæsthetic or sensori motor, and such centres exist in large quantities in the spinal cord, and they perform for us the lower functions of our lives without arousing our consciousness or only the substrata of the same.

But now, turning to the brain, although I am extremely anxious to maintain the idea just enunciated that, when discussing the abstract side of its functions we should remember the sensori motor arrangement of the ideal centre, I shall have to show you directly that the two sides—namely, the sensory and motor—in the brain are separated by a wide interval, and that in consequence we have got into the habit of referring to the groups of sensory and motor corpuscles in the brain as distinct centres. I trust you will not confuse these expressions, this unfortunately feeble terminology, and that you will understand, although parts may be anatomically separated and only connected by commissural threads, that functionally they are closely correlated.

In consequence of the bilateral symmetry of our bodies we possess a double brain—a practically symmetrical arrangement of two intimately connected halves or hemispheres which, as you know, are concerned with opposite sides of the body, for the right hemisphere moves the left limbs, and *vice versâ*.

For my purpose it will be sufficient if we regard the brain as composed of two great collections of gray matter or nerve corpuscles which are connected with sensory nerve-endings, with muscles, and intimately with one another.

In this transverse section of a monkey's brain, which is stained dark blue to show up its component parts, you will see all over the surface a quantity of dark gray matter, which is simply the richly convoluted surface of the brain cut across. Observe it is about a quarter of an inch deep, and from it lead downwards numerous white fibres down towards the spinal cord. The surface of the brain, the highest and most complicated part of the thinking organ, is called the cortex, bark, or rind, and in it are arranged the motor centres I am about to describe. These white fibres coming away from it to the cord, not only are channels conveying messages down to the muscles, but also carrying messages from the innumerable sense corpuscles all over the body.

So much for one grey mass of centres. Now down here at the base of the brain you see two lumps or masses of the same nature, and these are called, therefore, the basal ganglia or grey masses. Since they are placed at the side of the paths from the cortex, and undoubtedly do not interfere with the passage of impulses along those paths, we may put them aside, remembering that they probably are concerned with low actions of the nervous system, such as eating, &c., which are popularly termed automatic functions.

In this photograph of a model made by Prof. Aeby, of Berne, you see represented from the front the two cerebral hemispheres with the centres in the cortex as little masses on the surface, and the basal ganglia as darker ones at the bottom, while leading from them down into the spinal cord are wires to indicate the channels of communication.

Note, in passing, that both hemispheres are connected by a thick band of fibres called the "corpus callosum." It is, I believe, the close union thus produced between the two halves that leads in a great measure (though not wholly) to consonance of ideas.

The arrangement of the fibres will be rendered still clearer by this scheme, in which the cortex is represented by this concave mass, and the fibres issuing from the same by these threads.

The basal ganglia would occupy this position, and they have their own system of fibres.

I will now leave these generalisations, and explain at once the great advance in our knowledge of the brain that has been made during the last decade. The remarkable discovery that the cortex or surface of the brain contained centres which governed definite groups of muscles, was first made by the German observers Hitzig and Fritsch; their results were, however, very incomplete, and it was reserved for Prof. Ferrier to produce a masterly demonstration of the existence and exact position of these centres, and to found an entirely new scheme of cerebral physiology.

The cortex of the brain, although it is convoluted in this exceedingly complex manner, fortunately shows great constancy in the arrangement of its convolutions, and we may therefore readily grasp the main features of the same without much trouble.

From this photograph of the left side of an adult human brain you will see that its outer surface or cortex is deeply fissured by a groove running backward just below its middle, which groove is called the "fissure of Sylvius," after a distinguished mediæval anatomist. This fissure, if carried upwards, would almost divide the brain into a motor half in front and a sensory half behind.

Of equal practical importance is another deep fissure which runs at an open angle to the last, and which is called the "fissure of Rolando," Rolando being another pioneer of cerebral topography. Now it is around this fissure of Rolando that the motor side of the centres for voluntary movement is situated; and when this portion of the cortex is irritated by gentle electric currents, a constant movement follows according to the part stimulated.

Because of their upward direction, the convolutions bounding the fissure of Rolando are called respectively the "ascending frontal" and "ascending parietal" convolutions.

Now here, at the lowest end of the fissure of Rolando, we find motor areas for the movement of both sides of the face: that is to say that, as regards this particular piece of the cortex, it has the power of moving not only its regular side of the face, the right, but also the left—that, in fact, both sides of the face move by impulse from it.

Higher up we find an area for movement of the opposite side of the face only. I reserve for a moment the description of this portion of the brain, and pass on to say that above these centres for the face we find the next is for the upper limb, and most especially the common movement of the upper limb—viz. grasping, indeed the only forward movement which the elbow is capable of, namely, flexion. The grasping and bringing of an object near to us is the commonest movement by far, and we find here that this centre is mainly concerned in it. Behind the fissure of Rolando Dr. Ferrier placed the centres for the fingers.

Next above the arm area is a portion of the cortex which moves the lower limb only, and in front of this again is an area for consonant action of the opposite arm and leg.

Let me here remind you that this being the left hemisphere, these are the centres for movement of the opposite, that is, the right limbs, and that in the other hemisphere there are corresponding areas for the left limbs.

Thus here we have mapped out those portions of the cortex which regulate the voluntary movement of the limbs. So far I have omitted mention of the muscles of the trunk, namely, those which move the shoulders, the hips, and bend and straighten the back. Dr. Ferrier had shown that there existed on the outer surface of the cortex, here, a small area for the movement of the head from side to side.

Prof. Schäfer and myself have found that the large trunk muscles have special areas for their movement, ranged along the margin of the hemisphere, and dipping over into the longitudinal fissure. Thus all the muscles of the body are now accounted for, and I will first draw special attention to the fact that they are arranged in the order, from below upwards, of face, arm, leg, and trunk.

The consideration of this very definite arrangement led Dr. Lauder Brunton to make the ingenious suggestion that it followed as a necessary result of the progressive evolution of our faculties. For premising, in the first place, from well-ascertained broad generalisations that the highest centre, physically speaking, is also the highest functionally and most recent in acquirement, we find that the lowest is the face, and then we remember that the lowest animals simply grasp their food with their mouth. I imagine it is scarcely necessary for me to repeat the notorious confession that our faculties are arranged for the purpose of obtaining food as the primary object of what is called bare existence.

Proceeding upwards in the scale of evolution we next find animals which can grasp their prey and convey it to the mouth, and so we find next to the face area evolved that for the arm.

And so on, the next step would be the development of the legs to run after the prey, and here is the leg centre; while, finally, the trunk muscles are dragged in to help the limbs more effectually.

To my mind this idea receives overwhelming support from the consideration of the fact that, the higher our centres are the more they require education; the infant, for instance, in a few days shapes its face quite correctly to produce the food-inspiring yell, yet takes months or years to educate its upper limbs to aid it in the same laudable enterprise. Finally, what terrible probation some people pass through at the hands of dancing-masters before their trunk muscles will bend into the bow of politeness.

Now to return to the lower end of the fissure of Rolando, to the areas for movements of the face; it was long ago pointed out by the two Dax's and Prof. Broca that when this portion of the brain immediately in front of the face area was destroyed, that the person lost the power of articulate speech, or was only capable of uttering interjections and customary "strange oaths."

In fact this small portion of the left side of our brains (about 1¼ square inches) is the only apparatus for expressing our thoughts by articulating sounds, and note particularly that it is on the left side. The corresponding piece on the right side cannot talk as it were. This remarkable state of things is reversed in left-handed people. In these the right hemisphere predominates; and so we find that when this portion was diseased, there followed aphasia, as it is called. While, however, the right side customarily says nothing, it can be taught to do so in young people, though not in the aged.

Before leaving these motor areas, let me repeat, by way of recapitulation, that the only truly bilaterally acting areas are those for the lower facial and throat muscles. This is a most important fact, for the idea has recently been propounded that both sides of the body are represented in each motor region of each hemisphere. That is to say, each motor area has to do with the movements of both upper limbs, for example. In support of my contention that this is not in accordance with clinical facts, let me here show you photographs of the brain of a man who was unfortunate enough to suffer destruction of the fibres leading from one motor area. Here you see a puncture in the brain which has caused hæmorrhage beneath the fissure of Rolando and the motor convolutions in front and behind it.

In this transverse section of the same spot you see that the hæmorrhage has ploughed up the interior of the brain. Here is the cortical grey matter, but its fibres leading down to the muscles are all destroyed.

Now in examining this patient I asked him to move his left arm or leg; he was perfectly conscious, and, understanding the question, made the effort as we say, but no movement occurred.

Now if both sides of the body are represented in each hemisphere, it seems to me that such a case would be impossible, or at least that a little practice would enable the other hemisphere to do the work; but all clinical facts say that, once destroyed, the loss is never recovered.

If we examine this motor region of the cortex with the microscope we of course find these large corpuscles, which we have learnt are those which alone give energy to the muscles.

But you must not imagine that the motor region consists solely of these corpuscles. On the contrary, as you see in this diagram, we have several layers of corpuscles. I shall return to this arrangement of the corpuscles directly.

Looking back at the surface of the brain you notice that I have only accounted for but a small portion of the cortex. Dr. Ferrier was the first to show that the portion of cortex which perceived (and I use the word in its strictest sense) the sensation of light was this part, and it is therefore called the "visual centre or area." From recent researches it would appear that we must give it the limits drawn on this diagram. Below it we find the centre for hearing.

Thus we know where two sense perceptive centres are situated.

Microscopical investigation shows that this sensorial portion of the cortex is very deficient in large corpuscles, and is correspondingly rich in small cells. Here in this diagram you see these two kinds of structure in the cortex cerebri. Note the greater number and complication of the small corpuscles in the sensory part of the cortex, and the comparatively fewer though much larger corpuscles in the motor region.

It seems to me that several beliefs are justified by these facts.

In the first place the movements produced by the action of these motor centres are always the same for the same centre; consequently it has only one thing to do, one idea as it were. Thus, for instance, bending of the arm: this action can only vary in degree, for the elbow will not permit of other movements. Hence we may look upon it as one idea. Now observe that where one idea is involved, we have but few corpuscles.

Next consider the multitude of ideas that crowd into our mind when we receive a sensation. One idea then rapidly calls up another, and so we find anatomically that there are a corresponding much greater number and complication of nerve-corpuscles.

To sum up, I believe we are justified in asserting that where in the nervous system a considerable intensity of nerve-energy is required—(*e.g.*, for the contraction of muscles)—you find a few large corpuscles and fibres provided, and that where numerous ideas have to be functionalised there numerous small corpuscles are arranged for the purpose.

But now the special interest attaching to the sensory perceptive areas is that they, unlike the motor areas, tend to be related to both sides of the body. With our habit of constantly focussing the two eyes on one object, it will strike you at once that habitually we can only be attentively conscious of one object at a time, since both eyes are engaged in looking at it, and, as you know, we cannot as a matter of fact look at two things at once.

Hence I take it, both sensory perceptive centres are always fully occupied with the same object at the same moment, and that therefore we have complete bilateral representation of both sides of the body in each hemisphere. As a further consequence, each sensory perceptive area will register the idea that engaged it; in other words, both centres will remember the same thing. Thus it happens that each sensory area can perform the duty of the other, and therefore it is a matter of comparative indifference whether one is destroyed or not, and as a matter of fact when this happens we find that the person or animal recognises objects as they actually are, and in fact has no doubt as to their nature. Here you see anatomically the reason of this peculiarity is found to be that the optic or seeing nerves cross one another incompletely in going to each hemisphere, and thus each sensory centre represents half of each eyeball.

I must pass rapidly to the description of the rest of the surface of the brain—the hinder and front ends. At the outset I must admit that all our knowledge concerning them is very hypothetical in the absence of positive experimental results.

This much we can say, that they are probably the seats of intellectual thought, for many reasons which I have not time to detail. Further, we know that these intellectual areas are dependent for their activity entirely on the sensory perceptive centres, for the dictum that there is no consciousness in the absence of sensory stimulation is very well established, as I shall now show you, however astounding it may appear. In the first place, you will remember that when we wish to encourage that natural loss of consciousness which we call sleep, we do all we can to deprive our sense-organs and areas of stimulation; thus we keep ourselves at a constant temperature, we shut off the light, and abolish all noises if we can. But a most valuable observation was made a few years ago by Dr. Strümpell, of Leipzig, who had under his care a youth, the subject of a disease of the brain, &c., which, while destroying the function of one eye and ear, besides the sensibility to touch over the whole body, still left him when awake quite conscious and able to understand, &c., using his remaining eye and ear for social intercourse. Now when these were carefully closed he became unconscious immediately, in fact slept, and slept until he was aroused again, or awoke naturally as we say after some hours.

Hence the higher functions of the brain exercised when that organ is energising the reasoning of the mind, are absolutely dependent upon the reception of energy from the sense perceptive areas.

But my only point with reference to this part of the brain is to attempt to determine how far they are connected with the motor centres in the performance of a voluntary act. With the mechanism of choice and deliberate action I have nothing to do, but there can be no doubt that the part of the brain concerned in that process of the mind is directly connected with the motor region, as indicated on this diagram, to which I would now return. From what I have here written you read, arranged schematically, the psychical processes which for the sake of argument we may assume are carried on by the mind in these portions of the cortex.

I wish to point out that we have structurally and physiologically demonstrated with great probability the paths and centres of these psychical actions. There is no break: the mere sight of an object causes a stream of energy to travel through our sense areas, expanding as it goes by following the widening sensory paths here represented, and at the same time we feel our intellect learns that new ideas are rising up and finally expand into the process of deliberate thought, concerning which all we know is from that treacherous support, namely introspection.

Then comes impulses to action, and these follow a converse path to the receptive one just described; the nerve energy is concentrated more and more until it culminates in the discharge of the motor corpuscles. We might represent the whole process of the voluntary act by two fans side by side, and the illimitable space above their arcs would serve very well to signify the darkness in which we sit concerning the process of intellectual thought.

What I have hastily sketched is the outline of the process of an attentive or voluntary act. I say attentive advisedly, for I wish now to put forward the view that the proper criterion of the voluntary nature of an act is not the mere effort that is required to perform it, but is the *degree to which the attention is involved*. The popular view of the volitional character of an act being decided by the effort to keep the action sustained is surely incomplete, for in the first place we are not seeking to explain our consciousness of an effort, we endeavour to discover the causation of the effort. Our sense of effort only comes when the will has acted, and that same sense is no doubt largely due to the information which the struggling muscle sends to the brain, and possibly is a conscious appreciation of how much energy this motor corpuscle is giving out.

Now to give you an example. I see this tambour, and decide to squeeze it, and do so. Now this was a distinctly voluntary act; but the volitionary part of it was not the effort made, it was the deliberate decision to cause the movement.

I may now point out that in this whole process we say, and say rightly, that our attention is involved so long as we are deliberating over the object, that as soon as another object is brought to us our attention is distracted, that is to say, turned aside.

All writers are agreed that the attention cannot be divided, that we really only attend to one thing at once.

It seems to me that this is so obvious as not to require experimental demonstration, but I have led up to this point because I now wish to refer to the third part of my subject, namely, the question as to whether we have a really double nervous system or not; but by way of preface let me repeat that although we may have a subconsciousness of objects and acts, that that subconscious state is true automatism, and that such automatic acts are in no sense voluntary until the attention has been concentrated upon them. For example, again I press this tambour because I desire to raise the flag, and I keep that raised while I attend to what I am saying to you. My action of keeping the flag raised is only present to my consciousness in a slight or subordinate degree, and does not require my attention, deliberate thought or choice, and therefore, I repeat, is not a voluntary action, in fact it could be carried on perfectly well by this lower sensori motor centre, which only now and then sends up a message to say it is doing its duty, in the same way as a sentry calls out "All well" at intervals.

But to return. In consequence of the obvious fact that we have two nerve organs, each more or less complete, some writers have imagined that we have two minds; and to the Rev. Mr. Barlow, a former secretary of this Institution, is due the credit of recognising the circumstances which seem to favour that view. It was keenly taken up, and the furore culminated in a German writer (whose name I am ashamed to say has escaped me) postulating that we possess two souls.

Now the evidence upon which this notion rests, that the two halves of the brain might occasionally work independently of one another at the same moment, was of two kinds. In the first place it was asserted that we could do two different things at once, and in the second place evidence was produced of people acting and thinking as if they had two minds.

Now, while of course admitting that habitually one motor centre usually acts at one moment by itself, I am prepared to deny *in toto* that two voluntary acts can be performed at the same time, and I have already shown what is necessary for the fulfilment of all the conditions of volition, and that these conditions are summed up in the word attention.

Further, I have already shown that when an idea comes into the mind owing to some object catching the eye, that both sensory areas are engaged in considering it. It seems to me I might stop here, and say that here was an *à priori* reason why two simultaneous voluntary acts are impossible; but as my statements have met with some opposition, I prefer to demonstrate the fact by some experiments.

The problem, stated in physiological terms, is as follows:—

Can this right motor region act in the process of volition, while at the same time this other motor area is also engaged in a different act of volition?

Some say this is possible; but in all cases quoted I have found that subconscious or automatic actions are confused with truly voluntary acts. I mean that such automatic acts as playing bass and treble are not instances of pure volition, as the attention is not engaged on both notes at once.

Consider for a moment the passage of the nerve impulses through the brain that would have to occur. At the outset we find that the sensory perceptive centres would have to be engaged with two different ideas at once; but Lewes showed long ago that introspection tells us this is impossible, that "consciousness is a seriated change of feelings," he might equally well have said ideas. And again, we know that when two streams of energy of like character meet one another, they mutually arrest each other's progress by reason of interfering with the vibration waves.

I will show directly that this is actually the case in the action of the cortex when the above-mentioned dilemma is presented to it.

The experiment I have devised for this purpose is extremely simple.

A person who is more or less ambidextrous, and who has been accustomed for a long time to draw with both hands, attempts to describe on a flat surface a triangle and circle at the same moment. I chose these figures, after numerous trials, as being the most opposite, seeing that in a triangle there are only three changes of movement, while in a circle the movement is changing direction every moment. To ensure the attempt to draw these figures simultaneously succeeding, it is absolutely necessary that the experimenter should be started by a signal.

When the effort is made there is a very definite sensation in the mind of the conflict that is going on in the cortex of the brain. The idea of the circle alternates with that of the triangle, and the result of this confusion in the intellectual and sensorial portions of the brain is that both motor areas, though remembering, as it were, the determination of the experimenter to draw distinct figures, produce a like confused effect, namely, a circular triangle and a triangular circle. If the drawing is commenced immediately at the sound of the signal it will be found that the triangle predominates; thus, if I determine to draw a triangle with my left hand and a circle with my right, the triangle (though with all its angles rounded off) will be fairly drawn, while the circle will be relatively more altered, of course made triangular. On the other hand, if the two figures are not commenced simultaneously, it will be found that usually the one begun last will appear most distinct in the fused result, in fact will very markedly predominate.

Now the course of events in such an experiment appears to be clear.

The idea of a triangle and circle having been presented to the intellect by the sensory centres, the voluntary effort to reproduce these is determined upon. Now, if we had a dual mind, and if each hemisphere was capable of acting *per se*, then we should have each intellectual area sending a message to its own motor area, with the result that the two figures would be *distinct* and *correct*, not fused.

The other evidence that I referred to above, which is adduced in favour of the synchronously independent action of the two hemispheres, is from the account of such cases as the following. Prof. Ball, of Paris, records the instance of a young man who one morning heard himself addressed by name, and yet he could not see his interlocutor. He replied, however, and a conversation followed, in the course of which his ghostly visitant informed him that his name was M. Gabbage.

After this occurrence he frequently heard M. Gabbage speaking to him. Unfortunately M. Gabbage was always recommending him to perform very outrageous acts, such as to give an overdose of chlorodyne to a friend's child, and to jump out of a second-floor window. This led to the patient being kept under observation, and it was found that he was suffering from a one-sided hallucination.

Similar cases have been recorded in which disease of one sensory perceptive area has produced unilateral hallucination.

I cannot see that these cases in any way support the notion of the duality of the mind. On the contrary, they go to show that while as a rule the sensory perceptive areas are simultaneously engaged upon one object, it is still possible for one only to be stimulated, and for the mind to conclude that the information it receives in this unusual way must be supernatural, and at any rate proceeding from one side of the body.

To conclude, I have endeavoured to show that as a rule both cerebral hemispheres are engaged at once in the receiving and considering one idea. That under no circumstances can two ideas either be considered or acted upon attentively at the same moment. That therefore the brain is a single instrument.

It now appears to me that one is justified in suggesting that our ideas of our being single individuals is due entirely to this single action of the brain.

Laycock showed that the Ego was the sum of our experience, and every writer since confirms him. But our experience means (1) our perception of ideas transmitted and elaborated by the sensory paths of the brain; and (2) our consciousness of the acts we perform. If now these things are always single, the idea of the Ego surely must also be single.

THE FRENCH ASSOCIATION

THE fourteenth meeting of this Association has been held this year in Grenoble, one of the most intelligent and active French provincial cities, although it has not quite 25,000 inhabitants. It is situated on the banks of the Isère, one of the principal affluents of the Rhone, and is the head city of the Isère department.

The presidential address was delivered by M. Verneuil in the municipal gymnasium in the very hall where girls and boys are daily using horizontal and vertical bars. The actual President, M. Verneuil, is a surgeon in large practice, who delivered a long address on his profession under the title of "Confessions of a Surgeon of the Nineteenth Century." After having tried with much wit and force of expression to dispell prejudices current against practitioners, he went so far as to argue that operations are less frequent in France than in other lands, in spite of animal vivisection being free.

M. Napias, the general secretary, read a long paper on the scientific men who have died during the year, which has been singularly fatal to French science, and he announced the creation of a section of public hygiene and medicine. This section was inaugurated by an address of M. Chauveau, the Director of the Lyons Veterinary School, on the choleraic vaccination by Ferran. Not having been able to witness the operations conducted by Dr. Ferran, the referee was not in a position to give a definite opinion on this all-important matter; but he is satisfied that Dr. Ferran has adhered faithfully to the principles established by M. Pasteur. Although he may be assailed as lacking correct information on the biological part of the question, none of his assumptions can be considered as being in contradiction with well-stated and observed facts. It is probable that his method may be rendered les cumbrous and painful for the patients, but credit must be given to him for his daring experiments.

M. Galande, the treasurer, showed that the Association is possessed now of 20,000*l.*, invested in public funds. The amount of the annual subscriptions is 2250*l.*, so it leaves a large surplus for the publishing of the transactions and encouragement given to science.

It was announced that the present meeting should have to vote on the fusion with the Association Française, which was created by Leverrier, and presided over by Milne-Edwards since the great astronomer died. No successor will be given to Milne-Edwards, as the two scientific bodies will unite.

The public lectures at the Sorbonne will continue, and a scientific paper will be started, issuing in fortnightly numbers.

M. Rey, the Maire of Grenoble, delivered a complimentary speech to the members of the Association, reminding them that Grenoble was the site of the first Marcel Deprez experiments after their short inauguration at Munich. The results of these important experiments now continuing between Creil and Paris are satisfactory.

In the section of anthropology M. de Mortillet discussed the question of Tertiary man. He said the question was not to know if man as he exists at the present day already existed in the Tertiary epoch. Animals certainly varied from one geological stratum to another, and these variations increased as the strata were geologically distant. The higher the animals the greater the variation. It was to be inferred then that man would vary more rapidly than the other mammals. The problem was not to discover existing man in the Tertiary period, but only to find there an ancestral form of man a predecessor of the man of historical times. The question was, Do there exist in the Tertiary strata objects which imply the existence of an intelligent being? M. de Mortillet has no hesitation in saying there do. These objects have, in fact, been found at two different stages of the Tertiary epoch—in the Lower Tertiary at Thenay, and in the Upper Tertiary, at Otta; in Portugal, and at Puy Courny, in Cantal. These objects proved that at these two epochs there existed in Europe animals acquainted with the use of fire, and able more or less to cut stone. During the Tertiary period there existed, then, animals less intelligent than existing man, but much more intelligent than existing apes. This animal, to which M. de Mortillet gives the name of *anthropithique*, or ape man, was, he maintains, an ancestral form of historic man, whose skeleton has not yet been discovered, but who has made himself known to us in the clearest manner by his works. A number of flints were exhibited from the strata in question, which had been intentionally chipped and exposed to fire. After a long discussion, the almost unanimous opinion was expressed "that after this meeting and discussion at Grenoble there can no longer be a doubt of the existence in the Tertiary period of an ancestral form of man!"

The sitting of the Sections took place in the Palace of the University (Faculties).

NORTH AMERICAN MUSEUMS

A REPORT has just been issued on a visit to the Museums of America and Canada, by V. Ball, M.A., F.R.S., Director of the Science and Art Museum, Dublin. Prof. Ball visited a large number of institutions in various parts of North America, and in his introduction says that he was impressed especially with the system, thoroughness, and good order which appeared to pervade the arrangements in the majority of these institutions. Many of them are of late growth, but already possess an astonishing degree of vigour, while their supporters and officers look forward in a spirit of great hopefulness to what must be described as gigantic extensions of their spheres of usefulness in the future. Largely dependent for their existence on the liberality of private individuals, they take what aid they can get from the Government, and it amounts, in the majority of cases, merely to State recognition. Those of them which possess directly educational functions claim an abundant harvest of good results, and there can be no doubt that the facilities which now exist for instruction in science and art are largely availed of in the principal cities of America.

Mr. Ball did not happen to come across, if such institutions exist, any which were in a condition of decadence from the apathy and indifference of those for whose benefit they had been established. On the contrary, several are unable, owing to their means or room being limited, to receive all the pupils who present themselves.

"That an interest in museums is largely felt in America is not only evidenced by the number of them which are scientifically conducted and the large number of persons who visit them, but it is also proved by the existence of commercially-conducted museums, which are mere collections of curiosities; these are brought before the public in the true showman style, and there is reason for believing are often very profitable as speculations. The only one of these which I visited is the well-known "Museum" at Niagara Falls, which contains a varied collection of natural history and art objects. In a conversation with its manager, I learnt many amusing particulars as to its history. When I suggested to him getting casts of certain objects, he replied that it would not do for him to exhibit anything but the genuine articles to Americans."

The Smithsonian Institution was of course visited, and Mr. Ball sums up its functions thus:—

"The policy of the Smithsonian Institution is to initiate original plans for abstruse research, especially on lines not occupied by other organisations. It freely gives its publications and specimens without requiring an equivalent in return, and places its books, apparatus, and collections at the disposal of investigators and students in any part of the world. It has been the chief promoter of scientific exploration and investigation of the climate, products, and antiquities of the continent by the United States and State Governments, societies, and individuals."

Of the National Museum, Washington, we are told it is the authorised place of deposit for all objects of natural history, mineralogy, geology, archæology, ethnology, &c., belonging to the United States, or collected by the coast and interior surveys, or by any other parties for the Government of the United States, when no longer needed for investigations in progress.

The contents of the Museum as they now stand have been made up from the following sources:—

"I. The natural history and anthropological collections accumulated since 1850 by the efforts of the officers and correspondents of the Smithsonian Institution.

"II. The collections of the Wilkes' exploring expedition, Perry expedition to Japan, and other naval expeditions.

"III. The collections of the scientific officers of the Pacific Railroad Survey, the Mexican Boundary Survey, and of the surveys carried on by the engineer corps of the Army.

"IV. The collections of the United States Geological Surveys under the direction of the United States geologists, Messrs. Hayden, King, and Powell.

"V. The collections of the United States Fish Commission.

"VI. The gifts by foreign Governments to the Museum or to the President and public officers, who are forbidden to receive them personally.

"VII. The collections made by the United States to illustrate the animal and mineral resources, the fisheries, and the ethnology of the native races of the country on the occasion of the International Exhibition at Philadelphia in 1876, and the fishery collections displayed by the United States in the International Fishery Exhibition at Berlin in 1880.

"VIII. The collections given by the Governments of the several foreign nations, thirty in number, which participated in the Exhibition at Philadelphia.

"IX. The industrial collections given by numerous manufacturing and commercial houses of Europe and America at the time of the Philadelphia Exhibition and subsequently.

"X. The material received in exchange for duplicate specimens from the museums of Europe, Asia, and Australasia, and from numerous institutions in North and South America.

"The United States Geological Survey, under the direction of Major Powell, at present has its offices in the Museum, but they will shortly be removed to spacious quarters which are being provided for them in the city."

Of the Museum, &c., of the Academy of Natural Sciences, Philadelphia, Mr. Ball gives the following interesting account:—

"In a 'Summary History of the Academy,' by Dr. W. S. W. Ruschenberger, dated 1877, we are afforded a full insight into the origin and development of this, which is one of the oldest, if not the premier, society of the kind established in America.

"Its foundation originated in meetings held by a few Philadelphian gentlemen in the years 1811 and 1812. Its opening meeting took place on March 21, 1812, and its objects, as then defined were the pursuit and cultivation of science to the exclusion of everything of a political or sectarian character. It was apparently because of this last declaration that a considerable amount of hostility was excited in religious and other portions of the Philadelphian community. The small band, consisting of fourteen members and thirty-three correspondents, although they were men engaged in business avocations, diligently pursued the aims they had in view in spite of all opposition. Their library and museum steadily augmented, and meetings were held and lectures delivered for the discussion and dissemination of scientific knowledge.

"After various vicissitudes during the troubled years which followed, several removals to more commodious quarters took place, and in 1826 the Academy moved to a building which had been specially prepared for its reception, where two years later it was enabled to throw open its museum, entrance to which, from that time, for forty-two years, or up to 1870, was free to the public for two days in each week. In 1840 the museum and library had again been removed to a building which had been specially constructed for their reception at the cost of several liberal friends of the Academy. Yet again in 1876 a further migration took place to the present building, which is built of brick, faced with green serpentine, as are also many other public buildings in Philadelphia; the style of the architecture is Collegiate Gothic. The museum building and the valuable collections which it contains owe their existence at the present day exclusively to the generous gifts and gratuitous labour of private individuals.

"The functions of the Academy are varied, owing to the different directions in which it operates. Its leading characteristics have been thus summed up: 'It is scientific because it encourages original investigations to the extent of its ability, and publishes whatever investigators may discover for the information of men of science. Its publications are made up entirely of the reported results of original research.

"'It is educational because it gives gratuitous instruction to the beneficiares of the Jessup fund, and opens its library freely to students.

"'It is popular because it seeks to increase the taste for natural science, and spread knowledge by opening its Museum to the public.'"

Recently the byelaws of the Academy have been modified in such a manner as to authorise the establishment of Professorships whenever endowments adequate to their support shall be made. Thirteen proposed Professorships are enumerated, and donations towards an endowment fund are invited which may yield from 1500 to 3000 dollars a year for each year.

"The library consists mainly of works on zoology and botany, but there is also a valuable collection of volumes on Roman, Greek, and French antiquities, and the collections of scientific periodicals of learned societies, which have been largely obtained in exchange for those of the Academy itself, is very rich. In 1876 the library included about 25,000 volumes, since which time it may be presumed that considerable additions have been made.

"Under the direction of the Council of the Academy, the Museum is at present administered by Dr. Leidy, who is assisted by several other Curators. The internal arrangements, owing to overcrowding and the old-fashioned form of the cases, which have not been replaced from want of necessary funds, does not at first sight commend itself as affording any useful hints with reference to the subject of general Museum arrangement; but the contents of many of these cases, as is well known to many men of science, are of great value, as they consist largely of types from which species have been originally described. Here, for instance, are to be found a portion of Gould's famous collection of humming birds, many of Dr. Lea's types of unios, and Dr. Leidy and Prof. Cope's fossil vertebrates. Among these last, most notable is the *Hadrosaurus*, an ideal restoration of which rears its lofty frame in a prominent position in the main gallery. More is now known as to the characteristics of those kangaroo-like reptiles (*Deinosaurs*) than was the case when Dr. Leidy named this one after its discoverer, Mr. Foulke. The ornithological collection, which is one of the largest in the world, contains, in addition to the humming-birds already mentioned, numerous rare specimens, one of them being the now extinct Great Awk, of which there is another example in the New York Museum of Natural History. The collection of shells which is under the custody of Mr. Tyron is renowned for its extent and value.

"The Herbarium is considered by good authorities to be one of the richest, if not the richest, in the United States. In 1876 it contained upwards of 46,000 species of plants. It was commenced in 1812, since which time it has absorbed many private collections, either given or bequeathed to it by their owners or purchased out of funds provided by friends of the Academy. Besides a general collection of minerals there is a special one which was bequeathed by the late Mr. Vaux, who also left a sum of money to provide an endowment fund for the payment of the salary of a curator and for the acquisition of new specimens. This collection, so liberally provided for, includes many noble examples of rare minerals.

"The University of Pennsylvania possesses also a mineral cabinet which is administered by Dr. Genth, whose private collection is probably in some respects unique, especially as regards pseudomorphs and minerals which have been derived from others by alteration. Here it may be mentioned that in Philadelphia there are several important private collections of minerals which have been acquired at great expense by their owners—among them those of Dr. Lea and Mr. Bemment are especially noteworthy. However scientific institutions may have progressed in other parts of the United States of late years, Americans cannot but admit the debt which their country owes to the Academy of Natural Sciences for the leading part which it has taken for so many years in the advancement of knowledge of the natural sciences."

Mr. Ball gives a somewhat detailed account of the American Museum of Natural History, New York, which, however, we need not quote, as we recently referred to it in some detail.

The well-known Massachusetts Institute of Technology, Boston, was founded by charter in 1841, its objects, as sketched out by its first President, Prof. Rogers, being threefold, namely, the establishment of a Society of Arts, a Museum of Arts, and a School of Industrial Science. The Society of Arts was the first part of the scheme to be organised. It holds fortnightly meetings, from October to May, the objects of which are to "awaken and maintain an active interest in the practical sciences, and to aid generally in their advancement and development in connection with arts, agriculture, manufactures, and commerce." Discoveries and inventions are described and discussed at these meetings. Judging from the titles and characters of the subjects which have been communicated, the results of these meetings are often doubtless of such a character as to confer great benefit on the community at large. Abstracts of the proceedings are published in the annual reports.

In the new building a spacious and suitable hall has been provided for an Industrial Museum; but, although varied and valuable collections have been made of material suitable for such a Museum, it has been necessary to make use of them in the different departments of the school, where they are placed so as to be easy of access to teachers and students, which would not be the case were they centralised in the main building. The most important branch of the institution, Mr. Ball states, which has excited the admiration of so many visitors, is the School of Industrial Science.

This school was founded in 1865, and two subsidiary schools have since been organised under the control of the Corporation of the Institute. These are, respectively, the Lowell School of Practical Design and the School of Mechanic Arts. The studies in the school "are so arranged as to offer a practical and liberal education in preparation for active pursuits, as well as a thorough training for most of the active professions."

The regular courses, each of four years' duration, are as follows:—

I. Civil and topographical engineering.
II. Mechanical engineering.
III. A. Mining engineering.
III. B. Geology and mining.
IV. Architecture.
V. A.B.C. Chemistry.
VI. Metallurgy.
VII. A. Natural history.
VII. B. Preparatory to the professional study of medicine.
VIII. A. Physics.
VIII. B. Electrical engineering.
IX. A.B.C. General courses.

For proficiency in any one of these courses the degree of Bachelor in Science (S.B.), in the course pursued, is conferred.

The first six of these courses and VIII. B. are distinctly professional. The general courses IX. A.B.C. are for students who, though not desiring to enter a distinctly scientific profession, desire an education of a pre-eminently scientific character. Advanced courses of study may be pursued with or without reference to the higher degree of Doctor of Science. Women who are properly qualified are admitted to any of the courses of the school, and special laboratories in the different branches of study have been provided for their use. Schedules of prescribed studies in the various courses indicate very clearly the wei ht which is given to the modern languages and other branches of a liberal but strictly non-classical education.

The staff of professors and assistants is a large and highly competent one, and the practical part of the instruction appears to be carried on in a very earnest and sound manner. The fee for regular students is 400 dollars per annum, to which in estimating the total cost must be added board and lodging in the town, books, instruments, and personal expenditure. There are at present about 440 students on the roll. From the records of the School it would appear that numbers of its graduates occupy important positions all over the country, for which their special training has qualified them.

The School of Mechanic Arts is for the benefit of those who, from want of time or means, are unable to go through one of the regular courses of the School of Industrial Science. "The object is to develope the bodily and mental powers in harmony with each other." Its exact and systematic method affords the direct advantage of training the hand and the eye for accurate and efficient service with the greatest economy of time. The instruction in the mechanic arts given to each regular student at present embraces:—I. Carpentry and joinery; II. Wood turning; III. Pattern making; IV. Foundry work; V. Iron forging; VI. Vice work; VII. Machine tool work. The regular course includes two years of study in English, French, and elementary mathematics and physics. The general plan of the School is founded upon the systems followed in the Imperial Technical School of Moscow, the Royal Mechanical Art School of Komotan in Bohemia, the École Municipale d'Apprentis of Paris, and the Ambachts Schoole of the principal cities of Holland, modified, however, to suit local conditions. Applicants for entrance must be at least fifteen years old, and must pass an examination in arithmetic, geography, and composition. Fifty-six students have been on the roll during the current year.

The Lowell School of Practical Design was established by the trustees of the Lowell Institute for the purpose of promoting industrial art in the United States, but it is under the administration of the Corporation of the Institute of Technology. Tuition is free to all pupils. A considerable degree of skill in freehand drawing from nature and in the use of the brush is positively required for entrance to the school, which does not undertake to teach drawing

"*Course of Study.*—Students are taught the art of making patterns for prints, ginghams, delaines, silks, laces, paperhangings, carpets, oil-cloths, &c. The course is of three years' duration, and embraces (1) technical manipulations; (2) copying and variations of designs; (3) original designs or composition of patterns; (4) the making of working drawings and finishing of designs."

The school is provided with looms for different fabrics, and the pupils have the opportunity of working their designs in various materials. A constant supply of samples of novelties in textile fabrics of all kinds is received from Paris. Those students who, at the close of the half-year, do not show evidence of progress are permitted to withdraw. Some sixty students have received certificates from this school, and the majority of them have found employment in various factories and other places of business.

Among other institutions referred to in this Report are the Harvard Museum of Comparative Zoology, the Meteorological Museum, Harvard, the Peabody Museum, Connecticut, the Peter Redpath Museum, Montreal, and the Geological Museum, Ottawa. The Report is illustrated by numerous views and plans.

SCIENTIFIC SERIALS

Königliche Gesellschaft der Wissenschaften, Göttingen, January to March, 1885.—Memoir on Jacob Grimm, by F. Frensdorff.—On the optical properties of very thin metal plates, by W. Voigt.—Seventh annual report on the treatment of ear complaints in University Hospital, Göttingen, by Dr. K. Bürkner.—A contribution to the history of the Papacy during the tenth century, by Ludwig Weiland.—On the electric conductivity of liquid solutions in a state of extreme dilution, by Friedrich Kohlrausch.—On the Eris of Greek mythology, her outward appearance and representation in plastic art and literature, by Friedrich Wieseler.—On the theory of complex magnitudes formed of *n* units, by R. Dedekind.—The organic Aryan inflection of the locative case singular of the *u* declension, by A. Bezzenberger.—On Euler's integral in connection with Cauchy's "Mémoire sur les Intégrales définies," by A. Enneper.—A demonstration of the multiplication theorem for the determinants, by M. Falk.—A contribution to the study of the sympathetic nerves in the higher mammals, by Fr. Huth.—On some definite integrals by A. Enneper.—On the maximum of a four-sided figure of given dimensions, by A. Enneper.

Rendiconti del Reale Istituto Lombardo, July 9.—Principles of criminal law; preventive measures and police offences, concluded, by Dr. Raffaele Nulli.—The conflict between Julius Cæsar and the Senate, continued, by Prof. J. Gentile.—Direct oxidation of the iodides and of ammoniacal and organic nitrogen, especially by means of the bioxides of lead and manganese, by Prof. E. Pollacci.—Effects of the phosphates and other fertilisers on the wheat crops, by Prof. Gaetano Cantoni.—An exposition of Riemann's memoir on the theory of the Abelian functions, by Prof. Giulio Assoli.

SOCIETIES AND ACADEMIES

EDINBURGH

Royal Society, July 20.—Mr. David Milne-Home, LL.D., Vice-President, in the chair.—Dr. Harvey Gibson read the second part of his paper on *Patella*.—Prof. Tait read a paper by the Rev. T. P. Kirkman on the unifilar knots with ten crossings; and also a paper of his own on the census of ten-fold knottiness. There are 364 different forms of ten-fold knottiness, when the crossings are alternately over and under, included in 124 types, 50 of which are unique, while 74 have multiple forms.—Prof. Tait also communicated a paper by Messrs. Crocket and Creelman on the thermal effects produced in solids and in liquids by sudden large changes of pressure, and a paper by Mr. W. Peddie on a method of determining the resistance of electrolytes without endeavouring to prevent polarisation.—Prof. MacFadyean and Dr. G. S. Woodhead submitted an account of the construction of the auricles of the pig's heart. Beating of the heart and the superior *vena cava* may continue under proper stimulation for a few hours after death.—Mr. A. P. Laurie communicated a note of the heat of solution of zinc iodide. The heat of solution was determined by observations of the electromotive force of a voltaic cell invented by himself for the purpose.—Dr. J. McFarlane read a second paper on pitchered insectivorous plants.—Mr. H. R. Mill, of the Scottish Marine Station, read a paper on the salinity of the Tay estuary and of St. Andrew's Bay.—The meeting, which was the last for the session, was concluded by an address from the chairman.

PARIS

Academy of Sciences, August 10.—M. Bouley, President, in the chair.—Note on the chief momenta of terrestrial inertia, by M. F. Tisserand.—Remarks on the third part of the Map of Tunis, published by the French War Office, and presented to the Academy by Col. Perrier. The map is to the scale of 1 : 200,000, and the present sheets comprise the districts of Gafsa, Maharès, Kebili, Gabès (Cabes), and Zarzis. Three sheets only remain to complete the whole work, and for these the surveys have already been made.—The sixth part of the General Map of Africa, executed for the War Office to the scale of 1 : 2,000,000 by Capt. de Launoy. This part contains eight sheets comprising the districts of Tabora, Zanzibar, Livingstonia, Vicloux, Mossamedes, Linyanti, Tete, Quilimané.—Note on a registrar of the calorific intensity of solar radiation (one illustration), by M. A. Crova. The apparatus here described is intended faithfully to record the readings of an actinometer giving the calorific intensity of solar radiation to which it is *directly* exposed, while protected from the disturbing action of the winds.—On the treatment of mildew (*Peronospora vitis*) by means of sulphurous acid, by M. Emile Vidal.—A certificate, prepared by Dr. Ferran and signed by several physicians, respecting the results of anti-choleraic inoculations at Benifayo, accompanied by a diagram showing the progress of the epidemic before and after these inoculations, was presented to the Academy, by M. F. Angla. Similar documents are promised for other districts. A telegram was also received from M. Paul Gibier regarding the experiments made by him with hypodermic inoculations of the cholera bacillus.—Observation on Tuttle's comet, the return of which was noticed on August 8 and 9 by M. Perrotin at the Observatory of Nice.—Remarks on a demonstration of the law of reciprocity in mathematical analysis, by M. A. Genocchi.—On the temperatures and critical point of pressure for the chloride of ethyl, and another series of homologous bodies comprising ammonia, gas, and the three methylamines, by MM. C. Vincent and J. Chappuis.—On aqueous evaporation in a disturbed state of the atmosphere, by M. Houdaille. — On a method of obtaining a true standard volt; cause of previous errors, by M. A. Gaiffe.—Products of the oxidation of carbon by the electrolysis of an ammoniacal solution, by M. A. Millot.—On certain alloys of cobalt and copper, by M. G. Guillemin. The alloy with 5 per cent. of cobalt is described as specially interesting, being capable of resisting oxidation, malleable as ordinary copper, tenacious and ductile as iron. It might be largely used in the manufacture of rivets, tubes, and a great variety of copper-ware articles in daily use.— On the thermic phenomena attending the transformation of the protochloride of chromium into a sesqui-chloride, by M. Recoura.—On the crystallographic characters of the substituted derivatives of camphor, by MM. P. Cazeneuve and J. Morel.—On a new species of land turtle (*Testudo yniphora*) brought by M. Humblot from the Comoro Islands, and presented by him to the Natural History Museum of Paris, by M. Léon Vaillant.—On the Brisingidæ fished up from great depths by the *Talisman* Expedition, by M. Edmond Perrier.—Position of the embryo and formation of the cocoon in *Periplaneta orientalis*. The author describes the results of his observations, continued throughout the whole formation and evolution of the egg of this insect for the purpose of determining the exact relations existing between the organic axis of the egg, the principal axis of the embryo, and that of the maternal organism.—On the local treatment of fibrinous pneumonia by means of intra-parenchymatose injections, by M. R. Lépine.—On the cystitis and nephritis produced in the healthy animal organism by the introduction of the micrococcus ureæ (Cohn) into the urethra, by MM. R. Lépine and Gabriel Roux.—Note on the microbe of typhoid fever in man, its cultivation and inoculation, by M. Tayon.—Transmission of pathogenetic microbes from mother to fœtus, by M. Koubassoff.—An explanation of the abnormal development of the grape occasionally occurring in the vineyards of the Vaudois district, by M. J. B. Schnetzler.—On a specimen of pine found embedded in the upper Tschingel glacier at an altitude of 2475 metres, far above the present zone of the pine in this region, by M. Paul Charpentier.—Note on the employment of atmospheric heat for the purpose of obtaining a motor power capable of raising water to a certain height, by M. Ch. Tellier.

CONTENTS

THURSDAY, AUGUST 27, 1885

THE LIFE OF FRANK BUCKLAND

Life of Frank Buckland. By his Brother-in-Law, George Bompas. (London: Smith, Elder, and Co., 1885.)

FEW Englishmen were unacquainted with the central figure of this admirably written memoir. His ubiquity as a lecturer and inspector, the happy self-forgetfulness and adaptability of manner which associated him with royal princes as readily as with seaside fishermen, and the strong personality by which he permanently impressed all who came in contact with him, made him beyond all other men of his time the representative and the preacher of the subject to which he devoted all the energies of his life. That subject was natural history, a term not without meaning even in the present day of minute and subdivided scientific work, but conterminous with science half a century ago, when comparative anatomy was hardly known, when the microscope was costly and imperfect, when the provinces of nature had not been mapped nor its workers differentiated.

Frank Buckland was born a naturalist, into a home crammed with animals, living, preserved, fossil; his mother a woman of rare intellectual accomplishment and scientific taste, his father the first geologist of the age. At three years old he could "go through all the natural history books in the Radcliffe Library"; at four we find him lispingly explaining to a Devonshire parson who had brought with pride to Dr. Buckland "some very curious fossils," that they were the vertebræ of an Ichthyosaurus; at five he is rapturous over the teleology of the "tongue-bone" in the skeleton of a whale; and in the archæology of Worcester Cathedral can find only one object of interest—the figure of a lady who had been starved by a disease in the throat.

At twelve he went to Winchester, not the least barbarous school of that barbarous scholastic time. He was "launched," and "tin-gloved," and "toe-fit-tied," and "tunded," and "clowed," and "watched out" at cricket, and "kicked in" at foot-ball, living for two or three years the wretched life of a college junior amid a mob of boys not overlooked by any master and influenced by the bad traditions of a savage past. He used to say that it had done him good, had cured him of "bumptiousness" and arrogance, but he cherished painful memories of individual tyrants and of special acts of tyranny, and was wont when a senior boy to criticise with a bitterness alien from the ordinary conservatism of schoolboys the coarseness of a system which turned a gentleman's son, bred in the refinement of a cultured home, into an abject domestic serf.

Buckland's fagging days over, he was happy, for he could follow his bent undisturbed, and the pages which describe his later Winchester life are amongst the most amusing in the biography. Fond of school work he was not; he was, in fact, looked upon as a "thick," and his compulsory fagging experiences had given him a dislike for games. But he wired trout and eels in the clear Itchen streams, dug out mice on "Hills," chased badgers on Twyford Down, skinned and dissected cats, moles, and bats, articulated skeletons, baked squirrel pies, and cooked mice in batter. A buzzard, an owl, and a racoon tenanted his lockers in "Moab," a viper lived in his "scob" amongst his books, his hedgehogs kept open a perpetual fosse at the base of the college wall, and a regiment of tame jackdaws looked up to him as their patron. On "Saints' days" he attended the Winchester Hospital, bringing back gruesome fragments of humanity in his pocket-handkerchief, talked medical language, treated confiding boys professionally. Applying for admission to the sick house on behalf of a patient who had partaken too generously of "husked gooseberry fool," he informed the surprised second master that the invalid had a "stricture of the colon;" he was wont to offer sixpence to any junior who would allow himself to be bled; and he treated surgically a football-wounded shin with such results that the leg when shown eventually to a doctor was pronounced to be in imminent danger of amputation.

The Winchester life found fuller development at Oxford. No one who knew Frank Buckland there will forget those merry breakfasts in the corner of Fell's Buildings; Frank in the blue pea-jacket and the German student's cap, blowing blasts out of a tremendous wooden cow-horn; the various pets who made it difficult to speak or move: the marmots, and the dove, and the monkey, and the chamæleon, and the snakes, and the guinea-pigs, and the after-breakfast visits to the eagle or the jackal or the bear or the pariah dog in the little yard outside. His Long Vacations were spent in Germany, whence he brought back little besides collections of red slugs and green frogs; in 1848 he entered at St. George's Hospital, and in 1854 was gazetted Assistant-Surgeon to the second Life Guards.

The next eight years were very pleasant ones. His father's position as Dean of Westminster threw open to him all the best society in London: we read of parties at Miss Burdett-Coutts's, at the Duke of Wellington's, at Chief Baron Pollock's; microscopic evenings at Dr. Carpenter's; walks around the Abbey with Prince Albert; conversations with Sir B. Brodie, Mr. Gladstone, Whewell, Whately, Prof. Owen, Sedgwick, Bunsen, Ruskin. He was beginning to feel his strength and strike out his line in life; in these years he wrote his first magazine article, delivered his first lecture, published his first book. In 1865 he resigned his commission, married, took the house in Albany Street which he has made historic, started *Land and Water*, devoted himself to fish culture, became Inspector of Fisheries, and worked in his vocation till 1880, when he died at the age of fifty-four, worn out by excessive overwork and by the exposure to wet and cold in all seasons which his professional duties, as he interpreted them, involved.

His power as a lecturer was unrivalled. He could keep an audience in ecstasies of laughing enjoyment for two hours at a stretch. He had inherited his father's remarkable felicity of illustration; his own keen delight in his subject was contagious, his comedy incessant and irresistible. Never was a memory more stored with interesting facts. He was all eyes; noted everything, remembered everything, used everything. Through London streets, as he surveyed them from his favourite seat on the knife-board of an omnibus, on the walls of exhibitions, on sea-coast, river-shore, and hill-side, in the belfry at Ross, by Dean Gainsford's grave—phenomena which others overlooked or passed as trivial were by him pounced upon and analysed and made to bear fruit in discovery and correlation and historical association and practical scientific use. Of human prodigies in every department he was the recognised Proxenus and patron. Miss Swann the giantess and her husband Captain Bates the giant, and the Two-headed Nightingale, and the Siamese Twins, and the New Zealand Chiefs, and Fatima, and Zariffa, and Julia Pastrana the hairy woman, and Benedetti the sword swallower, and the Wild Man of the Woods, and the man who could sing two notes at once, and the man who could drink a bottle of milk under water,—all looked up to him as a father, or sat as guests at his table. He came by degrees to be accepted as an *Arbiter monstrorum;* as the necessary referee whenever any strange revelation or any novel puzzle presented itself in the world of nature. If a whale ran on shore at Gravesend, or a dolphin at Herne Bay; if an unusual sturgeon or tunny was consigned to a London fishmonger; if the lawyers at Nisi Prius were at issue whether a hole in a ship's bottom could have been made by the beak of a swordfish, or the Gloucester Magistrates hesitated over the identity of elvers with young eels; if a sick porpoise arrived at the Zoological Gardens in a condition requiring brandy and water to be exhibited internally and caustic applied without; if the Chief Rabbi felt searchings of heart as to whether oysters might for edible purposes be inserted in the Mosaic catalogue of things that creep; if a sea-lioness were ill in the Aquarium, or a plague of frogs occurred at Windsor; if search were required for John Hunter's coffin in St. Martin's Church, or the skeleton of William Rufus had to be exhumed in Winchester Cathedral,—it was inevitable that Frank Buckland should be telegraphed for first of all. And the influence he exerted was often highly beneficial. To his interference we owe the close time for seals and the Bill for the preservation of marine birds. A description in *Land and Water* of a neglected Museum at Canterbury shamed the Curator into setting it to rights; his good-humoured criticism, from a naturalist's point of view, of the pictures in the Royal Academy, taught the artists beneficially that an eye as keen as Ruskin's was noting their performances in a region beyond Ruskin's reach.

His home in Albany Street was one of the sights of London; but to enter it presupposed iron nerves and a stomach like those of Horace's reapers. Iron nerves—for, introduced at once to some five-and-twenty poor relations, exempt from shyness and deeply interested in your dress and person, to Jacko, and the Hag, and the Nigger, and Jenny, and Tiny, and the parrot and the jaguar, and the laughing jackass, and Jemmy the suricate, and Dick the bear, and Arslan the Turkish wolf-dog, you felt, like Jaques in the play, as if another flood were toward, and the animals were parading for admission. Dura ilia—for the genius of experiment, supreme in all departments of the house, was nowhere so active as at the dinner-table. We read of panther chops, rhinoceros pie, bison steaks, kangaroo ham, horse's tongue, elephant's trunk; of whale boiled with charcoal to refine the flavour; of tripang and lump-fish; of stewed whelks and land-snails, roasted hedgehog, potted ostrich. We notice in the diary such entries as "seedy from lump-fish;" "very poorly indeed, effects of horse;" and we sympathise with a departing guest who notes—"tripe for dinner—don't like crocodile for breakfast."

He was the Samson of science; the "Sunny One" amongst *savants*, as was Manoah's son amongst judges; roars of genial laughter accompany the heroism and the feats of both. But the comic recollections which surround him ought not to mask the serious admiration which is his due;—first, as a public teacher, circulating popular science, generating field clubs and microscopical societies, preparing a public to appreciate and to support the more purely scientific labourer; secondly, as a material benefactor, raising in fifteen years the commercial value of English and Scottish salmon to the extent of 100,000*l.* per annum; thirdly, as having in a manner rare, if not unique, passed behind the veil which hangs between us and the animal creation. He understood their gestures and expressions as we interpret those of one another, and they understood him in their turn; the creatures at the Gardens, the beasts at Jamrach's, the pets at home, seemed to know him in a human fashion; his dying words—"God is so good to the little fishes that I do not think He will let their inspector suffer shipwreck at the last"—show his identity of feeling with them; no one could talk to him long without a strangely new and reverential sense of brotherhood with these existences who were to him so entirely fraternal as people of his Father's pasture and sheep of his Father's hand. Science has had very many greater sons; none more simple, modest, blameless; none more genial, more humane, or more beloved. W. TUCKWELL

COMPENSATION OF COMPASSES

Practical Guide for Compensation of Compasses without Bearings. By Lieut. Collet, French Navy, Tutor in the Polytechnique School of France. Translated by W. Bottomley. With a Preface by Sir W. Thomson, F.R.S., &c. (Portsmouth: Griffin and Co., 1885.)

THIS work appears in its English garb under the auspices of Sir W. Thomson.

In the published instructions for the adjustment of his patent compass, Sir William Thomson gives short directions for the use of the deflector, an instrument to facilitate correcting that compass by magnets and soft iron when neither bearings of sun nor terrestrial objects can be obtained. With this deflector a fog is not the unwelcome visitor it generally is, for with the fog there is often a smooth sea, a condition favourable to a successful use of this delicate instrument.

As an invention of Sir W. Thomson it is certain that the inquirer into the use of the deflector will at once be disposed to look for an instrument theoretically correct in conception and of great refinement in construction. The useful work of fully describing the practical applications and several uses of this instrument has, however, been left to an able writer on subjects connected with the compass in iron ships—Lieut. Collett, of the French Navy—and the book now under review is the result.

It may be remarked that Sir W. Thomson, in the preface, fully recognises it as a complete and able exponent of the uses of this deflector, which is an important point to those desirous of using the instrument.

In four chapters of his Practical Guide M. Collet has given, in detail, practical rules for correcting the errors of the compass without bearings, illustrated by numerous examples, and including instructions for the graduation of the deflector, or measuring the magnetic force for each division of its scale. Collected in a tabular form, the results of this graduation will be found of great use to observers, and of the five advantages arising from it enumerated by the author, not least is that which gives an approximate value of the coefficients of deviation. This would prove useful when the observer, wishing to leave the magnets undisturbed, required only to know if any change of deviation had taken place.

Another advantage of this graduation is that it forms an additional method of measuring the diminution of the mean directive force of the compass on board ship as compared with that on land, or the term λ of the text-book. λ is a necessary element in the exact correction of the heeling error—a part of the correction to which the author devotes a chapter, as it rightly comes under the denomination of a compensation requiring no bearings.

Lieut. Collet, in his introductory chapter and elsewhere, strongly urges that the deflector, concerning the uses of which he has written so fully, should in the immediate future become the chief instrument used in the compensation of compasses, on account of the rapidity and sufficiency of precision with which it may be made, and that it be adopted for frequent if not daily use on board ships at sea. Before remarking on this proposal it may be as well to inquire into the present customs with regard to the standard or navigating compass at the time of its first compensation and subsequent changes of deviation.

In the Royal Navy the adjustment of compasses is invariably made by bearings, and the instances are rare when the adjustments of the standard compass alone, including the final swinging of the ship, occupy more than an hour or two with results absolutely correct. Subsequently to this one adjustment the compensating magnets are not moved during their three or four years' period of service, but the deviations of the compass are carefully observed on all occasions when bearings can be taken—in other words, from day to day—and noted for guidance when bearings cannot be taken. In the Mercantile Marine a large number of ships are fitted with Sir W. Thomson's standard compass with the accompanying magnets adjustable at pleasure. This compass is often compensated by experts in the use of the deflector and the magnets left in a given position.

Now, what is the almost universal practice of the commanders of these vessels subsequent to this adjustment by means of the deflector? They observe the deviation frequently by day and night when possible, note the results in a compass journal for present and future guidance, and object most strongly to any alteration of the magnets.

In the paragraph headed "Weather" it will be seen that a moderately smooth sea is required when using the deflector, and in another place it will be seen that it is no certain guide to navigation unless observations are made on all the cardinal points. The question therefore arises, Are the necessary conditions for using this instrument often available in the North Atlantic and "roaring forties," when bearings are at times unobtainable for some days?

The result of the foregoing consideration is to show that there is long custom of very practical men—and possibly prejudice—to overcome before Lieut. Collet's future of frequent use of compensation without bearings becomes general.

The nautical world has had the deflector as invented by Sir W. Thomson before it for some years; it now has an excellent practical guide to its use in the book under review, and it remains to be seen how far that world will avail itself of the invention.

It may probably suggest itself to some minds that the book would lose none of its value by being shortened somewhat in detail; indeed, the shorter the better, if combined with accuracy for the practical navigator, and should a new edition be required the translator who has done his part well, and knows the deflector thoroughly, will perhaps try his hand at the work of condensation.

THE FORBES MEMORIAL VOLUME

In Memoriam. The collected Scientific Papers of the late William Alexander Forbes, M.A., Fellow of St. John's College, Cambridge, Lecturer on Comparative Anatomy at Charing Cross Hospital, Prosector to the Zoological Society of London. Edited by F. E. Beddard, M.A., Prosector to the Zoological Society of London. With a preface by P. L. Sclater, M.A., Ph.D., F.R.S., Secretary to the Zoological Society of London. (London: R. H. Porter, 1885.)

THE death of Alfred Henry Garrod at the early age of thirty-three was a great misfortune to the cause of zoology in this country. But that his distinguished successor, William Alexander Forbes, a man full of vigour and in the best of health, should have suddenly succumbed to the influence of a pernicious climate at the age of twenty-eight, was perhaps a still more severe blow, and one that will long be felt by the naturalists of the present day. We do not seek to compare Forbes with Garrod, but it must be recollected that Forbes was a man of undoubtedly strong physique, for whom there was every prospect of a long and successful career. There can be not the slightest doubt that, had he not lost his life from the accidental force of circumstances, Forbes would have left a considerable mark on the progress of science As regards natural history at least, if not in some other matters, Forbes was a universal genius. Of the whole zoological series he had an enormous knowledge, ranging from one end of the animal kingdom to the other. Possessed of a most retentive memory and of an abundant stock of energy, he was unremittingly at work on his favourite subject, and never forgot what he had acquired either by reading or by experience. Not only was he thoroughly up in zoological literature, but he was also an accurate observer and a diligent collector in the field, where nothing came amiss to him. Mammals, birds, butterflies, and beetles were perhaps the groups which he knew best; but Forbes had, as already stated, an excellent general knowledge of the whole animal series. Whatever novel object might be shown to him he was very rarely at a loss for its correct name, nor for where to refer to for information about it.

It can thus be well understood, even by those who never had the good fortune to know Forbes, that the loss of such a man was keenly felt by his numerous friends and fellow-workers. Soon after his death, in 1883, it was resolved, at a meeting of the Zoological Club, that some sort of memorial of him should be carried out. After due consideration of the question it was unanimously determined by the Committee to whom the subject was referred that the best scheme would be the republication of Forbes's numerous papers in a connected form. This had been the course adopted in the case of Garrod, who had preceded Forbes in the Prosectorship of the Zoological Society of London. It was found that Forbes's contributions to science would make a volume of about the same size as the scientific papers of Garrod, and would not, it was believed, be of inferior interest.

The memorial volume, prepared and issued under these circumstances, contains sixty-seven papers published by Forbes in different periodicals from 1875 to 1882. The original illustrations have been in every case reproduced, and to increase the usefulness of the reprint, exact references to the paging of the original articles are added in the margin. At the end of the volume is given Forbes' last journal, reprinted from the *Ibis* for 1883, and containing a most interesting account of his observations during his fatal expedition up the Niger. Forbes died at Shonga, one of the stations of the United African Company on that malarious river, on January 14, 1883. Up to two days before his death the entries in the journal are in his own writing. The fatal termination of his illness, recorded by another hand, concludes the volume.

OUR BOOK SHELF

Elementary Algebra for Schools. By H. S. Hall, B.A., and S. R. Knight, B.A. (Macmillan, 1885.)

THIS is, in our opinion, the best *elementary* Algebra for school use. It is the combined work of two teachers who have had considerable experience of actual school teaching, aided by the advice of such men as the present Head of Clifton College, and so successfully grapples with difficulties which our present text-books in use, from their authors lacking such experience, ignore or slightly touch upon. Up to the point to which the subject is carried in this volume, it is treated with sufficient completeness for ordinary school purposes: the last four chapters present a somewhat concise account of ratio, proportion, and the progressions, which, however, covers enough ground for the ordinary examinations which schoolboys have to encounter. The authors propose to treat these parts in fuller detail in a *Higher Algebra*, which they are preparing. We do not propose to examine the book at any length, but confidently recommend it to mathematical teachers, who, we feel sure, will find it the best book of its kind for teaching purposes. Many subjects of interest are also treated of, and a vast collection of (3500) examples will furnish ample exercise for the boys, and save the teacher the trouble of concocting illustrations of the best methods. Answers are furnished at the end, so that those teachers who do not care that their pupils should have them handy, may have them sewn up.

Key to the Elements of Euclid. By J. S. Mackay, M.A. (W. and R. Chambers, 1885.)

THIS is a most valuable pendant to the edition of the "Elements" which we recently had occasion to notice so favourably. It is a book of nearly the same size as the "Elements" and yet contains, in consequence of the general omission of diagrams, solutions of the very large collection of admirable deductions which Mr. Mackay collected for the student in that work. De Morgan's words, quoted in the short preface, furnish ample ground for the omission of figures: "I am satisfied, from sufficient trial, that when proper description of the diagram is given in the text, the person who draws his own diagram from the text will arrive at the author's meaning in half the time which is employed by another to whom the successive appearance of the parts is prevented by his seeing the whole from the beginning."

The Essentials of Histology. By E. A. Schäfer. (London: Longmans, Green and Co., 1885.)

THIS will prove a useful book for students. It is arranged in forty-two lessons and appendix. Each lesson commences with a short statement of methods for the microscopic examination of the tissue described in the lesson. All simple tissues and organs are thus passed in review, and their most essential characters are succinctly described and illustrated. It is to be regretted that Prof. Schäfer has deviated from the customary plan of giving some kind of reference both for the text and the illustrations. The latter are mostly taken from Prof. Schäfer's portion of Quain's Anatomy, and their original source, although mentioned in Quain's, is here omitted.

An index at the end of the book would be a desirable addition.

E. KLEIN

An Atlas of Practical Elementary Biology. By G. B. Howes. (London: Macmillan, 1885.)

THE anatomical drawings of Mr. Howes have for some years been well known in all laboratories where animal morphology is taught. In his "Atlas of Elementary Biology" he has now published a very complete series of figures illustrating the chief of those animal and vegetable types which are generally given to students in their first session. The need for such a work as this is well known to every one who has any experience of biological teaching; and the name of its author is a sufficient guarantee of the careful accuracy and artistic excellence of the drawings it contains. The low price at which a student's text-book must necessarily be sold has precluded the use of colour, which might in a few cases have given some additional clearness to the figures; but all that could be done with black and white has been done, and every figure is evidently a faithful copy of an actual dissection, such as a student may reasonably hope to repeat for himself.

In the case of every animal chosen, a series of drawings showing the gross anatomy of the adult is followed by a few illustrations of the minute structure of its tissues, and of its main developmental features.

The drawings of adult anatomy are throughout excellent; the others, though the size of the work has somewhat restricted their number, will probably suffice for most of the needs of commencing students. It is however to be regretted that there is no figure showing the minute structure of the gill in Anodon, and also that Mr. Howes has not been able to accept Spencer's statement as to the conversion of the frog's blastopore into the permanent anus.

The botanical portion of the Atlas contains an admirable series of figures, showing the structure of the plants described in Huxley and Martin's well-known text-book, and completes a work which cannot fail to be of the greatest service both to teachers and to students of biology.

W. F. R. W.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Radiant Light and Heat

I AM sure that all students must be grateful to Prof. Balfour Stewart for his exposition in last week's NATURE (p. 322) of the errors and absurdities into which recent scientific men had fallen, and out of which they are now groping their way. But if it be not trespassing too much on his good nature, may I ask him one or two questions in order to further educe his views on points which he cannot but have given much thought to, though they are points which, without further explanation, some of us are liable to misunderstand. We have some of us had the "advantage of being wrong first," combined with the further advantage of thinking ourselves right, but I for one will now gladly admit that I was wrong, if I may thereby hope to join "the generation which is right."

The following are the five points I wish to receive help in understanding:—

(*a*) "It is absurd to suppose that particles of air are shot . . . with a constant velocity of 1100 feet a second."

I am disposed to agree; but am unable to see clearly how far this absurdity destroys the validity of the so-called "kinetic theory of gases," and of the mode in which sound is considered to be conveyed by such a medium, if indeed it is still so considered at all.

(*b*) "Can it be thought that hot bodies emit myriads of very small particles, which pass through space with the enormous velocity of 187,000 miles per second? Or again, is it likely that this velocity should be precisely the same for all bodies and for all temperatures?"

I should say it was highly *un*likely, in fact, that the idea is ludicrously absurd. This is a triumphant refutation of the corpuscular theory, but I am rather troubled by the thought that the argument seems equally to refute the wave-theory, if for "particles" in the above sentence, we substitute the word "waves." I know it is only my stupidity which causes me to feel this difficulty.

Again, it sometimes seems to me that the undulatory theory itself requires a good deal of "propping up;" and that several phenomena—for instance, "aberration"—explain themselves more easily and simply on the corpuscular.

(*c*) In speaking of the "transmutation of *visible energy* into heat," we are surely justified in calling heat "*invisible* energy" in contradistinction to the other; but, suppose the blow is so intense as to make a flash, are we to consider that flash as part of the invisible energy which has been "created," or are we to consider it a portion of the visible energy which has escaped destruction? The notion of a certain quantity of visible energy disappearing from the universe at one place, and an equivalent quantity of invisible energy being simultaneously created at another, is so beautifully simple and satisfying that I am sure the process can be made quite clear to any mind of common intelligence with a little more trouble.

(*d*) "This train of thought enables us . . . to assert that there is a definite mechanical relation between the amount of heat which leaves a hot body as it cools, and the radiant energy which accompanies the act of cooling."

I fear I am too stupid to understand this sentence. As I read it, it sounds like the following:—"There is a definite mechanical relation between the number of people which leave a train as it empties, and the number of people who get out of it and go away during the act of emptying." And the paragraph seems to go on thus:—"If, for instance, ten people get out of a train, and all of them enter an omnibus so as to be entirely absorbed by it, then, while the train has become ten people emptier, the omnibus has gained an equal number and has become ten people fuller."

I know that this is absurd, but I am unable to seize the point properly, and therefore venture to put my difficulty in this plain and outrageous way.

(*e*) "Radiant heat is physically similar to radiant light, the only difference being that its wave-length is greater, and its refrangibility less, than those of light."

May I ask if it is known *how much* greater "the wave-length of radiant heat" is than "those of light"? The modern distinction between them is evidently so simple and numerical that it must be possible to definitely draw the line and to specify the exact wave-length which characterises each, or at any rate which partitions the one from the other.

Similarly it would be a help to us students to have the refrangibility of radiant heat specified and distinguished from those of light, too.

There are one or two other matters concerning which I should have been glad of further information; but I will not now trespass further upon your space or upon the good nature of the professor.

A STUDENT

IN reply to the remarks of a student I may state as follows:—

(*a*) In the kinetic theory of gases the pressure of a gas is regarded as being due to a bombardment by the molecules of the gas, and the velocity of sound in any gas can by this theory be shown to be definitely related to the velocity with which these molecules move about.

(*b*) It is no doubt true that the demonstration of "aberration" on the corpuscular theory of light is of a simpler nature than its demonstration on the undulatory theory, but I have yet to learn that the geometrical simplicity of a demonstration is always a characteristic of truth. The question is rather, Can "aberration" be shown to be a legitimate consequence of the theory of undulations quite apart from the mathematical difficulty or easiness of demonstration? If the demonstration is *valid* its *easiness* can wait.

(*c*) While admitting that our nomenclature regarding energy is of a temporary nature, I have hitherto confined the term "invisible energy" to that kind of energy the motions constituting which are on so small a scale and so rapid that they cannot by any means be rendered visible. No doubt we see a red-hot body, but we do not and cannot see the motions of the individual molecules of the hot body.

(*d*) The train of thought referred to was that which concluded that the particles of a hot body (like those of a sounding body) are in a state of vibration and (in both cases) communicate their energy of vibration to a medium which surrounds them. It is thus a question regarding energy, therefore a mechanical question, and we are thus entitled to assert that there is a definite mechanical relation of equivalence in energy between the amount of absorbed heat which leaves a hot body as it cools and the radiant energy which accompanies the act of cooling.

We have now so clear and definite a conception regarding energy that "A Student's" simile of a train and an omnibus represents the truth, and it may perhaps look a trifle ridiculous to assert such an obvious equivalence. But my remarks were partly historical, and to the physical student of a past generation the equivalence would not be equally clear. The meaning is that the radiant heat and light given out by a body when cooling, measured in any way you like and used up in any way you like, will always be mechanically equivalent to the amount of ordinary heat which the body has lost.

(*e*) Your correspondent asks how much greater the wave-length of radiant heat is than that of light. Let me refer him to a diagram which was given in a recent number of NATURE in illustration of a lecture by Prof. Langley, and which will likewise be reproduced in the course of this present series of articles.

BALFOUR STEWART

Pulsation in the Veins

THE writer of a very long and exhaustive article on "The Heart," occupying forty-one pages in Rees's "Cyclopædia," quotes, among other authorities, Bichat, who says "that the blood, when it has arrived at the veins, is no longer influenced by the heart's action; *consequently these vessels have no pulsation*" . . . "that the blood's return in the veins is involved in an obscurity;" and he propounds as a "contrast" "the fact of general pulsation in the arteries, the absence of this in the veins." The writer of the article states that "many authors, particularly Haller, considering that this [the venous] system has no agent of propulsion, have ascribed to the veins some peculiar structure" of which the evidence is insufficient; also "that there is no analogy to the course of the blood in the arteries where the action of the heart produces the whole effect," and adds: "There is much obscurity on the subject, as well as in the course of the blood in the general veins; and every judicious mind cannot fail to observe that there is a great vacuum to be filled up."

The object of this paper is to contribute to the solution of this mystery—first by proving that there *is* pulsation in the veins, and that therefore the heart's action *is* directly concerned in the return of the venous blood, and secondly, by suggesting the mode in which it is exerted.

I had observed that, on very close and careful inspection, there was in the veins (in those at the back of the hand, for instance) a visible though exceedingly delicate pulsatory undulation; but so minute that I have generally (but not always) failed to show it to others. It therefore became desirable to devise some means by which the fact might be made more manifest.

In the first instance I requested a lady, who was unable to perceive any pulsatory movement in the veins on the back of her hand, to feel and silently count her own pulse while I counted aloud the beats as indicated by what I could perceive in those veins. She was surprised to find that my counting corresponded exactly with hers, but observed that the beats of her pulse came intermediately and *alternately* with my counting. This I had not thought of or suggested. But it is, in fact, what would be the necessary result of the heart's action, and corresponds with its *alternate* contraction and dilatation.

In order to make more evident this venal pulsation the following experiment was successfully tried:—A small piece of silvered glass (about ⅜ inch by ¼ inch) was made to adhere to the surface of a swollen vein on the hand in such manner that *one* edge of the glass rested on the central ridge of the vein, while the other was in contact with the surface clear of the visible vein by the side of it. This, applied in the sunshine, of course afforded a spot of light, the movement of which reflected from the mirror, would indicate the slightest tilting of its plane by the undulating action of the vein, and the result was beautifully conclusive. The light spot vibrated in accordance with the pulse, and its vibrations were in the direction which corresponded with the tilting which should be the result of the position of the mirror in relation to the vein. Then a second mirror was applied on the *opposite* side of the vein, and the vibrations of the light spot took an *opposite* direction, which was to be expected, as the result of a tilting anticlinal to the first. A mirror placed on the knuckle (where are no veins of sensible importance) showed no sensible vibration. Thus the objection which I anticipated, that the vibration of the light spot might be caused by the general response in the limbs to the ordinary arterial pulsation, is answered by the evidence that a varied position of the mirror in respect of an individual vein was productive of a correspondingly varied motion of the light spot.

If, then, it is proved that, notwithstanding all previous authorities (to which I have had access), pulsation in the veins does exist, pulsation corresponding in rhythm with that of the arterial system, it becomes a corollary that the heart's action *does* extend to the motion of the blood in the veins, and an evident solution of the mystery of the return of the blood from the extremities appears to result. The expulsive effect of the heart's contraction is familiar, but the effect of its expansion, much in consequence of the venous pulsation having been unseen and denied, has been, as far as I know, ignored. Every one knows how an indiarubber ball syringe is filled by its expansion after compression. Apply this analogy to the expansion of the heart, and the return of the venous blood, the valves in the veins cooperating, would be equally certain. But this involves the existence of a corresponding venal pulsation, the supposed absence of which supported the theory that the direct action of the heart was limited to the arterial system.

I add some directions for the successful trial of the mirror experiment. The pulsatory motion is very small, and the action of neighbouring veins seems to cause parts of the surface to be neutral in respect of the displacement of the plane of the mirrors. It is, therefore, desirable to search experimentally for the best place for them; that is, where the resulting displacement becomes most evident; also the use of some sort of vigorous movement of the body or limbs, such as would cause a general exaggeration of the heart's action, naturally causes the vibrations of the light spot to become more conspicuous. The hand should be supported in the most steady manner, otherwise the pulsatory vibration becomes mixed up with an indefinite movement of the light spot due to general unsteadiness. The mirrors should not be more than ⅜ inch square or thereabouts. The silvering is liable to be detached from the glass by adhesion to the skin, if the glutinous substance is applied directly to the back of the mirror; to prevent this its back and edges should be covered with thin gummed paper (such as the margin of a sheet of postage stamps affords). This protects the silvering, so that the mirrors may be used repeatedly, and their position changed as often as may be required; whereas without this precaution they may be spoilt on the first application. Any sticky glutinous substance which does not dry readily (such as indiarubber dissolved in mineral naphtha) is convenient, because by its use the mirror may be with the least trouble shifted from one spot to another, in the search for a place where the venous pulsation is most visibly effective; and this will not always be found exactly where from the appearance of the veins it might be expected to occur. J. HIPPISLEY

Stoneaston Park, Bath, August 10

The Fauna of the Sea Shore

IN the recent correspondence in NATURE on the "fauna of the sea shore," an ambiguity has arisen in the use of the term "littoral."

I, following Prof. Moseley, on whose lecture I was commenting, used the word in the extended sense of describing areas and faunas that were neither "deep-sea" (in the modern acceptation of the term) nor "pelagic." Mr. Hughes, on the other hand, has employed it in its common acceptation as descriptive of the shore area between tide marks.

The portion of the sea-bottom disturbed by waves has at present no term told off to describe it. It is not necessarily "littoral" in any sense, as that word will not cover the case of sand-banks far from the coast; such, for instance, as the banks of Newfoundland, where, according to both zoological and nautical evidence the waves act strongly on the sea-bottom. Some such term as "undal zone" might be used to describe those marine areas where the waves can sensibly affect the fauna.

The downward limit of this undal zone has not, I believe, been hitherto defined. In the case of oscillating waves (the ordinary ocean waves) 50 fathoms seems to approach the practical limit of disturbance, but, according to the evidence of marine charts, the waves appear to make themselves felt at greater depths.

In the late Mr. R. A. C. Godwin-Austen's map of the English Channel (*Q. J. G. S.*, vol. vi. p. 96), the following deposits are indicated, viz.:—

40 to 50 fathoms, fine granite shingle with fragments of *Haliotis tuberculata*.
50 to 60 fathoms fine granite shingle with fragments of *Patella vulgata*.
70 to 80 fathoms, coarse sand and gravel, with decayed *Patella vulgata*.
90 to 100 fathoms, coarse sand, fine gravel, *Cardium edule*, *Turbo littoralis*, and *Patella vulgata*.
Outside 100 fathoms, very fine shell sand, *Pecten varius*, *Cardium edule*, *Patella vulgata*, and *Turbo littoreus*.

Referring to one of these collections of shells (in upwards of 90 fathoms) between Ushant and the Little Sole Bank, the distinguished author remarks:—"Taking the two phenomena together, the occurrence of littoral shells and of marginal shingle, we may safely infer that we have at this place the indication of a coast line of no very distant geological period, buried under a great depth of water, and removed to a great distance from the nearest present coast-line."

The fact that shells are perishable owing to decay, corrosion, and the ravages of marine organisms, seems to me to militate against the probability that the shells in question are of geological antiquity; and their occurrence in connection with sand and shingle instead of mud would rather indicate the present action of currents strong enough to keep the sea-floor clean. This ordinary tidal currents cannot do, though wave and tidal currents combined can.

Under the joint influence of storm waves and storm-engendered currents, light shells may well travel down the channel bed to 40 or 50 fathom soundings. Theory and observation agree in the efficacy of wave and current to this extent. But to account for the presence of fresh littoral shells in 100 fathoms, we require the assistance of waves of sufficiently long period to affect the bottom at that depth, and to this extent theory in the case of ordinary ocean waves will not go.

In a paper submitted last year to the Dublin Society (*Proc.*, vol. iv. p. 241) I recorded observations of waves with an average period of 3½ minutes, and suggested that these waves arose from wind pressure on the surface of the sea; it would be interesting to know at what depth such very long, though irregular, waves would be capable of disturbing light deposits on the sea-bottom. In sheltered localities I have seen these waves attain the height of about three feet; in exposed localities they would doubtless be higher. ARTHUR R. HUNT

August 15

On the Terminology of the Mathematical Theory of Electricity

IN a letter (NATURE, vol. xxxii. p. 76) Mr. W. J. Ibbetson invites suggestions for a convenient abbreviation for "total or resultant pressure"; at the same time he suggests the adoption of "traction" for "intensity of tensile stress." As it seems a pity to employ two totally distinct words to express such closely related ideas as intensity of tensile stress and total tensile stress, I would suggest that, on the analogy of pressure, "*tensure*" should be introduced for "intensity of tensile stress;" and then, on the analogy of "tension" for "total tensure," "*pression*" for "total pressure." New words are hard to grow in a language, but in this case pressure and tension might interchange their suffixes as grafts and yield two fresh useful words.

As regards physical and mathematical terminology in general, is not the time ripe for the introduction of a prefix which will modify the meaning of a term as the adjective "negative" does? *Mega* and *micro* have proved useful for multiplying and dividing by a million, but how much greater scope would there be for a prefix "ne" or "neg" for reversing the sign of a quantity. Thus negative electricity might be called "*nelectricity*," a quantity of negative electricity as so many "*necoulombs*," a negative magnetic pole as a "nepole," a negative potential as of so many "nevolts," a negative angle could be spoken as of so many "negradions" or "nedegrees," a negative temperature as of so many "nedegrees." In many cases there would be no appreciable advantage, but if there was a general understanding as to the operation of the prefix "ne" in any case, it could be used wherever it would render the phraseology less cumbersome.

Melbourne, July 10 WILLIAM SUTHERLAND

An Encysting "Myzostoma" in Milford Haven

I HAVE recently had occasion to examine a number of *Comatulæ* from Milford Haven which were kindly given to me by Mr. W. Percy Sladen, F.L.S., and appear to belong to the type that was figured by Miller under the name of *Comatula fimbriata;* and I was surprised to find many of the pinnules presenting distinct traces of an encysting *Myzostoma*. In each of the dozen individuals the joints of one or more pinnules are abnormally developed, and in some cases they form definite cysts, which are, however, much smaller than those found on the pinnules of many *Comatulæ* and *Pentacrinidæ* from the Pacific and Oceania; but they are obviously of the same character and due to the presence of a parasitic *Myzostoma*. According to Prof. L. von Graff eight species of encysting *Myzostoma* are at present known, but they are limited to depths of 120 to 600 fathoms in the Pacific, the Eastern Archipelago, and the Caribbean Sea, with the exception of one which was dredged by the *Hassler* in 35 fathoms off Cape Frio, Brazil.

Mr. Sladen's dredgings at Milford, therefore, have considerably extended both the bathymetrical and the geographical distribution of these encysting species. The five *Comatulæ* found in the British area have yielded six of the free-living *Myzostomas*, four of which were discovered by the *Porcupine* and *Triton;* and we may probably take it for granted that the encysting form from Milford is another addition to the British fauna.

I propose to send all my material to my friend, Prof. von Graff, for examination; and as there will, no doubt, be much shore-dredging carried on during the next few weeks, I would call the attention of British naturalists to the facts mentioned above, and ask them to look carefully on the pinnules of any *Comatulæ* which they may find for cysts or other enlargements of the joints. P. HERBERT CARPENTER

Eton College, August 22

Solid Electrolytes

IN reference to Prof. S. P. Thompson's letter dated August 17 (NATURE, vol. xxxii. p. 366), may I be allowed to say that I too have observed the secondary currents which are produced by cells containing sulphides of silver and copper after being disconnected from a battery? I mentioned the fact at the meeting of the Physical Society on June 27, in a communication which will probably be printed in the *Phil. Mag.* next month. Indeed, the observation of these secondary currents preceded and led to the construction of the primary cells with solid electrolytes which I have recently described.

I should be glad to know whether Prof. Thompson can explain the curious effect produced by passing a battery-current for a moment through a cell containing a mixture of sulphide of copper and sulphur between silver electrodes. When the cell is first connected with the galvanometer the usual secondary current appears, but in a few minutes, or even seconds, this current falls to zero and is succeeded by a third, which is in the same direction as the battery-current, and generally continues for some hours. SHELFORD BIDWELL

August 23

THE SQUARE BAMBOO

THE cylindrical form of the stems of grasses is so universal a feature in the family that the report of the existence in China and Japan of a bamboo with manifestly four-angled stems, has generally been considered a myth, or, at any rate, as founded on some diseased or abnormal condition of a species having stems, when properly developed, circular in section.

Of the existence of such a bamboo there cannot, however, now be any kind of doubt. It is figured in a

Japanese book, the "Sô moku kin yô siû" (Trees and shrubs with ornamental foliage), published at Kyoto in 1829, and the figure is reproduced by Count Castillon in the *Revue Horticole* (1876, p. 32).[1] It is further figured in a work for a copy of which we are indebted to my friend Prof. Kinch (formerly of Tokiyo), called the "Ju-moku Shiri-yaku"—*i.e.* a short description of trees (of Japan). Finally, in 1880, Messrs. Veitch presented to the Kew Museum fine specimens of the stem of the square bamboo,

[1] The woodcut also appeared in the *Gardeners' Chronicle* for January 29, 1876, p. 147. I am indebted to the Editor for its use on the present occasion

brought from Japan by their intelligent collector Mr. C. Maries.

M. Carrière states, in an editorial note to Count Castillon's article, that the plant had been introduced into France at that date, and was indeed actually on sale in the nurseries near Antibes.

Nothing, however, till quite recently, appears to have been known as to the existence of the square bamboo in China,' from which country, however, it is extremely probable that the Japanese procured it. Thus, Mr. F. B. Forbes, whose personal knowledge of the Chinese flora is only second, perhaps, to that of Dr. Hance, informs me:—"I have never seen the square bamboo growing, and I have always supposed that its 'squarity' was artificially produced."

The first authentic account of its occurrence in China is, as far as I know, due to Mr. Frederick S. A. Bourne, of H.B.M. Chinese Consular Service. Mr. Bourne wrote to us, October 15, 1882, that he had made a journey from Foochow to a distance of 300 miles to the western border of the Fokien province, reaching Wu-i-kung, the celebrated monastery in the Bohea hills—a place, Mr. Bourne states, "only visited by a European once before, I believe—*i.e.* by Mr. Fortune, about the year 1845." In the gardens of this monastery he found several clumps of the square bamboo growing to the height of about eight feet.

The *Tropical Agriculturist* (an astonishing repertory of everything relating to the economic botany of the East) contains in its issue for November, 1882 (p. 445), an article extracted from the *North China Herald*, also relating to the square bamboo, plants of which, destined for the park at San Francisco, had been obtained by Dr. Macgowan at Wenchow. I extract from this article the following particulars, which show the interest the Chinese themselves attach to the plant:—

"Pre-eminence is assigned to the square variety of this most useful as well as ornamental plant, which has been a favourite in Imperial gardens whenever its acclimatisation has been effected in the north. The Emperor Kao Tsu once inquired of his attendants, who were planting bamboos, concerning the various kinds. In reply he was informed concerning several remarkable species. Chekiang in particular furnished one that was an extraordinary curiosity, in that it was square, and for that quality and its perfect uprightness was much esteemed by officers and scholars. They also told him that it was used for many purposes of decoration and utility, including, among others, that of being made into ink-slabs. Subsequently specimens were obtained, polished, and sent to his majesty, who thereon signified his respect for the article by rubbing ink with his own hand on the inkstand, and inditing an essay on the curiosity. In 650 A.D. the reigning Emperor sent a eunuch to Chekiang to obtain specimens for the Imperial Park. Besides being furnished from scattered portions of this province, it is found in Honan, Szechuen, Yunnan and Hunan; in the latter province it appears to present its peculiar characteristic in a marked degree, being as square, with corners, and as well defined as if cut with a knife. The Chekiang varieties have slightly rounded corners, and moreover they are more slender, being used only as pipe-stems, whereas the western kind is large enough to serve as staves for the aged. In its early stage of growth the square bamboo is nearly round, assuming the anomalous figure it afterwards presents as it advances towards maturity. Like several other kinds of bamboo it is thorny, abounding in small spines."

Dr. Macgowan being well known to botanists for his intelligent interest in all that relates to the vegetable productions of China, I ventured to write to him to ask his aid in procuring living specimens of this interesting plant for the Royal Gardens. Through his kindness and that of Mr. E. H. Parker, late acting consul at Wenchow, we were fortunate enough to receive a Wardian case filled with plants of the square bamboo, some of which at least appeared to be alive and likely to grow. Besides these Dr. Macgowan sent us specimens of walking-sticks and pipe-stems made from it.

I quote the following passages from the very interesting communication with which Dr. Macgowan was also good enough to favour us:—

"Its geographical range is from 25° to 30° N. latitude, littoral, and westward farther than I have been able to discover. Unlike other varieties of bamboo here, its shoots are developed in the autumn, not in the spring. It sprouts in September or October, and the stems grow until they are arrested by December cold, by which time they attain a height of from two to four or five feet. In the spring following their growth recommences, when the grass attains its full height, ten to fourteen feet. The lower portion of the culms bristle with short spines; in the second or third year their squareness is far less striking than when matured by several years' growth; that quality is sometimes so marked that a native botanist describes them as appearing like rods pared by cutting instruments. I have seldom found the corners much more sharply defined than in the largest of the specimens herewith transmitted. It is cultivated chiefly for ornament in gardens, in temple courts, &c.; the larger stems (sometimes as much as an inch and a half through) are used for staves; the smaller and less squarish for stems of opium-pipes; and the smallest and less mature for tobacco-pipes."

He further adds:—"Its anomalousness is attributed by the Chinese to supernatural powers—occult agencies varying with each district. The *Ningpo Gazetteer* tells how Ko Hung, the most famous of alchemists (fourth century A.D.), thrust his chopsticks (slender bamboo rods pared square) into the ground of the spiritual monastery near that city, which, by thaumaturgical art, he caused to take root and to appear as a new variety of bamboo—square."

As no flowering specimens of the square bamboo have reached the hands of botanists, its taxonomic position must at present be regarded as doubtful. Rivière ("Les Bambous," p. 315) refers to it as the *Bambou carré*, and Fenzi, quoting from Rivière (*Bull. Soc. Tosc. di Ort.*, 1880, p. 401), gives it the name *Bambusa quadrangularis*.

I can discover no reference to it in the late General Munro's classical monograph of the *Bambusaceæ* (*Trans. Lin. Soc.*, vol. xxvi.). Of the three groups into which he divides the genera, in only one, *Triglossæ*, is there any tendency to depart from the habit of the order in having anything but round stems; and this only occurs in the small genus *Phyllostachys*, in which they are somewhat laterally flattened. The stems of *Phyllostachys nigra* are often used in Europe for walking-sticks and light broom-handles.

But I do not think the square bamboo will turn out to be a *Phyllostachys*. Munro has a *Bambusa angulata* which is distinguished from all its allies by having the branches of the panicle angular. This is the only tendency to angularity of stem which I have discovered among the true *Bambuseæ*.

For the present, at any rate, the species must be known provisionally as *Bambusa quadrangularis*, Fenzi.

W. T. THISELTON DYER

FORECASTING BY MEANS OF WEATHER CHARTS

THE Meteorological Office has issued a work on the "Principles of Forecasting by Means of Weather Charts," which has been prepared at the request of the Council by the Hon. Ralph Abercromby.[1] The object of

[1] "Principles of Forecasting by Means of Weather Charts." By the Hon. Ralph Abercromby, F.R.Met.Soc. Issued by the Authority of the Meteorological Council. Official No. 60. 8vo. Pp. 123 + viii. London: 1885.

the author has been to give an account of the modern method of forecasting weather by means of synoptic charts; and although the general principles laid down hold all over the world, the details he gives refer only to Great Britain. The whole system of synoptic forecasting depends entirely on the observed association of different sets of phenomena, and is totally independent of any theory of atmospheric circulation.

The synoptic charts prepared at the Meteorological Office are constructed in the following manner. Every day at 8 A.M. and 6 P.M. telegraphic reports are sent up to London from about fifty stations in the United Kingdom, giving the readings of the barometer and thermometer, the direction and force of the wind, and the state of the weather. These readings are then plotted on a map, and the "isobars" and "isotherms" drawn, representing lines of equal pressure and equal temperature. The isobars are the most important element in forecasting. The direction of the wind is shown by arrows which have a number of "fleches" proportional to the force, while the weather is indicated by the letters of Beaufort's notation. While the force of the wind depends on the closeness, and the direction on the trend, of the isobars, the weather is governed by the shape of the lines. Although the shape of the isobars is continually changing, several well-defined forms are always reproduced. Seven of these are described, to which the following names have been given:—1. Cyclone—an area of low pressure, bounded by circular or oval isobars; 2. Secondary cyclone—a small, circular depression, subsidiary to the cyclone; 3. V-shaped depression—an area of low pressure bounded by V-shaped isobars, something like a secondary, but differing from it in many important particulars; 4. Anticyclone—an area of high pressure bounded by circular or oval isobars; 5. Wedge-shaped isobars—an area of high pressure bounded by isobars converging to a point like a wedge; 6. Straight isobars—a barometric slope, down which the isobars lie in straight lines; and 7. *Col* or neck of low pressure lying between two adjacent anticyclones.

Cyclones.—A cyclone may be of any diameter, from 100 to 3,000 miles. The most common are between 1,000 and 2,000 miles; and anything less than 1,200 miles across is a small one. The path of a cyclone is the path described by the centre. In this country 90 per cent. move towards some point of east, the most frequent direction being about east-north-east. The velocity is that of the centre; it may be anything from 70 miles an hour eastwards to 10 miles an hour westwards. About 20 miles is a common velocity, but sometimes a cyclone is stationary. The life of a cyclone is measured by the number of days during which it can be traced on synoptic charts; the length of life may be anything from a few hours to 20 days. The details of wind, weather, &c., in the different portions of a cyclone may be briefly summarised as follows:—The temperature is always higher in the front than in the rear; the warm air in the front having a peculiar close, muggy character, quite independent of the actual reading of the thermometer. The cold air in the rear, on the contrary, has a peculiarly exhilarating feeling, also quite independent of the thermometer. The front is always very damp, especially the right-front, while the rear is dry to a marked degree. The wind blows around the centre in the direction contrary to the motion of the hands of a watch; but as the direction is slightly inclined to the isobars, on the whole the circulation is an ingoing spiral. The amount of incurvature is usually greatest in the right-front, and least in the rear; so that sometimes the passage of the trough is marked by a sudden shift of wind. The force of the wind depends almost entirely on the gradients; in the centre it is a dead calm, and the steepest gradients are usually found at some distance from the centre. The direction from the centre in which the strongest winds are found depends on the position of the surrounding areas of high pressure.

There is no difference between ordinary weather and a storm, except in that property called *intensity*, and in this country a summer breeze and winter gale are equally the product of cyclones which differ only in intensity. Hence in forecasting storms it is necessary not only to foresee the arrival of a cyclone, but of one possessing sufficient intensity to cause a gale, and in tracking cyclones it by no means follows that the same one causes a storm during every day of its existence. Observation has also shown that a deepening cyclone is increasing in intensity, while one which is filling up is decreasing. When in watching the progress of cyclones by telegraph it is very important for forecasting to note changes in depth, as well as any other indications derived from the configurations of the isobars, or even from weather prognostics, which experience has shown to be associated with intensity.

Though the general characteristics of a cyclone are invariably maintained, still, individual cases vary much in detail. The principal sources of variation which modify, but do not alter, the general characteristics are:—1, the type; 2, the intensity; 3, the size; 4, local; 5, diurnal; and 6, seasonal variation.

Secondaries.—The secondary is a small cyclone formed on the side of a larger one which is called the "primary." Secondaries are almost invariably formed either along the prolongation of the trough of a cyclone, or else on that side of the primary which adjoins the highest adjacent pressure. The most important feature about them is the manner in which they deflect the isobars of the primary, so as to leave an area of slight gradients and light winds on the side of the secondary next the primary, and a line of steeper gradients and stronger winds on the side furthest from the primary. Their motion is usually parallel to that of the primary. The most striking difference between a secondary and a primary cyclone is the great amount of rain and cloud with absence of wind developed in the former, compared with the less rain and cloud but the stronger wind developed in the latter. In a secondary when the rain comes on, it is usually very heavy and falls straight; and in its general appearance and surroundings is very different from the driving or drizzling rain, so characteristic of the front of a primary cyclone. In forecasting, the principal indication of secondaries is rain, without much wind, and thunder-storms in summer; and their sudden formation very often unexpectedly disturbs and vitiates former forecasts. Sometimes several secondaries are seen on the chart; this is a sign of great intensity, and the indication in such cases is always for wild, broken weather, often with thunder-storms, but not for widespread gales.

V-shaped Depressions.—These are generally formed along the southern prolongation of the trough of a cyclone, or in the col or furrow of low-pressure which lies between two adjacent anticyclones. Their motion is generally eastwards along with their associated cyclone, but they are very often short-lived. They are entirely non-cyclonic. The line of the trough, along which the barometer rises, marks out the line along which the weather changes very abruptly, and this change is very often accompanied by a violent squall.

Anticyclones.—Anticyclonic isobars enclose an area of high pressure which is associated with fine weather and light winds circulating in the direction of the hands of a watch, but a little outcurved. The whole system is usually stationary for many days together. The general characteristics are a cold, dry air, and fine, or at least quiet, weather. The calms, or light winds, give free play to the radiation of the season, so that very hot days occur in summer and very cold nights and fog in winter. In forecasting, the indications are for settled fine weather, the details depending much on the season and local peculiarities.

Wedge Isobars.—These consist of isobars converging almost to a point, but enclosing an area of high pressure, instead of a low one, as in the case of the V's. The wedges seem to shoot up in front of cyclones and V depressions and to travel along before them. On the front, or east side, the weather is very bright, and the wind is north-west and moderate, while the temperature is that due to excessive radiation. On the rear, or west side, where the barometer begins to fall, the wind turns to south-west, and the sky overcasts in that peculiar manner which first gives a halo, and then gradually becomes black, without true cloud as the cyclone approaches. At the extreme north point of the wedge a shower or thunderstorm is sometimes observed.

Straight Isobars.—In these the pressure is high on one side and low on the other, without any definite cyclone, the isobars running straight across the slope which joins the regions of high and low pressure. Straight isobars are never persistent, and the area which they have occupied is usually traversed by a cyclone of greater or less intensity. For forecasting purposes the indications are for cool, cloudy, unsettled weather, the wind from moderate to fresh, according to the gradients, to be followed soon by rain, as a cyclone forms or comes up.

Cols.—The col consists of a neck of low pressure between two anticyclones. The wind is always light and the weather quiet, but variable in appearance, owing to the local influence of radiation. Though the general position is sometimes nearly stationary, the weather is rather variable, owing to the tendency of the depression which lies on the north-west to develop a secondary in the col. Hence in forecasting, though it is possible to tell what the weather would be in the col at any moment, the future course of the weather is subject to much uncertainty.

Mr. Abercromby devotes a considerable portion of his work to a discussion of weather-types and sequence. With reference to Western Europe, there are at least four well-marked types of weather: 1. The Southerly, in which an anticyclone lies to the east or south-east of Great Britain, while cyclones coming in from the Atlantic either beat up against it or pass towards the north-east. 2. The Westerly, in which the tropical belt of anticyclones is found to the south of Great Britain, and the cyclones which are formed in the central Atlantic pass towards the east or north-east. 3. The Northerly, in which the Atlantic anticyclone stretches far to the west and north-west of Great Britain, roughly covering the Atlantic Ocean. In this case cyclones spring up on the north or east side, and either work around the anticyclone to the south-east, or leave it and travel rapidly towards the east. 4. The Easterly, in which an apparently non-tropical anticyclone appears in the north-east of Europe, rarely extending beyond the coast-line, while the Atlantic anticyclone is occasionally totally absent from the Bay of Biscay. The cyclones then either come in from the Atlantic and pass south-east between the Scandinavian and Atlantic anticyclones, or else, their progress being impeded, they are arrested or deflected by the anticyclone in the north-east of Europe. Sometimes they are formed to the south of the north-east anticyclone, and advance slowly towards the east, or, in very rare instances, towards the west.

Mr. Abercromby next explains the use of various aids to forecasting, and gives some detailed examples of successful and unsucessful forecasts.

In concluding his work, Mr. Abercromby gives some remarks on forecasting generally, and points out that in many cases of small disturbances the minor features are so local that it is only the general character of the weather which can ever be forecast. Owing to the rapid nature of all meteorological changes, forecasts can never be issued very long in advance. The British forecaster labours under peculiar difficulties from his geographical position. Situated on the most outlying portion of Europe, and in the very track of storms which almost always advance from the westward, he has no intimation of an approaching cyclone till it is actually on him. Mr. Abercromby's opinion is that, however carefully the relation of weather to isobars may be defined and the nature of their changes described, the judgment which experience alone can give to enable a warning to be issued must ever depend on the professional skill of the forecaster.

RADIANT LIGHT AND HEAT[1]

II.

The Theory of Exchanges

It was known at a comparatively early period that if a body be placed in an enclosure of constant and uniform temperature, it will ultimately attain the temperature of this enclosure.

To fix our ideas, let us suppose that we have a chamber surrounded on all sides by walls which are kept at the temperature of boiling water (100° C.), and let us further suppose for the sake of simplicity that there is no air in this chamber, so that no heat can be carried about by movable particles of gas. If under these circumstances we put a cold body into the chamber, it will ultimately reach 100°, at which temperature it will remain. This is a statement of the doctrine of temperature equilibrium; but this equilibrium may be of two kinds—for it may either be a statical equilibrium, in virtue of which two bodies at the same temperature cease to radiate to each other, or it may be a dynamical equilibrium, in virtue of which each of these bodies independently radiates heat to its neighbour, receiving back, however, just as much heat as it gives out. In either case the ultimate result will be equality of temperature, and the only difference is with regard to the physical machinery by which this is brought about. In the theory of statical equilibrium the behaviour of two bodies of equal temperature with respect to heat may be compared to that of a man with respect to money who is getting neither richer nor poorer, because he is neither giving away nor receiving any money, whereas in the theory of dynamical or movable equilibrium the comparison is with the man who is getting neither richer nor poorer because he is receiving back just as much money as he is giving out.

Now, we are all of us conversant with frequent examples of individuals of this latter class, but the condition of things in this world is such that we cannot have any permanent example of the former, and similar considerations might convince us that if radiant light and heat be in reality a kind of energy, the theory of a movable or dynamical equilibrium must be much more suitable to such a constitution of things than that of a statical or tensional equilibrium. Historically, however, the question of temperature equilibrium was not decided by considerations regarding energy, our conceptions of which were not then sufficiently advanced to be of much service to those who were engaged in the discussion.

As the subject is one of great theoretical and practical importance, we shall proceed to give a short account of the circumstances attending the origin and development of what is now known familiarly as the *theory of heat exchanges*. About a century ago Prof. Pictet of Geneva made the following experiment:—He took two concave metallic reflectors, and, reversing the ordinary mode of procedure, put ice or a freezing mixture in the focus of the one and a thermometer in that of the other, upon which the temperature of the thermometer was observed to fall. This effect would at once be explained if we could suppose that cold was a substantial entity capable of radiation and reflexion like heat. But it was immediately recognised that such an hypothesis is quite inadmissible, and Prof. Pierre Prevost, also of Geneva, was thus driven to propose for the explanation of this experiment the theory of a movable equilibrium of heat.

It is very evident that such a theory will explain the

[1] Continued from p. 327.

fact. For, n accordance with it, bodies of the same temperature continue to radiate heat to one another, and hence the thermometer will radiate heat to the concave reflectors, which we may suppose to be of the same temperature as itself.

This heat will ultimately in great measure be reflected upon the ice or freezing mixture. Now, had this ice been of the same temperature as the other portions of the apparatus, it would have given back to the reflectors, and through them to the thermometer exactly as many heat rays as the latter had given to it.

But the ice being of a lower temperature, does not radiate back as many rays to the thermometer as this instrument gives out to the ice, and the temperature of the thermometer falls in consequence. It will be noticed that the same laws of reflexion and arrangement of mirrors that in the case where a hot body is placed in the one focus would have heated the thermometer in the other will, in the case of a cold body, cool the thermometer in the other; so that, without resorting to the unlikely assumption that cold is a separate principle, we may explain the above experiment on the supposition that bodies of the same temperature radiate heat to one another, or, in other words, on the hypothesis of a movable equilibrium.

Prevost's first memoir was in 1791, and in 1804 Leslie published his inquiry into the nature and propagation of heat. He there demonstrated the fact that good reflectors of heat, such as metals, were bad radiators. Prevost, in a treatise on radiant heat, published in 1809, showed that Leslie's conclusions followed from his theory, remarking that in a place of uniform temperature a reflector does not alter the distribution of heat, which it would do if it possessed at the same time the power of being a good reflector and a good radiator. Prevost seems to have entertained very correct views upon this subject, inasmuch as he conjectures that a good reflector is a bad radiator because, as it reflects the heat from without, so it also reflects the heat from within. Internal radiation, we shall afterwards see, follows as a consequence from the theory of exchanges.

Some time afterwards Dulong and Petit published their well-known memoir on radiation, which affords evidence of a peculiar kind in favour of the theory of exchanges. To illustrate the bearing of the experiments by Dulong and Petit on this theory, let us imagine that we have a hollow, blackened enclosure which is at the same time a vacuum, and that we have in its centre a large thermometer likewise blackened, the temperature of which is higher than that of the enclosure. We are supposed to be engaged in observing the rate of cooling of this thermometer, or, in other words, the excess of its radiation to the enclosure above that of the enclosure to it. Now let A denote the total radiation of the thermometer, which we may imagine to have the temperature a. Also let B denote that of the enclosure, which we may imagine to have the temperature b. Then $A - B$ will, by the theory of exchanges, represent the rate of cooling of the thermometer. In the next place let the thermometer have the temperature b and radiation B, while the enclosure has the temperature c and radiation C. Here $B - C$ will, by the theory of exchanges, represent the rate of cooling of the thermometer. Finally, let a be the temperature of the thermometer, and c that of the enclosure. Then $A - C$ will, on the theory of exchanges, represent the radiation or rate of cooling of the thermometer. Now $A - C = (A - B) + (B - C)$, that is to say, the rate of cooling in the third case will represent the sum of the two preceding rates *if the theory of exchanges be true*.

It was found by Dulong and Petit that this was actually the case, for with $a = 140°$ and $b = 80°$, $A - B$ was found to be 2·17.

Again, with $b = 80$ and $c = 20$, $B - C$ was found to be 1·40.

Finally, with $a = 140$ and $c = 20$, $A - C$ was found to be 3·56. Now this is very nearly equal to 3·57, or the sum of the two preceding rates, so that the evidence deduced from these experiments is decidedly in favour of the theory of exchanges.

In 1848 Provostaye and Desains made a definite advance towards a clearer conception of this theory. It may be stated thus. If we place a thermometer in our hypothetical chamber of constant temperature it is well known that the instrument will give the same indication, in whatever manner we alter the substance of the walls, provided only that their temperature be left the same.

It follows from this that the heat radiated, together with that reflected from any portion of the walls, forms a constant quantity independent of the nature of the substance of which this portion is composed. We thus see that it is not correct to assert that the reflective power of a substance is inversely proportional to its radiative power, the true statement being that in the case of an enclosure of constant temperature such as that we are now considering, the sum of the heat radiated and reflected from any portion is a constant quantity.

It was likewise perceived by Provostaye and Desains that this constant sum, while equal to that of a lampblack radiator, must be unpolarised, since heat from lampblack is unpolarised; and hence that, since the reflected heat is frequently polarised, the radiated heat must be polarised in an opposite manner, that is to say, in a perpendicular plane, in order that the sum of the two should be virtually unpolarised. Experimentally these observers found this to be the case.

It will thus be seen that the inquiry had now reached a stage at which a perfectly clear conception had been formed of the character with respect to intensity and polarisation of the heat emanating from any portion of the surface of an enclosure of constant temperature.

No attempt had however been made to split up the heterogeneous body of heat into its constituent wavelengths, nor was it perceived that an extension of the argument must necessarily lead to a separate equilibrium for every individual description of heat.

Internal radiation too, as a subject for experiment (if we except the remark made by Prevost), appears to have been overlooked, and its essential connexion with the theory of exchanges does not appear to have been perceived.

In March, 1858, I communicated to the Royal Society of Edinburgh a memoir in which these desiderata were supplied. In this memoir it was shown by a simple process of reasoning that the heat-equilibrium must hold for every individual description of heat, and that as a consequence this would lead to various conclusions, all of which were experimentally verified. The following facts were thus established:—

(1) The radiating power of thin polished plates of different substances was found to vary as their absorbing power: so that the radiation of a plate of rock-salt was only 15 per cent. of the total lamp-black radiation for the same temperature.

(2) It was shown that the radiation from thick plates of diathermous substance is greater than that from thin plates, no such difference being manifested when the substances are athermanous.

(3) It was found that heat radiated by a thin diathermous plate is less transmissible through a screen of the same material than ordinary or lamp-black heat, the difference being very marked in the case of rock-salt.

(4) Lastly, heat from a thick diathermous plate is more easily transmitted through a screen of the same material than that from a thin plate.

All these facts can be explained by a legitimate extension of the theory of exchanges.

Let us recur to our hypothetical chamber, outside the walls of which we may suppose there is a boiling-water arrangement, in virtue of which these walls are kept at the temperature of 100° C. The inside we shall suppose to be a vacuum. Let us in the first place hang up in this chamber two thermometers, one covered on the outside of its bulb with lamp-black, the other with polished silver. The former of these will absorb all the rays that fall upon it from the walls of the chamber, the latter, on the other hand, will absorb very few of these rays. Ultimately, however, both thermometers will attain the temperature of the walls. Since, therefore, according to the theory of exchanges the equilibrium of temperature is kept up by an equality of absorption and radiation, it is manifest that the radiation from the lamp-black thermometer must be great, because the absorption is great, and the radiation from the silvered thermometer small, because the absorption is small.

It will be noticed that this connexion between the two qualities, absorption and radiation, is deduced from a hypothetical case where everything is at a constant temperature. To prove it experimentally we may without any breach of scientific propriety take out the two thermometers from the enclosure, exposing them to a lower temperature, and noticing their velocity of cooling, when it will be found that the blackened thermometer cools more rapidly than the silvered one.

Or we may allow their radiation to fall upon a thermopile, and to be registered by a galvanometer, when it will be found that the indication of the galvanometer will be much greater for the blackened than for the silvered thermometer.

Let us next hang up in our enclosure a plate of glass and one of polished rock-salt.

The plate of glass will absorb all or nearly all the rays of dark heat that fall upon it from the sides of the enclosure. The plate of rock-salt will, on the other hand, absorb only a few of these rays. A similar argument to that already given will enable us to see that if the theory of exchanges be true, the radiation from a plate of rock-salt must be decidedly less than from one of glass, and this is found to be the case.

Next, let us hang up two plates of rock-salt, a thick one and a thin one. The thick one will absorb more rays than the thin one, and we shall therefore expect it to radiate more. This, too, will be found to hold experimentally, thus proving the fact of internal radiation. On the other hand, we shall observe no sensible difference if we hang up two plates of glass, one thick and one thin, the reason being that the thin plate of glass already absorbs all the heat which falls upon it, so that no increment of absorption, and hence of radiation, can take place by increasing the thickness. We thus see that it is only in the case of diathermanous bodies that the radiation increases with the thickness, while for athermanous bodies there is no such increase.

We are now in a better position for realising what takes place in our hypothetical enclosure.

There is a stream of heat from the walls which falls upon any substance which we may introduce into our chamber. Now this stream is not altered in intensity by altering either the shape or substance of the walls. Suppose, for instance, that they are of polished metal instead of being covered with lamp-black, then, while the heat radiated from them will be less, the reflexion of this heat will be so bandied backwards and forwards between these walls as to swell up the total amount to an equality with the lamp-black radiation, the only difference being that in the lamp-black radiation there is little or no reflexion, while in the other there is much reflexion and comparatively little radiation. Nor will the stream from the walls be altered by hanging up a plate of any substance between them and the body we introduce. For the plate will radiate on its own account just as much heat as it absorbs from the walls, so that the joint radiation of the two will be the same as if the plate were taken away.

Our remarks have hitherto applied only to the total intensity of this stream of radiant heat, and not to its quality—that is to say we have left out of consideration the specific mixture of various kinds of rays differing either in wave-length or in polarisation which go to make up the whole heterogeneous radiation. Now a little reflection will convince us that this specific mixture—this *quality* of the radiation-stream—must, as well as its *quantity* remain the same under any change made in the shape or substance of the enclosure. For suppose that we introduce a thermometer coated with some substance which exercises a selective absorption for certain rays of the stream, and not for others, then a change of quality would mean for this thermometer a change of absorption as truly as if there were a change of quantity. But by the theory of exchanges the absorption must remain the same, being equal to the radiation, and hence this can only be brought about by the quantity and the quality of the radiation-stream remaining each unaltered whatever change be made in the walls of the enclosure, or whatever substance be introduced between these walls and the thermometer. Carrying out this train of thought, we see why, as was proved by Provostaye and Desains, the sum of the radiated and reflected heat from any portion of the walls must be unpolarised, the reason being that the radiated heat from lamp-black is unpolarised and the one radiation must be equal to the other not only in quantity but in quality also. Again, the radiation of any surface or of any plate must be equal to its absorption, both as regards quantity and quality, so that the stream of heat may emerge from the surface or from the plate unaltered both in quality and in quality.

Thus the putting up of a plate between the walls and our coated thermometer will produce no effect, inasmuch as the stream of radiant heat which falls upon the coating will be unaltered both in quantity and quality by the interposition of the plate. We thus see why the radiation from a thin plate of rock salt should be of a quality which renders it much absorbed by a cold plate of the same material, the reason being that a body radiates that kind of heat which it absorbs.

We see, too, why heat from a thin plate of rock salt should be more absorbed by a cold screen of this material than that from a thick plate, inasmuch as the former consists of that kind of heat which is strongly absorbed, even by a thin plate, while the latter contains likewise a number of other rays which are not so strongly absorbed.

The conclusion to be derived from these remarks is that we have in reality a separate equilibrium for every description of heat, an equilibrium which is independent of the shape of the enclosure and of the substances of which it is composed. Furthermore, the stream of radiant heat may be supposed to circulate in the interior of a substance such as glass, water, or even metal, the radiation of each particle which it meets being exactly equal to its absorption, so that the stream proceeds through the interior, being virtually the same at one part of its path as at another. Again, it can be shown that it is essential to equilibrium that in the interior of a substance this stream of heat should be proportional to the *square of the refractive index*. That is to say, in an enclosure containing glass whose refractive index is 1·5 the stream of radiant heat in the heart of the glass will be 2·25 times greater than that proceeding through a vacuum; we cannot, however, tell what takes place in the heart of a crystal. It also appears that, for an enclosure of given temperature, the stream of a given kind of heat has a definite value, the amount of this increasing as the temperature increases.

We are, however, ignorant of the exact function of the temperature which expresses the value of this stream, but we know that this value increases more rapidly for the more refrangible rays of the spectrum than for those of greater wave-length and smaller refrangibility.

We now come to consider the luminous rays, and here the wondrous power of the eye can aid us to an extent far surpassing that of the most delicate pile and galvanometer for the dark rays.

Wollaston and Fraunhofer were the first to show that in the solar spectrum numerous dark bands occur, which indicate the absence of certain definite kinds of light.

Sir David Brewster afterwards showed that similar bands make their appearance when the spectrum is made to pass through nitrous acid gas, and it was thus rendered probable that the bands which appear in the solar spectrum were due to absorption likewise.

Brewster, J. Herschel, Talbot, Wheatstone, and W. A. Miller were amongst the first to make observations upon the luminous spectrum obtained by heating various substances, and it was soon perceived that such spectra consist of bright lines on a dark background, and thus appear to be a reversal of the solar spectrum, which consists of dark lines on a bright background. Fraunhofer was the first to notice a coincidence in spectral position between the dark double line D occurring in the solar spectrum and the bright yellow flame produced by incandescent sodium. Swan afterwards showed that the correspondence between the two black lines and the two bright lines is very exact, and that a very small quantity of salt is sufficient to call forth the bright lines. Ångström (*Phil. Mag.*, May, 1855), referring to a conjecture of Euler that a body absorbs all the series of oscillations which it can itself assume, expresses his conviction that the same body, when heated so as to become luminous, must emit the very rays which at ordinary temperatures are absorbed, and that the explanation of the dark lines in the solar spectrum embraces that of luminous lines in the electric spectrum. Probably, however, the first to give definite expression to this conception was Prof. Stokes, who, about the year 1850, commented on an experiment recently made by Foucault. This observer had found that, when a voltaic arc formed between charcoal poles was placed in the path of a beam of solar light, the double line D is thereby rendered considerably darker. If, on the other hand, the sun and the arc jut out the one beyond the other, the line D appears darker than usual in the solar light, and stands out bright in the electric spectrum. Thus the arc, remarks Foucault, presents us with a medium which emits the rays D on its own account, and which at the same time absorbs them when they come from another quarter.

The explanation given by Stokes of this experiment assumes that the vapour of sodium must possess, by its molecular structure, a tendency to vibrate in periods corresponding to the degrees of refrangibility of the double line D.

Hence the presence of sodium in a source of light must tend to originate light of that quality. On the other hand, vapour of sodium in an atmosphere around a source must have a great tendency to absorb light from the source of the precise quality in question.

In the atmosphere around the sun, therefore, there must be present vapour of sodium, which, according to the mechanical explanation thus suggested, being particularly opaque for light of that quality, prevents such of it as is emitted from the sun from penetrating to any considerable distance through the surrounding atmosphere.

It appears, from the historical sketch here given, that two independent lines of research were progressing towards the same conclusion. The one of these had for its basis the theory of exchanges, and endeavoured theoretically and experimentally to render this theory complete. The other was founded upon spectroscopic investigation, and endeavoured to apply to light an analogy deduced from sound, believing that, just as a string or tuning-fork when *at rest takes up* that *note* it gives out when *struck*, so a molecule when *cold absorbs* that *ray* which it gives out when *hot*.

In October, 1859, Prof. Kirchhoff of Heidelberg made a communication to the Berlin Academy on the subject of Fraunhofer's lines. His observations were made on this occasion by an examination of the spectrum of coloured flames made by Bunsen and himself, and he derived from them the following conclusions:—He concluded that coloured flames in the spectrum of which bright sharp lines present themselves so weaken rays of the colour of these lines, when such rays pass through the flames, that, in place of the bright lines, dark ones appear as soon as there is brought behind the flame a source of light of sufficient intensity in the spectrum of which these lines are otherwise wanting. He concluded further that the dark lines of the solar spectrum which are not evoked by the atmosphere of the earth exist in consequence of the presence in the incandescent atmosphere of the sun of those substances which in the spectrum of a flame produce bright lines in the same place.

Carrying out this train of thought, Kirchhoff, about the end of 1859, shows that as a mathematical consequence of the theory of exchanges, a definite relation must subsist between the radiating and absorbing power of bodies for individual descriptions of light and heat.

It will be noticed in this historical statement that I made my first experiments on dark heat; afterwards I proceeded to the subject of light. Meanwhile, however, Kirchhoff had independently been led to experiment in this direction, and, although his memoir slightly preceded mine in publication, I shall now give the experiments which I was led to make, more especially as they are very similar to those of Kirchhoff. In February, 1860, I communicated to the Royal Society of London a paper in which I showed that the light radiated by coloured glasses is intense, in proportion to their depth of colour, transparent glass giving out very little light. I also showed that the radiation from red glass has a greenish tint, while that from green glass has a reddish tint. It was likewise shown that polished metal gives out less light than tarnished metal and that when a piece of black and white porcelain is heated in the fire the black parts give out much more light than the white, thereby producing a curious reversal of the pattern.

Finally, in a paper communicated in May of the same year, it was shown that tourmaline, which absorbs in excess the rays of light polarised in a plane parallel to the axis of the crystal, also radiates, when heated, this kind of light in excess, but that when it is viewed against an illuminated background of the same temperature as itself, this peculiarity disappears. All these facts are a natural consequence of a movable equilibrium of temperature holding separately for every variety of heat, the word "variety" embracing any difference either in wave-length or polarisation which is the cause of unequal absorption.

The theory of exchanges, as here exhibited, has been founded upon the fact that in an enclosure of constant temperature all bodies will ultimately attain the temperature of the walls of the enclosure. This is the experimental foundation upon which our structure has been built, and we have not attempted to work under it or to find whether in its turn it be not founded upon some principle of a still deeper and more fundamental nature. We shall now briefly indicate that such is the case, and that this law of ultimate equality of temperature is a consequence of the theory of energy in which we are told that no work can possibly be got out of heat which is all at the same temperature. For if the ultimate result in our enclosure should be a variety of temperatures, then it would be possible to utilise this temperature-difference and convert heat into work, so that there would practically result a case of perpetual motion. Now, it is one of the most fundamental axioms of physical science that such a motion is impossible.

I have endeavoured to make use of this method of viewing the problem, in order to point out what forms the natural limit to our conception of a movable heat-equilibrium. Suppose, for instance, that we have a large spherical chamber of the temperature of 100° C., and that this chamber is removed from all gravitating influence, so that a solid spherical body, also of the temperature of 100° C., may rotate on its axis in the centre of this chamber without requiring the support of an axle. The chamber may likewise be supposed to be void of air, so that there is nothing but the ether to bring the revolving body to rest. Now, if a sort of diaphragm or rim be introduced into the chamber, as in Fig. 9, the result will

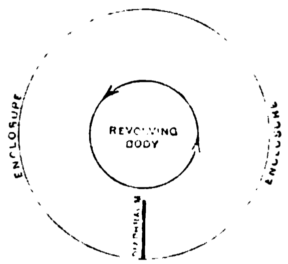


Fig. 9.

be that the particles of the enclosure to the left of the diaphragm will only receive heat from that portion of the revolving body which is approaching them, while those to the right of the diaphragm will only receive heat from those portions of the same body which are receding from them.

But the wave-length of light is altered in one way by a body which is approaching us, and in another way by a body which is receding from us, so that the particles to the left of the diaphragm will, in reality, receive a different kind of radiation from those to the right. Here, then, we have something which upsets the temperature equilibrium, and we may even conceive that the particles to the left of the diaphragm will absorb more heat, and therefore become hotter than those to the right. If so, we shall have the possibility of creating work out of this difference of temperature, or, in other words, of starting a kind of perpetual motion.

We thus begin to see that, somehow, the revolving body must lose as much energy as we gain by means of these differences of temperature, for otherwise we should have the transmutation of heat originally of the same temperature into work, which we cannot admit. But this means that a revolving body placed under these circumstances must gradually part with its energy of visible motion, although it is not in contact with anything else than the ethereal medium.

Before concluding this branch of my subject let me say a few words about phosphorescence and fluorescence.

It is well known that certain substances remain luminous—that is to say, continue to emit light for some time after they have been exposed to the light of the sun or of some other powerfully luminous body. Such substances are said to be *phosphorescent*.

It is likewise known that other substances, more especially certain liquids, emit light in a peculiar way while the luminous source acts upon them, but do not enjoy this property for an appreciable time after it has been withdrawn. Such bodies are said to be *fluorescent*.

It is manifest that the difference between phosphorescence and fluorescence is one of time, the bodies implied by the first term continuing to give out light for some time after the exciting source is withdrawn, while those implied by the second do not retain this property for an appreciable time after the withdrawal of the luminous source. Prof. Stokes, who has done much to advance this subject, has shown that the exciting cause of phosphorescence and fluorescence is more especially the rays of high refrangibility—even rays beyond the violet of the visible spectrum. On the other hand, the rays which the body gives out are generally of a lower refrangibility than the exciting rays. Hence invisible rays may, by means of a phosphorescent or fluorescent body on which they fall, render themselves visible. This phrase, however, is perhaps not strictly correct, inasmuch as, before becoming visible, they have been changed into other rays of lower refrangibility.

The object of introducing this subject here is rather, however, to discuss its bearing upon the theory of exchanges than to treat it as a separate branch of inquiry; and I may commence by remarking that at first sight it seems to contradict the general law that the quantity and quality of the light and heat given out by a body depend upon its temperature, and upon this only. Thus, a thermometer at 100° C. is supposed to radiate from the surface of its bulb heat which will be the same in quantity and quality whether the instrument has been heated by the sun's rays or by plunging it into boiling water. Now in such a body as luminous paint we have the light which we usually associate with a high temperature given out long after the sun has ceased to shine upon it, and when we know its real temperature to be that of the bodies around it. Do phosphorescent bodies form, therefore, an exception to the general law which represents the quality of the radiant heat as a function of the temperature?

I think we shall find, on examination, that in this general law it is taken for granted that no chemical change is taking place in the body in question, and no other molecular change than that implied in the cooling of the body. In a chemical action we have generally the transmutation of chemical energy into heat, and in molecular action we have generally the transmutation of molecular energy into heat likewise. That is to say, the body undergoing these changes becomes heated, and so gives out light and heat peculiar to the temperature to which it has been raised. But there seems to be no reason why molecular energy should not be somehow changed at once into radiant light and heat. In this case there would no doubt be an apparent breaking of the law above mentioned, which associates a certain temperature with a certain quantity and quality of radiant heat, but the exception would be only apparent. for, as we have stated, the law presupposes that no molecular change of this nature is taking place.

In like manner our argument regarding an enclosure of a constant temperature and the theory of exchanges in general, while it allows of the greatest possible variety of substance and form in the enclosure, virtually assumes that no chemical or molecular change is going on amongst the substances introduced. We are, in fine, supposed to be dealing with radiant energy and absorbed heat, and with no other form of energy, and indeed we have just seen that if we have a body in visible motion in the enclosure, the equilibrium no longer holds.

Thus we get rid of the difficulty by rejecting the bodies in question as not fulfilling strictly our requirements. No doubt the phenomena of phosphorescence and fluorescence are comparatively trivial exceptions, but we may imagine an enclosure in which all the substances are at the temperature of 100°, while some one substance is gradually changing its molecular state, until at length we have a violent explosion accompanied with light and heat. Here the result is so obvious that we have no hesitation in recognising such a body as an exception not contemplated by the theory of exchanges. We are persuaded that phosphorescent bodies are equally an exception, the only difference being that the character of this exception is not nearly so pronounced.

It has been pointed out by Prof. Tait that the conclusions of the theory of exchanges are only statistically true. That is to say, if we take a sensible time, such as a second, and a sensible quantity of any substance, such as a milligramme, then in an enclosure of constant temperature the absorption of that matter during one second is equal to its radiation during the same time, and this holds for all kinds of heat. On the other hand, if we take a single molecule and a billionth of a second, we cannot affirm the same equality. This is no doubt correct; in fact, if the equality between radiation and absorption were to hold for the smallest conceivable mass and the smallest conceivable increment of time, our equilibrium would in reality be a tensional one instead of being movable or dynamical. I shall conclude by repeating the words of Tait ("Heat," p. 253):—"It is vain, at least in the present state of science, to look for a truly *rigorous* investigation of the relation between radiating, absorbing, and reflecting powers. In all the professedly rigorous investigations which have been given the careful reader will detect one or more steps which are to be justified only by the statistical process of averages."

BALFOUR STEWART

(*To be continued.*)

THE LIFE OF AQUATIC ANIMALS AT HIGH PRESSURE[1]

THE magnificent expeditions of the *Talisman* and the *Travailleur* have called the attention of naturalists and physicists to the conditions of life at the bottom of the sea. A learned physiologist, Dr. Regnard, has conceived the happy idea of studying experimentally these condition of life at high pressure. With apparatus designed by M. Cailletet, he has subjected aquatic animals to enormous pressure, such as prevails in the depths of the ocean, and has examined the results when those inhabiting the surface are suddenly placed at great depths. Since his first experiments Dr. Regnard has invented an ingenious method by which he can see, notwithstanding the great pressure, what goes on inside the apparatus.

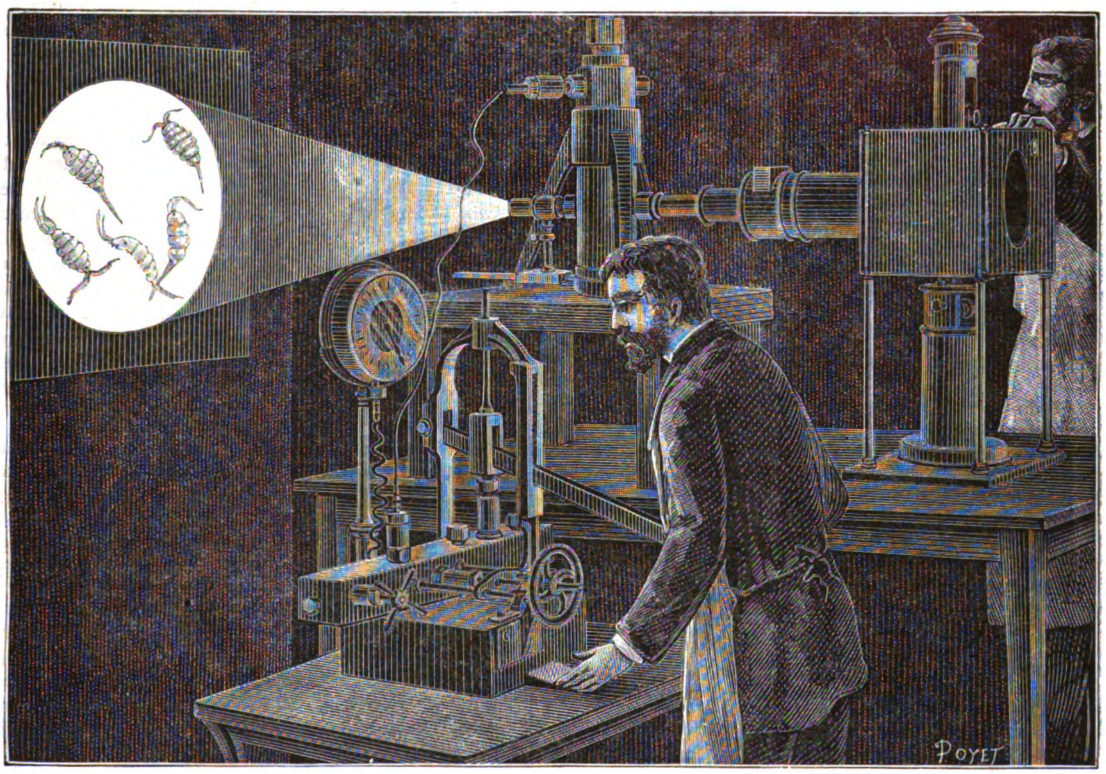


FIG 1.—General View of Dr. Regnard's Apparatus.

Hitherto the operator simply placed the animals on which he experimented in the iron block of the Cailletet pump, and subjected them to the pressure corresponding to a given depth; he then released them, sometimes very slowly (after several days), sometimes rapidly and even instantly. He examined then, physiologically and microscopically, the lesions produced. But all the intermediate stages between the entrance of the animals and the time they were taken out escaped the observer. But now the apparatus in Fig. 1 allows him to follow each minute the effects. The following is Dr. Regnard's description of his apparatus to the Academy of Sciences:—

Two holes are pierced through and through across the lower part of the Cailletet block, M (Fig. 2). In these two holes, placed in a straight line, are inserted two tubes in *r* and *r'*. These are hollow, and in each of them is solidly fixed a cone of quartz, B, the extremity of which joins the edges of the hole which is pierced in the screw nut E. A ray of light thrown by the orifice *r* will thus traverse the apparatus and emerge at *r'*. Experiments have shown that a similar apparatus will resist easily a pressure of 650 atmospheres, which represents that of the greatest depths that have been dredged—about 6500 metres. Across one of the quartz cones are sent the concentrated rays of an electric lamp. These rays cross the block full of water, and emerge on the opposite side, where they are received by an achromatic object-glass which projects them on to a screen. The observer therefore works at a distance from the apparatus, where he is sheltered from all danger (Fig. 1). This arrangement has another advantage. The orifice pierced at *r* is hardly half a centimetre in diameter, and one can experiment with animalculæ so small as to be scarcely perceptible

[1] From *La Nature*

with the naked eye in the vessel immersed in the block M. By projecting them with a lens they are increased about 200 times, and it is even possible to see by transparence the state of their organs." In the experiment represented in Fig. 1, one of the operators is occupied in regulating the electric lamp and in setting the microscope of projection, while the other commences to apply the pressure. The animalculæ projected on the screen are the *Cyclops*, small crustaceans which are met with at this time of the year in brooks, and which are scarcely a millimetre in length. These are so enlarged, and appear with such transparency, that we can follow on the screen the movements of their branchia, and even of their heart, during the experiment. Dr. Regnard is pursuing at present his

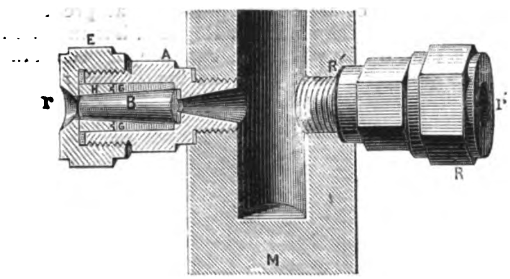


FIG. 2.—Details of apparatus in Fig. 1.

studies into life under high pressures. He showed last year that the unequal compressibility of the liquids and solids which form the organism caused the latter after a long pressure, to be soaked with water, become turgid, and consequently lose their functions. But, with the apparatus here described, he has been able to follow the phenomena which precede this. From the pressure at 1000 metres (about 200 atmospheres) the object shows inquietude, at 2000 metres it falls to the bottom of the vessel struggling; towards 4000 it remains inert and benumbed. When its normal pressure returns it recommences moving, unless the pressure has been long and its tissues are not soaked. This seems to show that the effect is a compression of the nervous system.

NOTES

WE understand that Mr. Francis Galton has already obtained valuable results from the Family Records sent him last year in response to his offer of prizes, and that he purposes to make much use of them in his Presidential address to the Anthropological Section of the British Association at Aberdeen.

WE have already intimated that Prof. Bonney has decided to retire from the Secretaryship of the Association after the Aberdeen meeting. We understand that Mr. A. T. Atchison will be proposed as his successor.

MANY interesting excursions have been arranged by the Local Committee of the Aberdeen meeting of the Association. One of them will, of course, be to the great granite quarries in the neighbourhood of Aberdeen. Her Majesty has invited 150 of the members to Balmoral, where they will be shown over the grounds and have lunch. It is not to be expected that the Queen will personally receive all the members, though it is possible that a few representative men of science may be presented to Her Majesty. Other excursions will be to Haddo House, Dunecht, Dunnottar, Drum and Crathes, Loch Kinerd, on the Saturday; while on the Wednesday and Thursday of the second week parties will be taken to Braemar, Invercauld, Haddo House, Huntly Castle, Elgin, Banff, Portsoy, and other places. The efforts which the Local Committee are making to render the meeting a success are all that could be desired. It is only to be hoped that they may succeed in persuading the Aberdeen hotel and lodging-house keepers to reduce their exorbitant charges. The arrangements for important discussions in Sections A and B we have already referred to.

IN connection with the meeting we venture to recommend to our readers the new edition of Baddeley's "Guide to Scotland," Part 1, a copy of which has been sent us. It includes all the country from the Borders to as far north as Aberdeen, Inverness, Gairloch, and Stornoway. No more useful, practical, and trustworthy guide to the region exists, while the thirty-seven admirably executed maps and plans will be found a great comfort and convenience. Dulau and Co. are the publishers.

M. JANSSEN will shortly begin a new series of experiments on the influence of gases in spectrum analysis, in continuation of those which he made about fifteen years ago at La Villette gasworks. The tubes in which the gas will be contained and compressed will have a length of more than 100 metres, and be able to bear an unusual amount of pressure. Thus a new degree of accuracy may be expected from these researches, which are progressing favourably at the Meudon Physical Observatory.

FOR more than a year some important measurements of the altitude and movements of clouds have been carried on at Upsala by the aid of two theodolites, one of which is mounted in the Linnæus and the other in the Botanical Gardens. These instruments, which belong to the Academy of Science, were used for auroral and cloud measurements by the Swedish expedition to Spitzbergen, 1882–83. The object of the measurements of the altitude and movements of clouds is not so much to obtain their mean altitude as to derive some knowledge of their movements in the upper part of the atmosphere, a matter which is of great importance to meteorology. The researches have advanced so far that it has been found possible to fix astronomically the movements and altitude of the cirrus clouds.

ACCORDING to the *Tägliche Rundschau* the population of Ratisbon has been greatly frightened by the sudden disappearance recently of thousands of jackdaws, which dwelt in the spire of the cathedral of the town, on account of a similar phenomenon occurring before the outbreak of the last cholera epidemic in the place. In Munich a similar phenomenon is also stated to have taken place.

REFERRING to "sonorous sand," the report of the secretary of the Smithsonian Institution says that an interesting problem to physicists and geologists has been the sand found in certain localities, which, when placed in motion by sliding, sometimes produces a very sonorous or resonant sound, peculiar in character and difficult of explanation. Prof. Bolton, of Trinity College, Hartford, desirous of making researches on the subject, and especially of studying the microscopical, chemical, and physical peculiarities of the grains, requested the aid of the Institution in obtaining materials for the purpose. A considerable variety of specimens was collected in the Sandwich Islands, the coast of Oregon, Germany, and many other places. These are now in Prof. Bolton's hands, and he will prepare a report on the subject.

THE Chesapeake Zoological Laboratory, as the marine station maintained by the Johns Hopkins University is designated, is *Science* states, established for the present summer session at Beaufort, on the coast of North Carolina. Dr. W. K. Brooks, the director, who was prevented last year by ill-health from giving as much time as usual to the laboratory, is fortunately quite restored to his usual strength, and is in full activity at his post. Twelve collaborators are with him. Several of these are already teachers in various branches of zoological science, and all of them are well prepared to make use of the opportunities which are afforded at this station. An unusual number are engaged in original researches. The season of 1885, although uncomfortably hot, has thus far been exceptionally favourable for collection. The weather has been calmer than heretofore in June and July, and specimens were found in June which have usually not appeared until the middle of August. The company, notwithstanding their personal discomfort from the heat, have maintained their full enthusiasm in the work upon which they are engaged; and it now appears as if the eighth session of the laboratory would be more fruitful in results than its predecessors, good as they have been.

A DUNFERMLINE correspondent writes to us that one of the most important and certainly the most complete cemetery of the Stone Age which has been laid bare in recent times has just been discovered in the grounds of Pitreavie, Dunfermline, Fifeshire. In connection with rebuilding operations a sand-pit was opened, and here, in a space of 15 yards by 10 yards, no fewer than five cists have been discovered. The cists were constructed of rough sandstone flags, and four of these measured about 42 inches in length, 20 inches in breadth, and 16 inches in depth. The fifth was little more than 18 inches square. A cinerary urn of baked clay was found in each of the large cists, but in the small "grove" nothing was found but a quantity of apparently calcined bones. A couple of flint scrapers and a bottle-shaped piece of limestone—which may have done duty as a hammer—were also among the finds. The urns measure from 5 to 6 inches across the mouth and from 4½ to 6 inches in height, and, strange to say, the construction of the bowls indicate that they have been made at different successive periods. No. 1 urn is an unshapely piece of sun-dried pottery; No. 2 showed an advance in the shape; and Nos. 3 and 4 are neatly formed and ornamented with a simple dotted pattern. The explorations will be continued, and it is expected that several other important finds will be made. Dr. Munro, the author of "Ancient Scottish Lake Dwellings," has visited the tumuli with a view to place a report in the hands of the Antiquarian Society of Scotland. A tradition exists that the site of the mound was an old graveyard, and some people who have been engaged in the district in agricultural pursuits for the past half a century state that numerous flagstones and pieces of urns have been turned up by the plough or grubbed, and Dr. Munro attaches great importance to the flint scrapers, and was of opinion that the bones found in the small cist were human bones.

AT the recent Railway Congress at Brussels the question whether it would be economical and desirable to use iron or steel instead of wooden sleepers was fully discussed. It was stated that metal sleepers of various patterns are being used in Holland and India to a considerable extent, and that they are being tried experimentally in Belgium, England, and other countries. An opinion was expressed that sleepers of the description which is being tried in England would afford good material support for the rails on main lines, although some inconvenience might be felt from a quoin of wood being used with it. It was also considered that other metal sleepers which are being tried in Holland and elsewhere had given satisfactory results. The cost of metal sleepers is higher than that of wood. They require good ballast, and there had not been sufficient experience from their use, in regard to their duration and maintenance, to enable the section to state specifically the relative advantages of the new description of sleepers. It was therefore considered that further experience is necessary. The difficulty of arriving at a conclusion as to what would be applicable in all countries and under all circumstances was exemplified in the discussion of this subject by the representative of the Egyptian railways. He stated that iron or steel sleepers cannot be economically used in Egypt, because they become corroded by the sand. The representative of the Indian railways, on the other hand, informed the section that iron or steel sleepers only can be used in India, because the white ant destroys wooden sleepers. Considerable discussion took place as to the construction of railways in regard to the curves, gradients, and works generally, including the question whether lines with a comparatively small traffic should be laid with heavy or light rails. It was, however, found impossible to lay down any general propositions which could be adopted under all the circumstances in which railways have to be made.

IT may be remarked that François Arago was born at Estagel in the beginning of February, 1786, so that a centennial celebration may be expected next year. A statue was erected in this place twenty-nine years ago at the expense of the late M. Pereire.

AN exhibition of labour was opened a few weeks ago at the Palais de l'Industrie, Paris. An electrical railway with a single rail was exhibited by M. Lartigue, and is carrying passengers with regularity on a zigzag line of about 200 metres' length. A series of popular exhibitions with magic lanterns on the new features of microscopy is largely attracting public attention. So-called antediluvian music is played on a series of irregular stones which have been selected so that they represent two octaves when suspended by strings.

THE American Ornithologists' Union will hold its next meeting in New York on Tuesday, November 17.

WE have received catalogues of electrical apparatus from two new firms: the first of these is the Kinetic Engineering Company, who are agents in this country for the well-known firm of Breguet. They are now exhibiting Lippmann's ingenious mercurial galvanometer. The second catalogue is that of Messrs. P. Jolin and Co., of Bristol. This enterprising firm describes several instruments of great use in the physical laboratory, especially the dead-beat galvanometer of D'Arsonval's type, and adjuncts therefore. This instrument appears to be specially adapted for private laboratories. We are glad to see new firms taking such good standing in the character of the apparatus they offer to the scientific world.

THE Java newspapers report that volcanic activity in the island continues to increase. Another mountain, called Raun, broke out on June 21, casting out much steam and ashes. In the evening smoke was ejected in such quantities as to darken the horizon on the windward side, until a shower of ashes fell, upon which the sky cleared up. Raun appears to be an active volcano, but no such violent eruption has been known in recent years. On the night of July 8 a new eruption of Mount Smeru took place; it was a heavy explosion followed by a stream of red-hot lava, which came down to the same spot which was laid waste by the former eruption. In the evening of July 9 another explosion followed.

"RESULTS of Twenty Years' Observations on Botany, Entomology, Ornithology, and Meteorology, taken at Marlborough College, 1865-84," is the title of a large pamphlet embracing a summary of twenty years' work. The tables are accumulations of facts properly registered. In the botanical notices the first appearances in each year are given, the day being noted as the day of the *year*, not of the month. This method is readiest for comparison and for striking the average. In addition the average for the twenty years, the earliest and latest days, the amplitude and the number of observations are given. The entomological notices are arranged in the same way, except that the earliest and latest appearances and the amplitude are omitted; these are not a great loss, for they can be ascertained from the tables in a moment by any reader. In ornithology the observations include the date when first seen, and when an egg and the young have been found. The meteorological notices include for each month of each year the highest, lowest, and mean readings of the barometer, the maximum and minimum temperature in the shade, the number of times the thermometer stood above certain points varying with the seasons of the year, the maximum in the sun, the minimum on the grass, amount of rain collected, and the number of rainy days. The wettest year of the twenty was 1882, when the rainfall was 43·79 inches; the dryest, 1870, with 23·41 inches. The weather records in these tables have been kept by one observer, with properly verified instruments, and all the observations have been critically examined at the Royal Meteorological Society; the botanical notices, though obtained by a large staff of observers, have all been recorded by one person, who saw all the specimens; but entomological and ornithological notes were taken by a series of recorders, and there is therefore not the same uniformity as in the two previous cases.

WE have received the annual report of the West Kent Natural History, Microscopical, and Photographic Society for the past year. It contains abstracts of several papers read during the year. It is a pity there is no abstract of the discussion introduced by the president at the annual dinner at Gravesend, on "Bacon and Beans." There are two papers on subjects connected with photography.

MR. W. F. STANLEY has recently brought out a new form of protractor and goniometer, which has the special merit of measuring an angle right up to the vertex. This new form of protractor will be very convenient to civil engineers in measuring angles upon ordnance maps which are most frequently subtended by short lines, and many other cases. Used as a goniometer, it will be very convenient to measure the angles of large crystals and planes of cleavage, also to draw the same direct from the instrument. The instrument consists of two concentric circles, the outer one carrying the graduation, the inner a Vernier; each supports an arm with an edge extending to the centre. The angles are measured by slipping the inner circle with its attached arm and Vernier round the groove on the outer circle, which keeps it in position. We believe the instrument has all the good points which Mr. Stanley claims for it, and it will be useful to artists as well in determining angles of perspective.

THE whitefish (*Coregonus albus*) now in the ponds at the Delaford Fishery are growing rapidly, some of them reaching seven inches in length. It will be remembered that the ova of these fish were brought from America last spring, and hatched out at South Kensington.

A REMNANT of the great forests which once covered the south of Sweden was recently dug out of a bog at Kiuneved, consisting of a boat 6 feet in diameter hollowed out of a log. The tree from which it was obtained must have been 20 feet in circumference. The wood, which was blue in colour, was very hard, and the boat so heavy that two bullocks could not move it.

MR. HENRY PHILLIPS, jun., one of the secretaries to the American Philosophical Society, has performed a very useful work in compiling a register of all the papers published in the *Transactions* and *Proceedings* of the Society since its commencement. The "register" forms a small pamphlet of fifty-six pages, the titles being arranged according to the authors' names. It is therefore an index to all the publications of the Society—but a name, not a subject, index.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. E. Pelditch; a Bosmani Potto (*Perodicticus potto* ♂) from West Africa, presented by Mr. C. R. Williams; two Gerbilles (*Gerbillus* ——) from Suakim, presented by Surgeon-Major J. A. Shaw; two White-faced Tree Ducks (*Dendrocygna viduata*) from West Africa, presented by Mr. Cecil Dudley; three Green Turtles (*Chelone viridis*) from the West Indies, presented by M. C. Angel, F.Z.S.; a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. J. C. O'Halloran; two Narrow-barred Finches (*Munia nisoria*) from Java, an Indian Silver Bill (*Munia malabarica*) from India, an Amaduvade Finch (*Estrelda amandava*) from India, presented by Mr. Horace Sanders; a Short-toed Eagle (*Circaetus gallicus*) from Southern Europe, presented by Mr. Henry Sotheran; a Mona Monkey (*Cercopithecus mona* ♂) from West Africa, presented by Mr. White; a White-necked Crow (*Corvus scapulatus*) from West Africa, deposited; nine Gold Pheasants (*Thaumalea picta*), received from the Right Hon. George Sclater-Booth, M.P.; a Barred-shouldered Dove (*Geopelia humeralis*), a Coquerel's Lemur (*Chirogaleus coquereli*), a Collared Fruit Bat (*Cynonycteris collaris*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE BINARY-STAR 70 OPHIUCHI.—Notwithstanding the care with which the orbit of this double-star has been discussed, the companion appears to be again deviating from its predicted position to a considerable extent. It will be remembered that from the anomalous motion of the smaller star Madler was led to the suspicion that the law of gravitation does not apply in this system, while Jacob thought there was indication of disturbance from a third body.

M. Perrotin gives the following epoch resulting from his measures made at Nice in 1883:

1883·49 ... Position 45°·6 ... Distance 2″·28

On comparing with the orbit assigned in No. 1 of "Astronomical Observations made at the University Observatory, Oxford," which accords closely with the measures up to 1878, and with the orbits Flammarion, Tisserand, and Schur, we find the following differences taken in the order, observation—calculation:—

	Position.	Distance.
The Oxford orbit	− 9°·9 ...	−0″·60
Flammarion	−12·8 ...	−0·18
Tisserand	−13·5 ...	−0·57
Schur	−17·4 ...	−0·73

It is very possible that in this case the difficulty of representing the position of the companion-star may be attributed to the paucity of measures near the peri-astron, rather than to an anomalous motion which has not been remarked in most of the other binaries. However this may be, the object no doubt is one deserving of continued attention. The Oxford orbit, which, it will be seen, is the nearest as regards the position angle in 1883, gives for 1885·5—position, 44°·6; distance, 2″·64.

TUTTLE'S COMET.—On September 10, at midnight, this comet will be in about R.A. 136° 33′, Decl. +3° 48′, rising at Greenwich two hours before the sun, and with an intensity of light one-third greater than when first observed at Nice on August 8. It may perhaps be observed after perihelion in the southern hemisphere if the more powerful telescopes are utilised. On August 13 the correction to Herr Raht's ephemeris was −13s. in right ascension and +5′·5 in declination. The comet is about 2′ in diameter, without very apparent central condensation.

THE COMET OF 1652.—At present we have only one calculation of the orbit of this comet—that of Halley, founded upon the observations of Hevelius in the scarce volume of the "Machina Cœlestis." It would be interesting to investigate the orbit anew from the observations made by Richard White at Rome, though he gives no nearer time for his distances of the comet from stars between December 21, 1652, and January 3, 1652, than "hora 2 post occasum solis." The observations will be found in *Zeitschrift für Astronomie*, vol. iv., where they are entitled "Observationes Cometæ, qui exeunte anno 1652 comparuit, habitæ Romæ per Riccardum Albium, Anglum." Zach supposed the observer to be Richard White, and there can be little doubt that he is the Mr. White repeatedly mentioned by Evelyn in his Diary. Zach has the remark, "Diese Beobachtungen können leicht besser als die des Hevelius seyn," and an examination of the latter will show that there is some foundation for this remark. On December 21, according to Halley's elements, the distance of the comet from the earth was only 0·14; on January 3 it had increased to 0·42.

The fact that the place of the ascending node of the comet of 1698, as it is printed in Halley's "Synopsis of Cometary Astronomy," is 180° in error, or, in other words, the place of the descending node has been given for that of the opposite one, furnishes a hint that it is not safe to accept a single calculation of the orbit of any of the earlier-computed comets without examination.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *AUGUST* 30 *TO SEPTEMBER* 5

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 30

Sun rises, 5h. 11m.; souths, 12h. 0m. 23·0s.; sets, 18h. 49m.; decl. on meridian, 8° 52′ N.: Sidereal Time at Sunset, 17h. 26m.

Moon (at Last Quarter on Sept. 2) rises, 20h. 28m.*; souths, 3h. 15m.; sets, 10h. 12m.; decl. on meridian, 8° 11′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 1 ...	12 17 ...	18 33 ...	2 28 N.
Venus ...	8 7 ...	13 57 ...	19 47 ...	2 47 S.
Mars ...	0 36 ...	8 48 ...	17 0 ...	22 50 N.
Jupiter ...	5 48 ...	12 28 ...	19 8 ...	7 6 N.
Saturn ...	23 43* ...	7 52 ...	16 1 ...	22 25 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Sept.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image	
			h. m.	h. m.	°	°
1 ...	θ^2 Tauri ...	... 4½ ...	22 1 ...	22 52 ...	62	247
1 ...	θ^1 Tauri ...	... 4½ ...	22 2 ...	22 51 ...	82	227
1 ...	B.A.C. 1391 ...	5 ...	23 1 ...	23 32 ...	117	189
1 ...	81 Tauri ...	... 5½ ...	23 9	near approach	333	—
1 ...	85 Tauri ...	... 6 ...	23 21 ...	0 1† ...	20	284
2 ...	Aldebaran	... 1 ...	1 40	near approach	154	—
2 ...	117 Tauri...	... 6 ...	22 34 ...	23 20 ...	84	221
3 ...	B.A.C. 1728 ...	6 ...	0 13 ...	0 48 ...	9	288
4 ...	26 Geminorum...	5½ ...	4 57	near approach	146	—
5 ...	68 Geminorum...	5½ ...	0 58	near approach	323	—

† Occurs on the following day.

The Occultations of Stars are such as are visible at Greenwich.

Sept.	h.	
2 ...	18 ...	Mercury in inferior conjunction with the Sun.
4 ...	3 ...	Saturn in conjunction with and 4° 17′ north of the Moon.
5 ...	7 ...	Mars in conjunction with and 5° 33′ north of the Moon.

GEOGRAPHICAL NOTES

Sad news has been received from the Dutch African Expedition; its leader, Mr. D. D. Veth, died from disease on May 19, in the camp on the banks of the Kala-Kanga River, between Benguella and Humpata. This is a real loss for science as well as to his venerable father, Prof. P. J. Veth, who has given his whole industrious life to scientific work.

The Austrian Government, with the consent of the Porte, has undertaken to make a geographical survey of the Albanian coast, with a view to preparing new maps. Two Austrian gunboats have accordingly left for Corfu with officials of the Chart Department on board. Here they will be joined by the Turkish officers, under whose superintendence the survey will be made.

It is stated in the latest *Ergänzungsheft* to *Petermann's Mittheilungen*, that there are in Peking four institutions at which astronomical and meteorological observations have been made for a number of years: (1) the Chinese Observatory, called *Kuan sang tai*, which has existed for about six centuries. In 1674 the Jesuits provided it with new astronomical instruments, without lenses, which are well preserved to this day. It is situated on the eastern wall of the Manchu town. (2) Bethang, or the Northern Church, the *Collegium Gallorum*, near the Imperial palace. Here in the middle of the eighteenth century the Jesuits erected an observatory, and made many astronomical observations, amongst them the transit of Venus of June 3, 1769. Besides these Père Amiot made meteorological observations for six years, from 1757 to 1762. (3) The Russian Legation, near the southern wall of the Manchu town. The astronomer Fuss, who made a great journey between 1830 and 1832 from St. Petersburg to Eastern Siberia, and by Kiachta to Peking, at the orders of the Academy of Sciences of St. Petersburg, spent seven months here, and organised astronomical, geographical, magnetic, and meteorological observations. (4) Beguan, about 300 metres from the north-eastern corner of the wall surrounding the Manchu city. Here the members of the Russian missionary body, and the native Christians under their direction, carried out a series of magnetic and meteorological observations between 1841 and 1860. In 1864 this Observatory was separated from the missionary establishment, and in 1867 the St. Petersburg Academy of Sciences selected Dr. H. Fritsche for its director, a position which he held for sixteen years. For twelve of these he lived in Peking, while the other four were spent for the most part in journeying through the Chinese Empire and Siberia, in order to inspect the meteorological stations and the three magnetic observatories at Ekaterinburg, Barnaul, and Nerchinsk, to establish new stations, and specially to obtain astronomical, geographical, and hypsometric observations in as large a number of places as possible. His investigations into the meteorology of Eastern Asia were published by the Academy in 1877, and he now publishes in the *Ergänzungsheft* above alluded to the results of his sixteen years' observations in other departments. He describes his numerous journeys in China, Mongolia, and Manchuria, and gives a mass of data with regard to the latitude and longitude of places, and their heights above the sea-level. There are also, in the second part of the paper, a large number of measurements connected with earth magnetism. The title of the paper, which is a long one, and represents a vast amount of travel and labour, is "Ein Beitrag zur Geographie und Lehre vom Erdmagnetismus Asiens und Europas," von Dr. H. Fritsche, *Petermann's Mittheilungen Ergänzungsheft*, No. 78.

In the current number of *Petermann's Mittheilungen* the principal article is an account, historical and geographical, of "a lava desert in the interior of Iceland," and the largest lava area in Europe. The "desert" in question is situated in that part of the plateau in the interior which lies between the Vatnajökull and the rivers Skjálfandafljót and Jökulsá. It is known to the inhabitants of the neighbouring coasts as Odádahraun. The author, Th. Thoroddsen, describes his journey from Myvátn in detail.—Prof. Nell explains Fischer's perspective projection for maps, and gives a map of Asia on this system; while Herr Flegel describes his journey in 1879 with the Henry Venn expedition up the Pico Grande from the Cameroons.

The *Zeitschrift* of the Gesellschaft für Erdkunde at Berlin (Band 20, Heft 3) is almost wholly occupied with an account by Herr Schmidt of the travels of the friar Rubruk between 1253 and 1255 into the heart of Central Asia, and to the borders of China. This remarkable journey is described and explained with much painstaking learning. The only other contribution to the number is a table of lengths of the principal Russian rivers from General Tillo's survey.

From the latest reports the Australian New Guinea expedition appears to have progressed satisfactorily so far. The Government of Queensland had offered to hold frequent communication with the party by means of the steamer *Advance*, with a view of obtaining information of the progress of the work of exploration. A branch of the Geographical Society of Australasia is to be formed at Brisbane.

A Parliamentary blue-book (Corea, No. 3, 1885) lately published contains the report of a journey made by Mr. Carles, the Vice-Consul at Seoul, from that place to Phyöng Kang, where some gold mines exist. These lie to the west of the main road between Seoul and Gensan, and were stated to be of greater extent than any existing in Corea. They are in the Phyöng Kang district, in the neighbourhood of the town of Pai-namou-tjang, about 100 miles from the capital. Part of the road lay across a vast lava-field, which appears to exceed in extent even the largest in Iceland. Between Chhöl-wön and Pai-namou-tjang, a distance of 40 miles, there is only one break in its bed, which Mr. Carles attributes to the action of the stream which flows near Phyöng Kang; the uniform depth of the lava is about 100 to 140 feet, and it has a continuous and gradual ascent towards the north. Local statements as to its extent beyond Pai-namou-tjang were vague, but the plain could be seen stretching 13 miles farther up the divide of the eastern and western watersheds. Twenty miles north of this divide Mr. Carles left a similar plane last year, stretching from Anbyön to Kosan, but nearly 1000 feet below the level of the present plain. There are thus three great oval fields of lava passing almost in a straight line through the mountain chain which runs from the north to the south of Corea at a height of about 1500 feet above the sea near the divide, and of 500 feet in the lower levels. There is also another plain about 4 miles wide and 12 miles long to the east in Keum-sŏng district, the direction of which is not so well defined, but in which the depth of lava is apparently even greater than that in the others. No crater is visible in any direction to account for the enormous mass of lava; no hot springs were heard of within 30 miles, and sulphur is said to be imported from China, so that the gigantic overflow would appear to have taken place in the valley, and to have completely buried the volcano from which it came, if such were its source. At the first gold-washing visited about 270 men were said to be employed. Trenches were being dug in a bed of shingle by the river-side, and being driven parallel with the course of the stream. The men worked in parties of six, with one washer, who managed his wooden bowl very cleverly. Only small particles of gold are found, but the results seemed uniform and far superior to those of any other place visited by Mr. Carles in Corea. At two different washings which he witnessed, and which were said to give about the average yield, three basins of good earth, representing less than an hour's labour of six men, produced about fifteen pieces of gold—small indeed, but clearly visible at three yards' distance. Farther up the valley, where the men were working in smaller gangs, the yield was about the same in proportion to the number of men. On the western slope are other workings, where some 300 men are engaged, but these do not appear to be so productive. It appears that this valley has never before been worked for gold; in other places it has been sought for ages, and always found after the summer floods had brought down fresh detritus; but here the shingle seemed never to have been disturbed, or, rather, arranged in walls, before. The country here also seemed more promising than elsewhere, and to be worth the visit of an experienced miner.

For many years it was believed that the highest mountain in Sweden was Sulitjelma, on the frontier between Sweden and Norway, the height of which is about 6000 feet. A couple of years ago it was, however, discovered that the mountain of Sarjektjåkko, in Swedish Lappland, was a thousand feet higher. Lately, Dr. Svenonius, well known for his explorations of this provinee, has declared that neither of these mountains is the highest in Sweden, the honour belonging to Kebnekaisse, another peak in the same province, which the topographical surveyor of the province of Norrland has measured and found to be 7192 feet in height.

According to recent advices from the Faroe Islands, a well-known landmark has disappeared there, viz. the rock called "the Monk," situated about five miles south of Sumbö. Its height was nearly 100 feet. On the top of it lay some large boulders, which could be seen distinctly. Already last year part of the top fell down, but the body remained until last winter or this spring, when its disappearance was discovered.

MINERAL PRODUCTS OF THE UNITED STATES

The second Report on "The Mineral Resources of the United States," by Albert Williams, jun., Chief of the Division of Mining Statistics and Technology, United States Geological Survey, is now in press and will be issued shortly. This Report is for the calendar years 1883 and 1884, and contains detailed statistics for these periods and also for preceding years, together with much descriptive and technical matter. The following are the totals of the production of the more important mineral substances in 1884:—

Coal.—The only statistics in which the trade is interested are those relating to the amount of coal which is mined for and reaches the market. There is, besides, a local and colliery consumption which is usually disregarded in statistics, and which ranges from 5 to 6½ per cent. of the total shipments. Of what may be called the commercial product the quantities in 1884 were as follows:—Pennsylvania anthracite, 30,718,293 long tons; bituminous and brown coal, lignite, and small lots of anthracite mined elsewhere than in Pennsylvania, 66,875,772 long tons; total, 97,594,065 long tons. The spot value of the commercial product was: Pennsylvania anthracite, $61,436,586; bituminous and all other coals, $70,219,561; total, $131,656,147. Including the local consumption, &c., the total product in 1884 may be stated at 106,906,295 long tons—namely, 33,175,756 long tons of Pennsylvania anthracite and 73,730,539 long tons of bituminous and all other coals; and the value at the mines was: Pennsylvania anthracite, $66,351,512; bituminous and all other coals, $77,417,066; total, $143,768,578. The total production (that is, including colliery and local consumption) of anthracite was 1,160,713 long tons less than in 1883, while its value was $10,905,543 less, the disproportionate decline in value being due to a fall of 25 cents. per ton in spot price ($2·25 to $2). The total bituminous coal production increased 5,199,039 long tons over that of 1883, but its value was $4,820,734 less, the average valuation at the collieries having fallen from $1·20 to $1·05. The total output of all coals showed a net gain in tonnage of 4,038,326 long tons, and a decline in value of $15,726,277.

Coke.—There were 4,873,805 short tons of coke made in 1884, worth $7,242,878 at the ovens. This production consumed 7,951,974 short tons of coal. The amount of coke made was 590,916 tons less than in 1883, and the value was $878,729 less.

Petroleum.—The production of crude petroleum in 1884 was 24,089,758 barrels of 42 gallons each, of which the Pennsylvania and New York oil-fields produced 23,622,758 barrels. The total value, at an average spot price of 85 cents, was $20,476,294. As compared with 1883 the production was 689,529 barrels greater; but the total value was $5,263,958 less, the average sp t price having fallen from $1·10, or 25 cents per barrel.

Natural Gas.—The estimated value of the natural gas used in the United States in 1884 was $1,460,000, as against $475,000 in 1883. The value is computed from that of the coal superseded by natural gas.

Iron.—The principal statistics for 1884 are as follows:—Iron ore mined, 8,200,000 long tons; value at mine, $22,550,000. Domestic iron ore consumed, 7,718,129 long tons; value at mine, $21,224,854. Imported iron ore consumed, 487,820 long tons; total iron ore consumed, 8,125,949 long tons. Pig iron made, 4,097,868 long tons—a decrease of 497,642 tons as compared with 1883; value at furnace, $73,761,624, or $18,148,576 less than in 1883. Total spot value of all iron and steel in the first stage of manufacture, excluding all duplications, $107,000,000, a decline of $35,000,000 from 1883. Fuel consumed in all iron and steel works, including blast furnaces, 1,973,305 long tons of anthracite, 4,226,986 long tons of bituminous coal, 3,833,170 long tons of coke, and 52,110,660 bushels of charcoal, besides a notable quantity of natural gas. Limestone used as flux, 3,401,930 long tons; value at quarry, $1,700,965.

Gold and Silver.—The mint authorities estimate the production in 1884 at $30,800,000 gold and $48,800,000 silver (coining rate); total, $79,600,000. This was an increase of $800,000 gold and $2,600,000 silver as compared with 1883. The gold production was equivalent to 1,489,949 troy ounces, and the silver to 37,744,605 troy ounces.

Copper.—The production in 1884, including 2,858,754 pounds made from imported pyrites, was 145,221,934 pounds, worth $17,789,687, at an average price of 12¼ cents per pound in New York City. The amount was 28,070,139 pounds greater than the production of 1883; but the value was $275,120 less than that for 1883, owing to the decline in price. In 1884 4,224,000 pounds of bluestone (sulphate of copper, "blue vitriol") were made; worth, at 4·3 cents per pound, $181,632.

Lead.—Production, 139,897 short tons. Total value, at an average price of $75·32 per ton on the Atlantic sea-board, $10,537,042. The production was 4060 tons less than that of 1883, while the decrease in value was $1,785,677. The production of white lead (carbonate) is estimated at about 65,000 short tons, worth, at 4⅞ cents per pound, $6,337,500, almost all of which was made from pig lead. The production of litharge and red lead has not been ascertained.

Zinc.—Production of metallic zinc, 38,544 short tons; worth, at an average price of 4·44 cents per pound in New York City, $3,422,707. The output was 1672 tons greater than in 1883, and the value increased $111,601. Besides the spelter and sheet zinc, about 13,000 short tons of zinc white (oxide) were made directly from the ore, the total value of which, at 3½ cents per pound, was $910,000.

Quicksilver.—Production, 31,913 flasks (of 76½ pounds net = 2,441,344 pounds), or 14,812 flasks less than in 1883. Total value, at an average price of $29·34 per flask at San Francisco, $936,327, a decline of $317,305 as compared with the total value of the product of the previous year. During the year 600,000 pounds of quicksilver vermilion were made, worth $288,000.

Nickel.—Production of nickel contained in copper-nickel alloy, 64,550 pounds, worth, at 75 cents per pound, $48,412; an increase of 5,750 pounds, but a decline of $4508 in total value, owing to the falling off in price.

Cobalt.—The amount of cobalt oxide made in 1884 was about 2000 pounds, as against 1096 pounds made in 1883. Its value, as $2·55 per pound was $5100. The value of cobalt ore and matte cannot be ascertained, as it is chiefly dependent on the nickel contents.

Manganese.—The output of manganese ore in 1884 was about 10,000 long tons, or 2000 tons more than in 1883. The total value, at $12 per ton at the mines, was $120,000, or about the same as in 1883, the average price having declined $3 per ton.

Chromium.—The production of chrome iron ore, all from California, was about 2000 long tons, or about two-thirds as much as in 1883. At an average value of 17·50 per ton at San Francisco, the total value was $35,000.

Tin.—A little tin ore was taken out in the course of development work in Dakota, Wyoming, Virginia, and Alabama, but the only metallic tin made was a few hundred pounds from ore of the Black Hills (Dakota) mines, made in sample tests at New York City pending the building of reduction works at the mines.

Platinum.—The amount mined in 1884 was about 150 troy ounces, worth, crude, $3 per ounce.

Aluminium.—The amount made in the United States in 1884 was 1800 troy ounces, an increase of 800 ounces over the production in 1883. At 75 cents per ounce the total value was $1350.

Building Stone.—It is estimated that the value of the building stone quarried in 1884 was $19,000,000, as against $20,000,000 in 1883, the decline being due partly to dullness of trade and partly to the increased use of other structural materials.

Brick and Tile.—The output was about the same as in 1883, but as manufacturers cut down expenses still further, meeting a lower market, the total value is estimated at $30,000,000 as against $34,000,000 in 1883.

Lime.—There were 37,000,000 barrels (of 200 pounds) made in 1884, the average value per barrel at the kilns being not over 50 cents, or $18,500,000. The production was about 5,000,000 barrels greater than in 1883, but owing to the fall in price the total value was about $700,000 less.

Cement.—About 100,000 barrels (of 400 lbs.) of artificial Portland cement were made, or 10,000 barrels more than in 1883; the total value, at $2·10 per barrel, being $210,000. The production of cement from natural cement rock was 3,900,000 barrels (of 300 lbs.), or 200,000 barrels less than in 1883; worth, at 90 per cents per barrel, $3,510,000. The total production of all kinds of cement was about 4,000,000 barrels, valued at $3,720,000.

Precious Stones.—The estimated value of American precious stones sold as specimens and souvenirs in 1884 was $54,325, and the value of the stones sold to be cut into gems was $28,650; total, $82,975. About $140,000 worth of gold quartz was saved as specimens or made into jewelry and ornaments.

Buhrstones.—The value of the buhrstones yearly made in the United States is about $300,000.

Grindstones.—Dealers estimate the value of the grindstones made in 1884 at $570,000.

Phosphates.—The production of washed phosphate rock in South Carolina during tne year ending May 31, 1884, was 431,779 long tons, worth $2,374,784, or 53,399 tons more than in the previous year, wtth an increase of $104,504 in value. The average spot price, $5·50 per ton, was 50 cents less than in the preceding year. The recent discoveries of phosphate rock in the adjoining States of North Carolina, Alabama, and Florida will probably lead to a still further increase in production. Of manufactured fertilisers, 967,000 short tons, worth $26,110,000, were made in the year ending April 30, 1884, and 1,023,500 short tons, worth $27,640,000, were made in the year ending April 30, 1885.

Marls.—In New Jersey about 875,000 tons, worth $437,500 at the pits, were dug in 1884. In addition, small quantities were produced for local use in some of the Southern States. The production is declining, owing to competition with fertilisers made from phosphate rock, &c.

Gypsum.—In the Atlantic States, from Maine to Virginia, 65,000 long tons of land plaster and 60,000 tons of stucco, total 125,000 tons, were made in 1884, of which nearly all was from Nova Scotia gypsum. The statistics for Michigan have not been reported, but the production did not vary greatly from that in 1883, in which year it was 60,082 short tons of land plaster and 159,100 barrels (of 300 lbs.) of stucco. In Ohio 4217 short tons of land plaster and 20,307 barrels of stucco were produced. There was also a small production in other parts of the country; but the total amount of domestic gypsum used is not known.

Salt.—The production in 1884 was 6,514,937 barrels of 280 pounds (equivalent to 1,824,182,360 pounds, or 32,574,685 bushels, or 912,091 short tons, according to the unit used). The total value, computed on average wholesale prices at the point of production, was $4,197,734. The apparent output was 322,706 barrels greater than in 1883, while the value was $13,308 less; but the production figures do not include a considerable stock on hand in the Onondaga district, not officially reported because not inspected.

Bromine.—The production is estimated at 281,100 pounds, all from the Ohio and West Virginia salt district; worth, at 24 cents per pound, $67,464.

Borax.—Production about 7,000,000 pounds, or 500,000 pounds more than in 1883. The total value, however, was less than that of the product of 1883, being about $490,000 at San Francisco rates, as against $585,000 in 1883.

Sulphur.—No exact statistics. The production was only 500 tons, worth about $12,000.

Pyrites.—About 35,000 long tons were mined in the United States, worth about $175,000 at the mines. Some 33,500 tons of imported pyrites were also burned, making a total consumption of 68,500 tons.

Barytes.—Full statistics not received. The production is estimated to have been about 25,000 tons; worth, at $4 per ton, unground, at the point of production, $100,000.

Mica.—The production of merchantable sheet mica, not including mica waste, was 147,410 pounds, valued at $368,525.

Feldspar.—The production was 10,900 long tons, or 3200 tons less than in 1883. Its value at the quarries was $55,112.

Asbestos.—The amount mined was about 1000 short tons, worth about $30,000.

Graphite.—Production nominal, the supply being drawn from the stock accumulated in 1883.

Asphaltum.—The annual production is about 3000 tons, having a spot value of $10,500.

Alum.—About 38,000,000 pounds were made in the United States in 1884, or 3,000,000 pounds more than in 1883. At an average spot value of 1⅞ cents per pound, the product was worth $712,500.

Copperas.—The amount made in 1884 was 15,500,000 pounds, worth, at 60 cents per hundredweight, $93,000.

Mineral Waters.—The sales of natural mineral waters in 1884 amounted to 68,720,936 gallons, valued at $1,665,490, an apparent increase of 21,431,193 gallons, and $526,007 upon the figures for 1883. While the sales are undoubtedly increasing, it is possible that the excess in the reported quantity and value of the waters sold in 1884 as compared with 1883 may be partly due to the greater fullness of the returns for 1884. Besides the waters bottled and placed on the market there is a large local consumption, not included in the foregoing figures.

Totals.—As was remarked in the former report, it is impossible to state the total mineral product in any form which shall not be open to just criticism. It is evident that the production statistics of such incongruous substances as iron ore, metallic gold and silver, the spot value of coal mined, and the market value of metallic copper after having been transported hundreds of miles, the spot value of a crude substance like unground, unrefined barytes, and the value of a finished product like brick (in which the cost of manufacture is the leading item) cannot well be taken as items in a general summary. The statistics have been compiled with a view to giving information on those points which are of most interest and utility, and are presented in the form usual in the several branches of trade statistics. The result is that the values stated for the different products are necessarily taken at different stages of production or transportation, &c. Theoretically perfect statistics of mineral products would include first of all the actual net spot value of each substance in its crudest form, as taken from the earth; and yet for practical purposes such statistics would have little interest other than the fact that the items could be combined in a grand total in which each substance should be rated on a fairly even basis. The following groupings, therefore, are presented with a full realisation of the incongruity of many of the items. The grand total might be considerably reduced by substituting the value of the iron ore mined for that of the pig iron made, by deducting the discount on silver, and by considering lime, salt, cement, borax, &c., as manufactures. It will also be remarked that the spot values of copper, lead, zinc, and chrome iron ore are much less than their respective values after transportation to market. Still the form adopted seems to be the only one which admits of a comparison of the total values of the mineral products from year to year.

Résumé of the Values of the Metallic and Non-metallic Mineral Substances produced in the United States in 1884.

Metals	$186,097,599
Mineral Substances named in the foregoing Table	220,007,021
	406,104,620
Fire-clay, kaolin, potter's clay, common brick clay, terra cotta, building sand, glass sand, limestone used as flux in lead smelting, limestone in glass making, iron ore used as flux in lead smelting, marls (other than New Jersey), gypsum, tin ore, antimony, iridosmine, mill-buhrstone, and stone for making grindstones, novaculite, corundum, lithographic stone, talc and soapstone, quartz, fluorspar, nitrate of soda, carbonate of soda, sulphate of soda, native alum, ozokerite, mineral soap, strontia, infusorial earth and tripoli, pumice-stone, sienna, umber, &c., certainly not less than	7,000,000
Grand Total	$413,104,620

The total value of the metals and minerals produced in 1884 was $39,100,008 less than in 1883, and the decline in 1883 from 1882 was $3,012,061; that is, the falling off in value began on a small scale in 1883, but was accentuated in 1884. The net decline has been due rather to a depression in price than a decrease in quantity; indeed, several important substances show a decided increase in production, notwithstanding the general dullness of trade. The over-production, taking the whole field into consideration, has been less than was generally feared.

PROF. L. SOHNCKE ON THE ORIGIN OF THUNDERSTORM ELECTRICITY [1]

In order to express more than mere surmises as to the origin of thunderstorm electricity we must, above all, be familiar with the atmospherical conditions under which thunderstorms usually occur. For this purpose we must first take into consideration two general facts in meteorology: first, the average decrease of temperature with increase of height in free air; and secondly, the nature of the upper clouds.

With regard to the first point, a considerable amount of data is available in the observations of several scientific balloonists, especially those of Mr. J. Glaisher. Glaisher has constructed a table, based upon his numerous ascents, showing the average decrease of temperature for the altitudes of 1000, 2000, 3000 feet, &c. This table shows that even in the warm summer months the temperature of the freezing-point is met with generrally at the level of between 3000 and 4000 metres (say 10,000 to 13,000 feet).

Generally speaking, the aggregate of those points of space in which the temperature of 0° C. prevails at any given moment must lie on a certain surface, which may be denoted as the "isothermal surface of zero C." It is of especial interest to ascertain whether the result yielded by Glaisher's ascents as to the height of this surface in midsummer is confirmed by other ascents. In order to obtain an opinion upon this point I have grouped together those ascents which afford a sufficient number of data, in order to deduce therefrom the height of the isothermal surface of zero. This table includes twenty-three ascents by eight different balloonists at different seasons of the year; about half the ascents were made during the summer months. The following are the conclusions drawn from this table:—

In the warmest summer months the isothermal surface of zero was found to be at an height of about 3000 to 4000 metres, but occasionally sinks even at this season to about 2000 metres (say 6500 feet) above the level of the sea. It generally rises in the course of the forenoon, and, apparently, more rapidly the nearer noon is approached. It sinks in the course of the afternoon, and, apparently, more rapidly with the greater distance from noon. Its level may vary about 2000 metres in from one to two hours. The change from rising to sinking does not occur exactly at noon, but perhaps one hour or even more after noon, according to season.

A knowledge of the decrease of temperature on days of thunderstorms, especially just before the storm, presents therefore especial interest. Only few data exist on this point.

Glaisher made an ascent at 6 p.m. on the 31st August, 1863, after a thunderstorm had taken place at 8 a.m. He did not reach the isothermal surface of zero, but found a temperature of 1° C. at a height of 2300 metres (say 7500 feet). I have never found such a low temperature at a similar height in any of the six ascents in August and the beginning of September.

Flammarion made an ascent during the night of the thunderstorm of the 14-15 July, 1868, and met with 0° C. at a height of 2400 metres (say 6500 feet), but this was at 4h. 26m. a.m. Among all the midsummer ascents there is only one in which the isothermal surface of zero was met with at a lower level.

Welsh made an ascent in the afternoon of the 17th August, 1852, two hours before the occurrence of a thunderstorm; at 5 p.m. the isothermal surface of zero lay at a height of 3500 metres (say 11,500 feet), but it was rapidly sinking. Welsh did not find such a rapid decrease of temperature upwards in any of his other three ascents as in this one.

Kämtz has drawn the conclusion, based upon the great refraction which has often been observed with sultry thunderstorm air, that the rapid change of temperature with height is an important condition for the formation of thunderstorms, especially in summer. In order to obtain more precise data upon this point I have undertaken a small meteorological investigation as to the difference of temperature existing just before thunderstorms between Freiburg in the Breisgau and the Höchenschwand in the Black Forest, 2326 feet above it. I found that in seventeen cases which were suitable for comparison, in the years 1880 and 1881, the difference of temperature just before the thunderstorm was less than the average for the day and season in three cases only; in other cases it was greater.

From this it appears that, in most cases, the abnormally rapid decrease of temperature with height, and, in connection with this, the abnormally low position of the isothermal surface of zero may be taken as characteristic of the condition of weather before thunderstorms.

Secondly, attention must be paid to the nature of the upper clouds not only generally, but also more especially before thunderstorms. The clouds which lie above the isothermal surface of zero must of course mainly consist of ice particles, although, of course, the formation of clouds of superfused water particles is not excluded. The appearance of the ice clouds is, moreover, somewhat different from that of the water clouds. The former are known as "cirrus" and the latter as "cumulus" clouds. Observations on the height of clouds, made either in balloon ascents or on the ground, agree in showing that the limit of both kinds of clouds in midsummer lies about 4000 metres (say 13,000 feet) high, which agrees pretty well with the above calculation of the level of the isothermal surface of zero. It is not surprising, therefore, that balloonists frequently reach snow-clouds even in midsummer—for instance, Glaisher on June 26, 1863, between 3300 and 4200 metres (say 11,000 and 14,000 feet); Fonvielle on July 4, 1875, at 3450 metres (say 11,300 feet); Barral and Bixio on July 27, 1850, between 4500 and 6300 metres (say 15,000 to 20,500 feet); Welsh on August 17, 1850, at 5990 metres (say 19,500 feet).

While the distinction between ice and water-clouds, from their mere appearance as seen from the earth, is always somewhat difficult to be made out, we have in many cases an infallible

[1] Extract from "Sitzungsberichte der Jenaischen Gesellschaft für Medecin und Naturwissenschaft." Jahrg 1885. Sitzung vom 1 Mai.

means of distinguishing between them—namely, by the character of the solar and lunar halos which are very often seen in thin veils of clouds. It has been established beyond doubt that the rings of light of larger size, or halos of about 22° diameter, are caused by refraction in ice crystals. (This angle is that of the least deviation for rays of mean refrangibility in passing through ice-prisms of 60°). On the other hand the smaller rings (coronæ) of from 1° to 6° diameter owe their origin to the refraction of light through spheres of uniform size. Halos are not nearly so rare as is commonly supposed. M. Galle observed seventy-eight halos and about as many parhelia in a year and a half, and often even in the heat of summer. Kämtz laid great stress on the importance and infallibility of this optical means of distinguishing between the two classes of clouds.

After these preliminary considerations let us turn to thunderstorms. The local or heat thunderstorms (identical with most summer thunderstorms) are best known, while the large cyclonic thunderstorms have been less investigated. In the first case, the appearance of the clouds which rise high in the sky as gigantic columns of cumulus, show that they owe their origin to a strong ascending current of great humidity. According to Dr. Reye, the principal condition for the formation of a continuous ascending moist air current is the abnormally rapid decrease of temperature in its vicinity, while in the current itself the decrease of temperature with height is essentially retarded, owing to the latent heat set free by the condensation of vapour. Under these conditions, the distribution of temperature in the atmosphere is therefore such that the isothermal surface of zero in the ascending current is raised especially high, while outside this current the surface has an abnormally low position. In this way, therefore, water still in a liquid state reaches the ice-region; ice-clouds and water-clouds must exist side by side. If the moist current rises sufficiently high its temperature sinks below 0° C. and this gives rise to cirrus clouds of snow and hail, which latter frequently accompanies thunderstorms. Kämtz has shown from his observations in high mountains that the height of the locus of thunderstorms must not be placed too low; the usual estimations of the height of thunderstorms based upon observations of lightning and thunder cannot be taken into account here, for they only show (and that very inaccurately) the position of the lowest structure of the thunderstorm clouds.

Both Hann and Kämtz agree that water and ice clouds always exist simultaneously in the sky, and not only during local thunderstorms but also during those of the other kind. Hann describes the layers of "cirrostratus" cloud as always existing with thunderstorms. Kämtz has always been able to recognise halos *i.e.* the characteristic indication of the presence of ice particles before thunderstorms, as soon as he could trace the change from clear sky to thick clouds. And in all three of the previously mentioned balloon ascents on days of thunderstorms ice particles have been observed in the air.

We may take it that it has been established that in every thunderstorm clouds composed of water particles and others of ice particles exist simultaneously side by side, and that, of course, they are mutually changing places it is very easy to suppose that the friction of water particles and ice particles may serve as a source of electricity. But this is in no way a mere supposition, for it is a fact already established by Faraday. In his experiments on the cause of the production of electricity in Armstrong's steam electrical machine, which was considerably modified by him, he frequently caused compressed air to strike against solid objects. The cooling arising from the expansion of the air caused a copious formation of fog, and the friction of these particles against the objects always excited the particles with + electricity and the solid objects with − electricity. It was only by the friction of the particles against ice that the latter became + on every occasion, while wood and metal were excited with − electricity by the friction of the particles.

I have frequently repeated these experiments of Faraday's, and, as was to be expected, entirely confirmed them. Of course several precautions must be taken if we do not wish to be checked by evidently contradictory results. The principal causes of disturbance may arise by the carrying away of particles of grease from the greasing of the taps, and on the other hand by the friction of the particles on the walls of the tube, if the turning on is not quick enough. In the latter case the particles become + and communicate this electricity to the objects they meet, and thus, therefore, the character of the electricity by friction with these bodies is partially or wholly masked. The colder the ice the more powerfully it becomes electrified—a fact which appears to be in connection with the increase of its insulating power with decreasing temperature.

If, therefore, air-currents flow against each other, one being of ice particles and the other of water particles, the ice particles become positively and the water particles negatively electrified, and as by no means a rapid mixing of both kinds of air-currents is requisite, which may be seen *inter alia* from various observations on smoke-laden air-currents in laboratories, the oppositely electrified bodies are quickly repelled from each other.

The real cause of thunderstorm electricity appears to me to lie in the sequence of phenomena above described. It is not my intention to discuss the behaviour of the further phenomena connected with thunderstorms.

A more detailed exposition of the theory very briefly sketched here, as well as the observations used for its proof, will be found in my Treatise on the Origin of Thunderstorm Electricity and of the Ordinary Electricity of the Atmosphere, just published by G. Fischer, Jena. ("Der Ursprung der Gewitter-Elektricität, und der gewöhnlichen Elektricität der Atmosphäre.")

CYSTOLITHS

M. J. CHAREYRE[1] has made a detailed examination of these structures in plants belonging to the Urticaceæ, and to many other families. The following are some of the chief results:—

In the Urticaceæ the prolonged action of darkness causes complete disappearance of the calcium carbonate in the cystolith, though without their mass sustaining any diminution; they retain completely their original form. This takes place before the etiolation which is the result of placing the plants in question in the dark. It is due probably to the cessation of the action of chlorophyll. Calcium oxalate disappears in the same way from the cystoliths. The lime set free by the decomposition of these salts collects in the stem, where it exists in combination with some other acid.

In the Acanthaceæ, on the other hand, none of these phenomena are exhibited, and the cystoliths undergo no change from the action of darkness; and this difference in the behaviour of the cystoliths in these two natural orders appears to correspond to no less important differences in their constitution. The calcium carbonate appears in one family in the crystalline, in the other family in the amorphous, form.

All the seeds of Urticaceæ examined before germination presented reservoirs of food-material consisting exclusively of aleurone, in each of which was a rounded globoid. The same was the case with the Acanthaceæ, except *Acanthus* and *Hexacentris coccinea*, plants containing no cystoliths, and in which the reserve-material of the seeds consists chiefly of starch. The calcareous reserve-material contained in the seeds in the form of globoids disappears more rapidly when they germinate in a soil formed of pure silica than in ordinary soil, or in one composed of calcium carbonate. But no part of this reserve-material contributes to the formation of deposits of calcium carbonate, whether as cystoliths or in any other form, nor to the production of crystals of calcium oxalate. In seeds which germinate in pure silica the cystoliths do not arrive at full development; the pedicel is formed, but no deposition of either cellulose or lime takes place at its extremity. In soil composed of calcium carbonate the cystoliths appear at the same time as in ordinary soil, *i.e.* at the moment when the green cotyledons are disengaging themselves from the seminal envelopes, but their development is somewhat more rapid. Seeds sown in ordinary soil or in calcium carbonate, but kept in darkness, give rise to rudimentary cystoliths without any calcium carbonate.

Yellow dying leaves of many Urticaceæ present, as contrasted with green leaves, cystoliths containing a smaller quantity of calcium carbonate, but this is not the case with Acanthaceæ or with *Pilea*.

Both the calcium carbonate in the cystoliths and calcium oxalate are believed by the author not to be merely products of excretion, but to play an important part in the life of the plant.

[1] See *Revue des Sciences Naturelles* for 1884 and 1885.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE following list has been issued by the Science and Art Department of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships, May, 1885:—William Burton, aged 22, science teacher, Manchester, National Scholarship; Philip L. Gray, 19, assistant master, Southampton, National Scholarship; Charles Lang, 22, engineer, Johnstone, N.B., National Scholarship; Thomas Clarkson, 20, engineer, Pendleton, Manchester, National Scholarship; Harry E. Hadley, 18, student, Worcester, Royal Exhibition; William Scudamore, 16, student, Northampton, National Scholarship; Frederic W. Lanchester, 16, architect's assistant, Southampton, National Scholarship; Thomas H. Holland, 16, student, Helston, National Scholarship; Harold E. Hey, 14, student, Manchester, National Scholarship; William Blackmore, 18, student, Sheffield, National Scholarship; Hugh O. Bennie, 20, engineer, Glasgow, Royal Exhibition; William Kelsall, 17, student, Bradford, National Scholarship; Henry Sowerbutts, 17, student, Manchester, National Scholarship; Frederick Chattaway, 24, chemist, Birmingham, National Scholarship; James Young, 23, shoemaker, Belfast, Royal Exhibition; Arthur J. Moulton, 20, engineer's apprentice, Preston, Royal Exhibition; Harold C. Coote, 17, student, London, Royal Exhibition; Robert H. Unsworth, 20, engineer, Pendleton, Manchester, Royal Exhibition; Sidney H. Woolhouse, 15, student, Weaste, Manchester, Royal Exhibition; David Wilkinson, 21, agent, Preston, Free Studentship; Henry P. Motteram, 19, student, Small Heath, Birmingham, Free Studentship; Albert E. Briscoe, 17, machinist, Birmingham, Free Studentship; Orlando J. Preston, 16, student, Bristol, Free Studentship; James McKenzie, 20, engineer, Glasgow, Free Studentship; Philip C. Coultas, 18, student, Bristol, Free Studentship.

We have received the calendars for the ensuing session of the University College, Dundee, and of the Durham College of Science, Newcastle-on-Tyne. A very important addition to the educational programme of the former is the establishment of a new Chair of Biology. This chair was needed on account of the recognition of the science department of the college by the University of Edinburgh, and also because the science curriculum was incomplete for graduation in London University. The new chair has been filled by Mr. D'Arcy Thomson, of Cambridge.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, August 17.—M. Bouley, President, in the chair.—Observations of the minor planets made at the Observatory of Paris (large meridian instrument) during the second quarter of the year 1885, communicated by M. Mouchez.—Note on typhoons and the so-called "grains arqués" of the eastern hemisphere (two illustrations), by M. Faye. From the descriptions of these meteorological phenomena made by observers in the Indian and Pacific Oceans, and in Senegal, the author concludes that all such cyclonic movements of the atmosphere affect a circular form. The importance of this conclusion is obvious in connection with the theory which regards these atmospheric disturbances as sharply defined whirlwinds of circular shape, not as the result of currents converging towards a common centre of attraction without definite outer limits.—Researches on the present and the prehistoric races of Brazil, in connection with the sixth volume of the Natural Museum of the *Archives* of Rio de Janeiro, presented to the Academy on behalf of the Emperor Don Pedro II., by M. de Quatrefages. The contents of this volume are of great importance for the comparative study of the Brazilian races past and present, and of the primitive cultures of the more civilised populations in North and South America. It contains papers by M. Hartt on the river and marine shell heaps occurring in various parts of Brazil; by M. J. B. de Lacerda on the human remains found from time to time in these deposits, and by M. Peixoto on the Botocudos still surviving in the eastern provinces of Brazil. But the chief attraction of the volume is the valuable and richly illustrated memoirs of M. Ladislaus Netto, on the remarkable artificial hill of Pacoval, which is now fully described for the first time. This hill, entirely the work of man, stands on the margin of a lake in the island of Marajo, and although reduced by erosion and weathering to a fifth or a sixth of its original size, is still 300 metres long, 250 broad, and 6 high. It presents the outlines of a gigantic Jabuti turtle (*Emys faveolata*), in this respect showing analogies with the works of the mound-builders in the Mississippi basin. Its contents are of the most varied character, including stone implements of all kinds, idols, amulets, and a vast quantity of earthenware, funeral urns, vases, *tangas*, &c., covered with ornamental designs remarkable for their delicacy and taste, either painted, incised, or modelled in relief. Some of the signs appear to be of a hieroglyphic character, presenting certain analogies to the early Chinese, Egyptian, and Mexican writings. One inscription, which M. Netto has attempted to interpret, seems to speak of long migrations, most probably from the Andes highlands down the Amazons basin, towards the Atlantic seaboard.—Experimental researches on cholera, by MM. Paul Gibier and van Ermengem. Appointed by their respective Governments to study Dr. Farran's method of preventive vaccination, these biologists have independently arrived at the same conclusion, that the sub-cutaneous injections of the cultivated virus (comma bacillus) does not preserve from cholera the animals on which their experiments have been made.—Observations of Tuttle's comet made at the Observatory of Nice (Gautier's equatorial), by M. Perrotin.—Equatorial observations of Barnard's comet (*a*) made at the Observatory of Algiers with the 0·50 m. telescope, by M. Ch. Trépied.—Account of a remarkable solar protuberance observed on the eastern edge of the disk at Paris on August 16, by M. E. L. Trouvelot.—Description of a new magnifying apparatus for the projection of microscopic objects as well as of images of large dimensions, by MM. Théodore and Albert Duboscq.—On the action of the iodide of phosphonium on the oxide of ethylene, by M. J. de Girard.—On the elective alcoholic fermentation of sugar, by M. H. Leplay. Against the objections of MM. Bourquelot and Maumené the author maintains from his own experiments that the elective alcoholic fermentation as originally discovered and described by M. Dubrunfant really exists and must be accepted as a scientific although hitherto unexplained phenomenon.—On the organisation, anatomy, and digestive function, of *Pachydrilus enchytræoides*, by M. Remy Saint-Loup.—Extraction and composition of the gases contained in the foliage of floating and submerged aquatic plants, by MM. N. Gréhaut and J. Peyrou.—Recurrence of the superficial earthquake at Escarpel and in the neighbourhood of Douai, Département du Nord, by M. Virlet d'Aoust.

CONTENTS

THURSDAY, SEPTEMBER 3, 1885

THE ANDAMAN ISLANDERS

On the Aboriginal Inhabitants of the Andaman Islands. By Edward Horace Man, Assistant Superintendent, Andaman and Nicobar Islands, with Report of Researches into the language of the South Andaman Islands, by A. J. Ellis, F.R.S. Reprinted from the *Journal* of the Anthropological Institute of Great Britain and Ireland. (London: Trübner and Co.)

"IN considering the habits, customs, and physical peculiarities of a savage race, it is important to acquire as much information as possible regarding the land they inhabit, and also to ascertain the nature and extent of the influences exercised by, or resulting from, their intercourse with other nationalities."

The author of the work from which the above extract is quoted has proved himself fully qualified to treat of this interesting race of people, among whom he resided for four successive years in his capacity of Assistant Superintendent, from the scientific point of view which he has so well defined in the foregoing passage. The volume before us consists essentially of a series of papers communicated at various times since 1880 to the Anthropological Institute, and now republished, with the sanction of the Institute, in a separate form, with an introduction and fourteen short appendices. The report on the language of the South Andaman Islands concludes the volume, and bears a separate title-page indicating that it has been drawn up by Mr. A. J. Ellis, F.R.S., from the materials furnished by Mr. Man and Lieut. R. C. Temple, of the Bengal Staff Corps.

The Andaman Islands consist of a group situated in the Bay of Bengal between the 10th and 14th parallels of N. latitude, and comprise Great and Little Andaman, the former consisting of North, Middle, and South Andaman, together with the Archipelago, Interview, Rutland, and many other small islets. The entire area of the islands is estimated at about 2508 square miles, of which about 2000 square miles are comprised in Great Andaman. Some pages of the introduction are devoted to a description of the physical features, climate, and scenery, the author calling special attention to the numerous fine harbours which offer safe anchorage during all seasons. With respect to the population, Mr. Man estimates the total number of the aborigines of Great Andaman as probably about 2000, and of those inhabiting Little Andaman 1000 to 1500; the aggregate population of all races is about 15,000, nearly four-fifths of this number being made up of the convicts inhabiting the penal settlement. A succinct history of the settlement is given, from which it appears that the modern history of the Andamans dates from 1857, although a previous attempt to found a penal station had been made by the Honorable East India Company, but this was abandoned in 1796 on account of the high death-rate.

The author recognises eight distinct tribes of aboriginal inhabitants in Great Andaman and one in Little Andaman. The natives with which the officers in charge of the station at first came into contact displayed much hostility and considerably harassed the operations of the working parties; but improvements have gradually been effected in the relationship between the aborigines and the settlers chiefly through the establishment of Government homes, and now, as Mr. Man states in a passage quoted from Dr. Day, "the convicts are left unmolested, the implements of agriculture are not stolen, the fishing stakes are left undisturbed, the gardens are no longer pillaged, runaway convicts have been recaptured, and shipwrecked sailors assisted." The author, who had charge of one of the homes, also states that these "have effected good in bringing together members of the various tribes, between whom the way has thus been paved for intermarriages, which were of course formerly of rare occurrence; tribal feuds have also here been amicably arranged, while, through visits paid to Port Blair and other homes by members of all the Great Andaman tribes, as well as by our visits in the station steamer to the more distant encampments, the knowledge of our power, resources, and kindly intentions has spread throughout their respective territories." The aboriginal inhabitants of Little Andaman are, however, still unreclaimed, and all attempts to civilise them have hitherto failed; their hostility towards strangers is such that any persons unfortuate enough to be cast on their shores would be as ruthlessly slaughtered now as at any period prior to our annexation of the islands.

The effect of the contact with civilisation upon those more friendly tribes who have accepted the advantages offered by the homes is however similar to that which invariably results from all such attempts:—"in proportion as they gain in intelligence and tractability, the more fat and indolent do they become, and, having no incentive towards exertion, frequently lose in great measure their quondam skill in hunting." Still more serious is the moral deterioration which has taken place through contact with the convict population, and Mr. Man is careful to point out that his observations have been confined to those primitive communities which have not yet had time to be affected by the virtues and vices of modern civilisation. One interesting point which has been brought out by an attempt to educate the native children is that up to the age of ten or eleven they are as intelligent and can learn as well as the children of civilised races, but after this age no further progress is possible. This feature in the mental evolution of savage races has, if we remember correctly, been observed in the case of many other uncivilised tribes.

In the succeeding portions of the volume we have an immense amount of detailed information upon all the points which are likely to be of value to the anthropologist. With regard to the vexed question of the origin of the race, Mr. Man considers that the natives are the direct descendants of the prehistoric inhabitants, that they all belong to the same race, and that the tribal differences are the effects of isolation by the natural barriers of the country and the constitutional jealousies and hostilities which formerly prevented the tribes from living on amicable terms with each other. Ethnologically the author regards these people as Negritos, and "racial affinity—if there be any—may possibly some day be found to exist between them and the Semangs of the Malayan Peninsula, or the Aëtas of the Philippine Islands."

T

Following the section on the ethnology of the Andamanese we have an excellent description of their form and size, forty-eight males and forty-one females having been most carefully weighed and measured, with the result that the average height of the men is 4 feet 10¾ inches and of the women 4 feet 7¼ inches, and the respective average weights 98⅛ lbs. and 93¼ lbs. To give an idea of the thoroughness with which the author has dealt with his subject, under the heading "Anatomy and Physiology," we have a series of five sets of observations on the temperature and rate per minute of respiration and of the pulse on five subjects ranging in age from seventeen to twenty-two years. Descriptions of the pathology, medicine, physiognomy, physical powers and senses, psychology and morals, magic and witchcraft, of the tribal distribution, topography, arithmetical faculties, and of their habitations, government, laws, crimes, &c., complete the first part.

With respect to diseases it appears that pulmonary consumption and other pectoral complaints are or were the chief causes of mortality among these people; to these have unfortunately now to be added that "terrible scourge" which has spread over the greater part of Great Andaman, and which, as in Australia, unless successfully dealt with, threatens, as Mr. Man informs us, "the early extermination of the race."

The morals of the Andamanese in their primitive state appear to be of a distinctly high standard, as will appear from the following extracts:—

"Much mutual affection is displayed in their social relations, and, in their dealings with strangers, the same characteristic is observable when once a good understanding has been established . . . every care and consideration are paid by all classes to the very young, the weak, the aged, and the helpless, and these, being made special objects of interest and attention, invariably fare better in regard to the comforts and necessaries of daily life than any of the otherwise more fortunate members of the community. Andamanese children are reproved for being impudent and forward . . . they are early taught to be generous and self-denying . . . the duties of showing respect and hospitality to friends and visitors being impressed upon them from their early years," &c. With regard to their modesty Mr. Man states that the esteem in which this virtue is held, "and the self-respect which characterises their intercourse with each other may even be said to compare favourably with that existing in certain ranks among civilised races." It is much to be regretted that the so-called "civilisation" with which these people have been brought into contact should have led to the moral deterioration which the author with scientific candour does not scruple to disclose. It is perhaps hardly necessary to add that the stories concerning the prevalence of cannibalism among these tribes have been completely disproved both with respect to the present time and to former periods of their history.

In the second part of his interesting monograph the author treats of the language, relationships, names, initiatory ceremonies, marriage, death and burial, superstitions, religious beliefs, demonology and mythology. In the third part we have an account of the social relations of the Andamanese, their mode of life, games and amusements, and a description of their weapons, manufactures, &c. Want of space forbids anything more than a mere mention of the ground covered by these sections, but it will suffice to say that they are characterised by the thoroughness which is such a valuable feature of Mr. Man's work. The few slight defects which we have noticed are on matters of quite minor importance, such, for instance, as the statement in the introduction, that "the water in the harbour of Port Blair has been found to be remarkable for its high density, as is evidenced by the rapid oxidation of iron immersed in it;" in its present form this reads rather like a case of *non sequitur*.

It remains only to add that in the fourteen appendices we have a mass of most valuable information on various subjects connected with these islands and their inhabitants: most of these appendices are philological; one is devoted to a list of the native trees, and another to a list of the shells.

The Report on the language of the South Andaman Islanders is reprinted from the *Transactions* of the Philological Society, before which body it was delivered by its author, Mr. A. J. Ellis, F.R.S., as his retiring presidential address in 1882. The volume is illustrated by a good series of typical photographs of the natives and five plates of weapons, ornaments, &c., and a map of the islands forming a frontispiece.

In concluding this notice we must not omit to mention that Mr. Man's mode of treatment is based upon the instructions drawn up by Col. Lane-Fox (now General Pitt-Rivers) on behalf of a Committee of the British Association, and published among the Reports for 1873. This Report was afterwards issued in an expanded form as a Manual of Anthropological Notes and Queries, and the work now under consideration may be regarded as one of the most important practical results of the labours of the Committee referred to. We believe that Mr. Man is at present engaged in a similar study of the inhabitants of the neighbouring Nicobar Islands, one of which—Camorta—was selected as a station by the Eclipse Expedition of 1875. We shall look forward with much interest to the continuation of the author's labours in this new field.

R. M.

COMMERCIAL ORGANIC ANALYSIS

Commercial Organic Analysis. Vol. I. By Alfred H. Allen, F.I.C., F.C.S. (London: J. and A. Churchill, 1885.)

NOTWITHSTANDING the fact that enormous numbers of text-books on chemical subjects have been appearing during recent years, a few comprehensive works on the subject of commercial analysis have been long and greatly needed. When it is considered how every day commerce has been availing itself more and more of the powers of scrutiny and control afforded by chemical analysis, this delay may appear remarkable. But the truth is that to produce such a work very exceptional qualifications and a very unusual degree of experience are necessary. A work on commercial analysis must be thoroughly practical if it is to be useful, and prescribe methods of analysis only which experience has proved to be accurate and serviceable. Analysts as a rule have their specialities—these specialities often being determined by local industries—and long experience frequently leads them to devise or modify processes without any record appearing outside their own laboratories. Almost every analyst has his own manuscript "process-book," according to which he expects his assistants or pupils to work, and so it becomes a matter of extreme difficulty for an author to produce a work that shall be generally acceptable as a laboratory guide. The too frequently occurring discrepancies in commercial analyses may in a measure be attributed to the same cause, and there can be no doubt that a unification in the methods of conducting and recording analyses is greatly to be desired. This end will doubtless be greatly furthered by the production of standard books such as the present one.

A first edition of the work before us appeared in 1879. It has undoubtedly taken already a very high position, and has been welcomed as filling a conspicuous gap in the literature of analytical chemistry. The value of a division between organic and inorganic analysis to the ordinary analyst may not be great, but it is useful to the author in enabling him to keep his work within bounds. The first edition of the book appeared in two volumes; in the new edition a rearrangement and extension is being made, and it will now occupy three volumes. The first volume deals with organic bodies of the fatty series and of vegetable origin, and includes chapters on the alcohols, ethers, and other neutral derivatives of the alcohols, sugars, starch and its isomers, and vegetable acids. The second volume, which is to appear shortly, will be devoted chiefly to coal-tar products and bodies of the aromatic series, to hydrocarbons generally, fixed oils and the products of their saponification, and the tannins. Nitrogenised organic substances, including cyanogen compounds, alkaloids, organic bases, and albumenoids will be treated of in the third and concluding volume. This arrangement of the subject is, we think, a great improvement on the previous one, and makes the book much more convenient for reference.

Mr. Allen treats his subject in as scientific a manner as possible, and this gives quite a peculiar character to his work. It is not, like so many books on analysis, merely a series of receipts or processes of chemical handicraft; but a work assuming the possession of some really scientific knowledge on the part of those using it. It would be easy to go too far in attempting to generalise in such a subject as commercial analysis and in introducing theoretical details; but although the author goes so far, for instance, as to introduce structural formulæ for many of the substances dealt with, it cannot be said that he demands more knowledge than should be forthcoming from those engaging in this difficult and often obscure branch of analysis.

The introduction, extending over thirty-five pages, embraces a description of some general methods, such as the determination of specific gravity, of melting- and boiling-points, optical properties, &c. The rest of the volume is devoted to a consecutive account of substances comprised under the several headings. After the author has described briefly but sufficiently what the substance is or ought to be, he gives the methods for its detection, estimation, or analysis, and intersperses the account with such general information as is likely to be of value to the analyst. We cannot attempt to enumerate the somewhat remarkable collection of products dealt with in the course of the work. Wines, beers, cordials, tinctures chloroform, sugars, confectionery, starch, vinegar, the commercial acetates, tartrates, and citrates—are examples taken at random, which will serve to give some idea of the variety. They are, however, treated in a connected manner, in illustration of which we may refer with special approval to the division on sugars, and starch and its isomers.

With regard to the methods recorded by Mr. Allen we may say that on the whole they are such as have borne the test of experience, whilst new processes or modifications of old ones are duly referred to and discussed. The author acknowledges assistance from many men of experience, and has, we think, used it to the best purpose. His descriptions are clear and concise, and the book is remarkably free from errors of any kind. We think it really an excellent enterprise, excellently carried out, and congratulate Mr. Allen on having produced a scientific and thoroughly practical book which, we are confident, will find a place in the library of every practical chemist.

RECENT TEXT-BOOKS OF DETERMINANTS

Lecciones de Coordinatoria con las Determinantes y sus principales aplicaciones. Por D. Antonio Suarez y D. Luis G. Gascó. (Valencia, 1882.)

Traité Élémentaire des Déterminants. Par L. Leboulleux. (Genève, 1884.)

Die Determinanten, für den ersten Unterricht in der Algebra bearbeitet. Von Dr. H. Kaiser. (Wiesbaden 1884.)

Lessons Introductory to the Modern Higher Algebra. By George Salmon, D.D. Fourth Edition. (Dublin, 1885.)

THE first of these works is outwardly a very handsome volume, and on examination we find that the authors have also done their part in the most painstaking and methodical way. The main part of the title, "Coordinatoria," is apt at first to mislead, and indeed after a cursory glance at the contents a cosmopolitan reader might be pardoned for thinking that "Coordinatoria" was a misprint for "Combinatoria," for what our grandfathers spoke of as the *Ars Combinatoria* is the subject of the opening chapters. "Coordinatoria" it is, however, and in the preface it is placed as a science side by side but in contrast with the science of Quantity.

There are in all twenty chapters in the book. The first seven (146 pp.) deal with permutations, combinations derangements or inversions of order, substitutions, and difference-products: they form a lengthy and most carefully prepared introduction to the theory which follows. The next ten chapters (242 pp.) deal with determinants, and expound all the more important properties in the most methodical, simple, lucid and ungrudging manner. The learner, for example, is prepared for the evaluation of a determinant whose elements are expressed in figures by—

§ 327. Simplification by addition.
§ 328. Simplification by subtraction.
§ 329. Simplification by addition and subtraction.
§ 330. Simplification by multiplication.

And so on, up to—

§ 335. Simplification by multiplication, addition, and subtraction.

An impatient Briton might be tempted to call this "simplification to the death," but after calmly perusing the whole he might be induced to confess that he had said so in his haste. The last three chapters deal with applications of determinants: one is arithmetical, and is mainly concerned with continuants and magic squares—a rather invidious juxtaposition; one is algebraical, and gives the determinantal solution of a set of simultaneous linear equations; and the last is geometrical. A very valuable feature of the book is a *résumé* in 40 pp. of all the definitions and theorems given in the preceding 410 pp. No one but a most enthusiastic and painstaking teacher would have thought of adding such an admirable abstract.

The next book on our list might have been more accurately described as a *very* elementary treatise: it must have been intended for pupils with exceedingly little algebraical training. The first 18 pp. are occupied with determinants of the second order, and they are followed by 33 pp. treating of those of the third order. It may be safely affirmed that the pupil who requires 18 octavo pages to teach him the theory of such abstruse functions as determinants of the second order would do well to redirect the expenditure of his mental energy. The book is carefully and accurately written, and there is a wealth of simple exercises in it, worked and unworked.

Dr. Kaiser's pamphlet is of the same ultra-elementary character—considerately restricted, however, to 23 pp. On a former occasion (NATURE, vol. xxix. pp. 378, 379) we drew attention to the fact that a new Introduction of this kind appears every year in Germany, and that of late they have not been improving. We merely notify, therefore, that this is the production for 1884.

The preparation of a new edition of Salmon's "Modern Higher Algebra" has been entrusted to Mr. Cathcart. It contains about 40 pp. of new matter, the chief increase arising from the expansion of the chapter on "Applications to Binary Quantics" into *two* chapters, the first with the old title, and the second headed "Applications to Higher Binary Quantics." The changes made on the portion which deals with determinants are slight, and consist chiefly in the insertion here and there of well-chosen examples.

OUR BOOK SHELF

The Three First Years of Childhood. By Bernard Perez. Edited and translated by Alice M. Christie. With an introduction by James Sully, M.A. (London: W. S. Sonnenschein and Co., 1885.)

THE earliest years of infancy are of importance to two classes of inquirers—to the educator who knows how much evil results from the wrong treatment of young children, and to the evolutionist who, rejecting the *tabula rasa* of Locke, looks to infancy as the time freest from any effect of artificial training. In the study of other *men's* minds the observer is as likely as not to be purposely deceived by them, whereas deceit is an accomplishment which few infants have attained to.

Mr. Bernard Perez seems well to combine these characters. He is an educator who has published various works on school matters, and he describes man as an animal which ought to be reasonable, while he is not necessarily so, as criminal scandals and the success of bad novels prove. He notes that the preponderating elements in a child's will are impulsiveness and stubbornness, incapability of fixed attention, qualities most opposed to the temperament of philosophy and discipline. Much of his book is advice to practical educators, whom he urges to study the manifestations of infancy and to endeavour to lead their youngest pupils by example and not check their behaviour by authority; their intellect should be helped, not controlled. He specially points out the danger of deceit before even the youngest of children.

But, on the other hand, there is little of the tone of the pedagogue in his book. Far more is it a book of suggestion than one teaching with authority, and it will encourage the spirits of fruitful doubt and inquiry in the mind of every reader. He enters heartily into the teaching of modern science, even to using the argument that infants have not certain sensations *because* they would be of no use to them at that age; and, thinking it necessary to caution his readers against leaving everything to hereditary dispositions and powers. He urges the importance of comparing early human life with animal life, thus making cats, dogs, birds, and babies more interesting than before. We may enjoy his book without accepting the teaching that human language has grown out of such involuntary signs as laughter, sobs, and screams, afterwards performed voluntarily. No doubt these involuntary sounds are of more use to an infant than more sober utterances, and have therefore become innate and involuntary, while language is an artificial acquirement. We think that few who have watched their vigorous antics will feel sure that a state of equilibrium, a passive state of health, or even that of moderate and appropriate exercise in moving their limbs, is the most enjoyable sensation to infants, though this latter pleasure is sufficient to explain many actions of infants for which our author seeks a deeper reason. On the other hand, we think that the moral sense has become more deeply impressed than he suggests, and is far from entirely the result of approbation and disapprobation.

Attention and vivid perception seem strangely shaken up in his remarks; the latter faculty explains the dislike which children have to hearing a tale repeated with variations. They have indeed got it all "by heart."

Mr. Sully, in his very suggestive introduction, raises the question, Who is best qualified to follow up this delicate business of observing and rightly explaining all the movements and utterances of such young objects? Neither father, mother, nurse, nor doctor is completely qualified for the study. Mr. Sully concludes that the father and mother must conjointly undertake the work, the cooler intellect of the one checking and steadying the close and loving knowledge of the other. Let us suggest that an elder sister is most likely to succeed, and thus indicate a path to intellectual usefulness and even eminence well fitted for a lady's sphere. It will elevate every little labour from drudgery into a scientific study of variations and resemblances of the greatest importance, and add immensely to the interest of nursery life in a large family. On such observations may be based, by herself or by more ambitious philosophers, theories of racial varieties, of biology, and of education. Sir W. Hamilton points out that the study of the human mind requires no scholarship or costly apparatus, and the principal acquirement necessary for success in the study we suggest is a little close knowledge of one's own thoughts and feelings. In recording observations Darwin's golden rule must always be strictly adhered to: Theorise freely—every other observer will help to demolish anything that will not hold water, and whether true or not it may be a suggestive hypothesis. Be most scrupulous as to recording as a fact anything not strictly correct; no one can disprove it, and it may throw back the reception of a useful truth for a generation.

W. ODELL

Un Capitolo di Psicofisiologia. Da Enrico dal Pozzo. Foligno, 1885.)

A GOOD book on abnormal mental phenomena of all sorts was to be expected from Prof. dal Pozzo, one of the very oldest living investigators of this branch of physiology in Europe. The present excellent little treatise comprises the substance of seven lectures delivered during the current year to the medical students at the University of Perugia on "Hypnotism," "Animal Magnetism," "Somnambulism," "Human Radiation," and "Psychism." The whole field is thus covered from the time of Mesmer down to Mr. Crookes's experiments, and the still more recent "Thought Readings" of Mr. Bishop and Mr. Cumberland. As a philosopher of the monist school, the author naturally rejects the spiritualistic conception, accepts the term "psychism" only in Mr. Crookes's sense, and regards all these manifestations as strictly co-related and explicable on physiological grounds. Human radiation he is also disposed to admit as a biological property, hence has no difficulty in believing in such well-attested facts as may be explained by it. But whatever cannot be so explained he regards as unworthy of credence, and treats the terms "spiritual," "transcendental," and the like, as synonymous with ignorance. The power claimed by paid mediums to hold commune with the departed is, of course, emphatically denied, and it is cogently argued that the medium can tell us nothing regarding present or past facts of which the audience may be ignorant. He cannot, for instance, say how many chairs are in the next room if the number is unknown to all present, whereas the somnambulist will often tell it exactly. Hence if these psychic manifestations did not depend on human radiation, but were the work of spirits, it would follow that these spirits are more ignorant than ordinary somnambulists. And to the assertion that psychism produces phenomena absolutely inexplicable by human radiation, the answer is that who cannot do the less can scarcely do the more in matters of this sort.

At the end of the work a chapter is added on Giordano Bruno, and his philosophic system, which, although not directly connected with the subject, will repay perusal.

Die Nutzbaren Pflanzen und Tiere Amerikas und den alten Welt vergleichen in Bezug auf ihren Kultureinfluss. Dr. L. Höck. (Leipzig: E. Engelmann, 1884.)

IN a pamphlet of fifty-eight pages Dr. Höck institutes a comparison between the useful plants and animals employed by man in the two hemispheres. Although the comparison is made in a somewhat rambling manner in the text, the conclusions arrived at are clearly tabulated in the form of an appendix. The influence of useful plants and animals on civilisation seems almost lost sight of, except on p. 10, where guesses at their mode of influence, rather than evidence proving it, are offered. Only those species considered by Dr. Höck to be the most important to mankind are noticed; hence the comparison can only be regarded as approximate to the truth. The author finds that the Old World or eastern hemisphere affords 269 useful plants and 58 animals against 52 plants and 13 animals derived from the New World. In consideration, however, of the larger area of the eastern than of the western hemisphere, which he estimates as being in the proportion of 9 to 4, he concludes that the New World only affords rather more than half so many as the Old.

The tables in the appendix indicate a certain amount of carelessness or confusion, which slightly vitiates the conclusions arrived at. Thus, *Citrullus Colocynthis* and *Momordica Elaterium* are classed under fruits used as food, instead of under medicinal plants; *Rumex Patentia* is indicated as English spinach, and *Haematoxylum campechianum*, which is stated in the text to be a New World plant, is given in the appendix as belonging to the Old World. It is difficult to understand the principle upon which the "more important" plants have been selected, many of them being by no means so extensively used as others which are omitted; this is particularly noticeable in the list of medicinal plants and those used in the arts. But, in justice to the author, it must be admitted that the task he has undertaken is a most difficult one, and cannot be fully treated in so small a space as he has given to it. His claims that the greater proportion of the present work was already completed before De Candolle's "Origin of Cultivated Plants" fell into his hands must also be allowed due weight.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Iona

BEFORE the close of the season when there is easy, and indeed luxurious, access to the Island of Iona by steamers from Oban, I would call attention to the high interest which attaches to its geology in connection with the rocks now called "Archæan."

Although the rocks of Iona are lithologically very distinct from the old gneiss of the Hebrides (which is the true "Laurentian" and closely resembles the rocks near Quebec), yet they are equally distinct from the mica slate series of Argyllshire, and I have always regarded them as undoubtedly belonging to the pre-Cambrian horizons. I had never seen, however, until last week, the beautiful sections exhibited in the precipices of the south-west corner of the island. Tourists often visit the little "Bay of the Coracle," where St. Columba is said to have landed, and I had not myself gone farther west. But the very calm sea of last week tempted me to boat round the farther coast to the south-west, and I was much struck by the sections there seen. The rocks are quite free from vegetation, and the exhibition of the strata is very striking. They are intensely hard and highly silicious—beautifully coloured with red, green, and black—and the beds dip at a high angle with remarkable flexures and faults of all kinds.

On the side of the island where the cathedral is, and which tourists visit, the rock is entirely different in its mineral aspect and character—being a dark or black slaty rock, thinly bedded, and with no bright colouring at all. It belongs, however, evidently to the same series, and has generally the same dip and strike as the beds farther west.

I should be very glad if some geologist acquainted with the different horizons of the Archæan series so largely developed in Canada could visit Iona, and determine to which of these horizons its rocks belong. Between them and the mica slates of the mainland of Argyllshire there is interposed the massive granite of the Ross of Mull—which comes up close to the eastern shore of Iona, and on the other side of which, near Bornepan, the mica schists are in the same relative position; while underneath the granite itself, and sometimes interbedded with it, there are some beds of a dark hornblendic gneiss.

The whole neighbourhood is evidently one of great interest in connection with the oldest metamorphic rocks of our island.

S.S. *Columba*, Campbelltown, August 30 ARGYLL

Radiant Light and Heat

THERE are two points in my article of last week which I should like to have the opportunity of discussing at somewhat greater length.

(1) In this article I made use of the following expression, having especial reference to phosphorescent bodies which continue after excitement to emit luminous rays at a comparatively low temperature:—"*There seems to be no reason why molecular energy should not be somehow changed at once into radiant light and heat.*" Let me now explain what I meant by this statement. The concluding quotation from Prof. Tait leads us to see that the definite connexion between the quantity and quality of the heat and light given out by a body and the temperature of that body, which the theory of exchanges asserts, is only statistically true. I can imagine, therefore, a few neighbourin g

molecules of some phosphorescent substance to be in a state of constraint, and to relieve themselves, thus causing vibrations which are communicated to the ether—the whole change taking place so quickly and on so small a scale that the statistical law above-mentioned does not apply, and is not therefore broken. Nay, further, I can imagine an enclosure, the walls of which are coated internally with an excited phosphorescent body performing for all practical purposes the part of an enclosure of low temperature under the theory of exchanges, and yet it may be continuing for some time to emit visible rays.

(2) I can, however, imagine the following question to be put: Let there be a phosphorescent substance which is capable of being excited by certain rays coming from a black body at the temperature T, these rays being apparently converted into others of lower refrangibility which continue to be given out for some time by the phosphorescent body. Let us further suppose that the phosphorescent body does not suffer chemical decomposition at the temperature T.

Now imagine a temperature enclosure kept at temperature T, the interior walls of which are lined in part with this phosphorescent substance. What will happen in this enclosure?

I think there can be little doubt that if there be such an enclosure capable of existing permanently and without decomposition of the substances which compose it, then the rays which it gives out must be those required by the theory of exchanges, But if the further question be asked in what way does the phosphorescent body conform to the theory of exchanges, we may, I think, plead ignorance. As far as I am aware we have experimentally little or no knowledge of what the phosphorescent substance will do under these conditions, presuming that it can exist undecomposed. All our knowledge is limited to its behaviour at a low temperature when acted on by high temperature rays, and its peculiar behaviour under these conditions cannot, I think, be viewed as a valid objection to the theory of exchanges.

BALFOUR STEWART

The Eleven-Year Meridional Oscillation of the Auroral Zone

THIS very remarkable law, in favour of which Mr. Tromholt quotes a short series of observations made at Godthaab, which, he says, are supported by a few in other Polar regions, would, it seems to me, if satisfactorily proved, not only advance the science of terrestrial magnetism a stage, but also materially help to elucidate the exceedingly mysterious bond of union between the aurora and weather. As long as we simply knew that the manifestations of the Aurora Polaris increased and diminished *everywhere* with the spotted area of the solar surface, we were obliged to conclude that there was a similar increase and decrease in the electrical energy of terrestrial currents, and meteorological evidence did not favour the idea that the eleven-year variation in terrestrial currents was on such an extensive scale as the amplitude of the auroral oscillation would imply. But now if the law which Tromholt has indicated, really exists, a great deal of the difficulty in correlating the two phenomena disappears, since it is obvious that a comparatively small displacement of the zone would cause the annual average number of auroræ to increase or diminish by their normal amount. Thus from lat. 60° N. to lat. 65° N., a distance of only 350 miles, the annual average number of auroræ diminishes from 80 to 40.

I will not now dwell upon analogous eleven-year oscillations of isobars, such as Blanford's Asiatic seesaw, and the indications of similar secular displacements of the Atlantic isobars noticed by Allan Brown and others, or upon the extraordinary resemblance in form between the auroral zone and the mean storm track of the northern hemisphere charted by Prof. Loomis in his latest contribution to meteorology; but I would merely say that Tromholt's discovery seems likely to become the touchstone which may, in the hands of an intelligent and comprehensive worker, clear up the entire question, and I earnestly hope that no efforts will be spared to corroborate it.

I will conclude by adding my mite. In looking over Fritz's monograph on the connection between solar spots and terrestrial magnetism and meteorology, I have found a series of observations at Godthaab and Jakobshavn (69° 22′ N.) further north, which do not appear to have been utilised by Mr. Tromholt, and which, when combined in the form of percentages, cover a space of ten years, and add strong corroboration to the law indicated by Tromholt.[1]

TABLE I.—*No. of Auroræ seen annually at Godthaab and Jakobshavn, compared with Wolf's Sunspot Numbers*

Years ...	1840	41	42	43	44	45	46	47	48	49	50
Godthaab ...	—	60	93	84	87	74	32	—	—	—	—
Jacobshavn.	10	15	15	18	12	24	21	17	14	11	21
Sunspots ...	63·2	36·8	24·2	10·7	15·0	40·1	61·5	98·4	124·3	95·9	66·5

TABLE II.—*The above numbers of Auroræ converted into percentages of their means and compared after smoothing with smoothed Sunspot Numbers*[1]

Years ...	1840	41	42	43	44	45	46	47	48	49	50
Godthaab ...	—	84	131	118	122	104	45	—	—	—	—
Jacobshavn.	62	93	93	111	74	148	130	105	86	68	130
Smoothed means of both	70·5	87	106·2	129	109	109·2	101·2	95·7	86·2	88	109
Smoothed sunspots	54·4	40·2	23·9	15·1	20·2	39·1	65·3	95·6	110·7	95·6	76·3

The figures in Table II. speak for themselves.

To corroborate this law by further observation will necessitate a prolonged sojourn in some region *north* of the maximum auroral zone, and Greenland appears to be almost the only region where this could be done in the absence of a regular Polar expedition.

E. DOUGLAS ARCHIBALD

Tunbridge Wells

[1] "Ueber die Beziehungen der Sonnenfleckenperiode zu den magnetischen und meteorologischen Erscheinungen der Erde," p. 48.

[1] The figures are smoothed by the formula $\frac{a + 2b + c}{4}$, where b is the figure for the epoch and a and c the preceding and succeeding figures.

On Cases of the Production of "Ohm's (or Langberg's) Ellipses" by Biaxial Crystals

IN examining the macled crystals of potassium chlorate, which are so extremely common in the ordinary crystallised salt, I have found that all those which consist of two hemitrope plates only, nearly equal in thickness, give the above-mentioned secondary interference-curves when placed in homogeneous convergent plane-polarised light.

This result is no more than we should expect if the crystals were uniaxial, as Prof. Langberg showed (*Pogg. Annalen Ergänzungsbd.*, I., 540) many years before the curves were independently discovered by Prof. G. S. Ohm (see NATURE for November 27, 1884, p. 83). But potassium chlorate is a biaxial crystal, the angle included by the optic axes being 28° 30′ (determined in olive oil), and I do not find that the production of the curves in such crystals has been hitherto noticed.

The plane of the optic axes, however, makes so large an angle, viz. 38° 30′ (as determined in olive oil), with the normal to the surfaces of the plates in which potassium chlorate usually crystallises, that the isochromatic curves in the vicinity of this normal belong to a very high order, and do not sensibly differ from portions of circles of large radius. Thus in a macle, in which the crystallographic position of one of the components differs by 180° from that of the other, the planes of the optic axes make equal angles of 38° 30′ with the normal on opposite sides of it, and so the conditions determined by Langberg for the production of the secondary ellipses are fulfilled. I have, in fact, made artificial twins of this kind by cementing together plates of the salt oriented as above indicated; and I find that they show the ellipses precisely as the natural macles do. Of course, in order to see them, the compound plate must be so placed that the plane which includes the normal and the two acute bisectrices makes an angle of 45° with the plane of polarisation of the light. In a good micropolariscope the four optic axes and portions of the lemniscates immediately surrounding them are visible at the edges of the field.

It is possible, but not common, to find crystals of potassium chlorate consisting of three plates nearly equal in thickness, the top and bottom plates being symmetrically disposed, while the intermediate one differs from them in crystallographic position by 180°. In such cases the secondary interference-curves are much more complicated, two sets of ellipses being generally visible, one on each side of the centre of the field (the exact position, of course, depending on the relative thickness of the plates, as Langberg has shown). One macle I have found to consist of five or six distinct plates, and the secondary curves produced by this are too complicated to be easily described.

I do not find any marked difference between the curves produced by the iridescent twins and those given by the ordinary macles. Many of the iridescent crystals show, when the plane of symmetry is either parallel or perpendicular to the plane of polarisation of the light (the analyser being crossed), a few broad, black, curved bands crossing the main black band lying in the plane of symmetry, which are probably portions of the isochromatic curves of a very thin plate. But, on the other hand, some non-iridescent crystals show these bands, and some iridescent crystals do not show them at all. Also the iridescent crystals which reflect D light at moderate incidences show very perfectly the circular band described by Prof. Stokes (NATURE for April 16, 1885, p. 566, par. 9) as sharp black crescents, the horns of which nearly touch each other at the plane of symmetry.

Almost the whole of the ordinary commercial crystallised potassium chlorate seems to consist of macles; so that, in order to get a single individual crystal for examination, I have always had to cut away one component of a twin.

It seemed worth while to try whether other biaxial crystals would, when similarly combined, give similar phenomena. I took a crystal of barite (barium sulphate), the angle included by the optic axes of which is, according to Groth, 63° in air, and cut a plate of it in such a direction that the plane containing the optic axes made an angle of 53° with the normal to the surfaces of the plate. I then cut it in half and cemented one of the portions upon the other in a reversed position. The compound plate thus produced shows the secondary ellipses (which, however, are very nearly circles) in great perfection. I have also made similar compound plates of borax, nitre, and citric acid, and found them to give similar results. H. G. MADAN

Eton College, August 24

The August Meteors

BETWEEN August 4 and 20, 174 shooting stars were recorded here in 16½ hours of observation. These included about 37 Perseids, chiefly seen on August 5, 8, and 13, but the shower was not well observed owing to cloudy weather. The following are the chief radiant points determined from the paths registered:—

No.	Epoch August	Radiant α °	δ °	Notes
1	16–20	5	+12	Meteors bright, max. Aug. 20.
2	13	51	+58	Perseids.
3	4–17	292	+52	Near χ Cygni.
4	5–13	296	±0	On equator near η Aquilæ.
5	5–20	317	+22	Meteors slow and faint.
6	8–17	318	−9	Slow, S.W. of β Aquarii.
7	15–17	328	+27	Slow, faint.
8	11–15	329	+8	Slow, bright, E. of ϵ Pegasi.
9	16–20	345	±0	Rather swift, bright.
10	8–20	345	+53	Very swift, short.
11	16–20	351	+38	Swift, E. of o Andromedæ.

Many other shower centres were less distinctly shown. Nos. 4 and 9 fall exactly on the equator, and were sharply defined.

As to the shower of Perseids on August 10, I believe it was more brilliant than usual, though I made no regular observations on that night this year in consequence of overcast sky. Many meteors were, however, noticed in the clear spaces which now and then occurred, and judging from the frequency of the apparitions the display was a fine one. As to the duration of the shower it was still visible, though very feebly, on August 20, for I registered 2 undoubted Perseids during a watch of 3¼ hours, when 31 meteors were recorded.

With regard to the minor displays of this epoch they are more remarkable for their number than for individual intensity. The most active of these radiants, as recently observed, was No. 10 at 345° + 53°, which supplied about 10 meteors, but the rate was less than one per hour, so that it cannot be ascribed much importance. W. F. DENNING

Bristol, August 25

Disinfection of Sewers

IN the last number of the *Lancet* (August 15, 1885) I have read of the measures taken by the Metropolitan Board of Works for the deodorising and disinfecting of London sewers. Between 30,000 to 40,000 tons of sodium manganate and from 10,000 to 12,000 tons of sulphuric acid are daily poured in the London sewers.

By what experiments has it been ascertained that the quantities of disinfectants used are sufficient, and how is it proved that the sewers have been properly disinfected?

I need not point out the difference between the deodorising and the disinfecting of sewage. The latter may be perfectly deodorised, and yet be quite adapted to favour the vegetation of bacteria.

The oxidising and deodorising action of sodium manganate cannot be sufficient to prevent bacterial life, unless when the salt is present in large quantities. Considering the enormous volume of London sewage, it is not to be believed that even such a vast amount of manganate as 40,000 tons *per diem* would suffice to destroy bacterial life in the sewers.

The adding of sulphuric acid to the manganate must certainly enhance the disinfecting action of the latter. Only, I do not understand why the quantity of sulphuric acid is relatively so small in comparison with the quantity of manganate. I do not see why manganate should be used at all when sulphuric acid, a more powerful and less costly disinfectant, can be used alone.

It is well known to all who occupy themselves with the cultivation and study of bacteria that these micro-organisms do not grow well in acid media, and that the addition of acids, especially of mineral acids, checks their growth completely.

It can be said that the antiseptic action of acids is of household knowledge, for vinegar is constantly used in the preservation of animal and vegetable products. That mineral acids have a greater disinfecting action than vegetable acids is also well known, unfortunately even by dealers in vinegar, who give durability to this condiment by the addition of a tiny proportion of sulphuric acid.

It is probable that pathogenic bacteria, even more than the bacteria of ordinary fermentations and of putrefaction, are in need of alkaline media, and therefore are more sensitive to the action of acids. In the animal body bacteria invade those fluids and tissues where the alkaline reaction prevails; and it is proved that the germs of disease are easily spread by milk, a liquid generally alkaline. Moreover, it has been proved by experiments on some pathogenic bacteria that gastric juice, although of so slight acidity, easily, and sometimes effectively, checks their development.

Sewage contains all the elements necessary for the nourishment of bacteria, and its alkaline reaction renders it very favourable to their growth and preservation. Disinfection means the destruction of existing bacteria and preventing the development of newly-sown bacterial germs. Therefore I am persuaded that the cheapest and more simple method for effectively disinfecting sewage is to render its reaction *permanently acid* by the addition of a sufficient quantity of mineral acid.

There are of course disinfectants far superior to mineral acids in antibacterial energy. But they are generally costly substances, that cannot be applied to the disinfection of such an enormous quantity of matter as the sewage of a town. As for cheap disinfectants, such as ferrous sulphate, ferric chloride, sodium manganate, their action is inferior to that of mineral acids. Especially of the two former it can be said that their deodorising action is due to their saline constitution, and their disinfecting action to their acid reaction.

The great difficulty in extensive disinfections is to ascertain if the disinfection has been complete—*i.e.* if the substance disinfected has been rendered unfit for the development and preservation of bacteria. Even laboratory experiments, to ascertain the *minimum* of disinfectants necessary for the destroying of bacteria, are not easily conclusive. But, in using acids, the disinfection can be considered complete when a permanent acid reaction is obtained.

I do not believe the quantities of sulphuric acid poured in the London sewers sufficient to give a permanent acid reaction to the sewage. Disinfection must be done completely, or not at all: there are no half measures in disinfection. Therefore I maintain that the London disinfection is useless, and the sewage remains likely to become the culture fluid of infectious germs, unless the sewage is rendered permanently acid. All the sodium manganate added to a sewage that remains alkaline, gets decomposed; the manganese precipitates as sulphide, or is deposited in combination or mixture with the organic sediment. The sewage will thus be cleared and deodorised for a while; but it still contains in solution all the elements necessary for the nourishment of Bacteria, and is still favourable to their growth and preservation. The disinfecting action of sodium manganate would avail only if large quantities of the salt remained dissolved in the sewage, over and above of the quantities decomposed in deodorising and clearing the putrid fluid.

It might be objected that, even if mineral acids stop the development of bacteria—a point that cannot be doubted—they may not kill the spores, thus permitting the germs of disease to escape. There are no experiments (of which I am aware) to answer this objection. But there is reason to believe that pathogenic germs do not resist for a very long time when in unfavourable media; even in sewers, that are not over-filled and stagnant, and that are well ventilated, infection does not easily linger. If inside the sewers disinfection is complete, and bacterial growth checked, and all disease germs rendered inactive, until carried for away from all populous centres, I think we can leave it to air, and to the other natural agents, to ultimately destroy the surviving germs, or completely alternate their pathogenic qualities.

Amongst the mineral acids, hydrochloric would, of course, be the cheapest. But I think sulphuric acid ought to be preferred, nitric acid being too costly and too corrosive. Sulphuric acid does not attack easily calcareous cements; and if the sewers have their walls well plastered, the action of a *slight excess* of sulphuric acid in the sewage would be very slight indeed. Cements, more resisting than plaster, could be prepared. Moreover, if some portions of teh sulphuric sewage get carried in the air, or are dried in the higher parts of the sewers, the germ-laden particles do not rid themselves of the acid by evaporation; on the contrary, the acid becomes more concentrated and active, and finally must disorganise and destroy the noxious germs. This is very important in preventing the effects of sewage air.

Since 1881 Prof. Beilstein of St. Petersburg (NATURE, vol. xxiii. p. 394), experimentally concluded that sulphuric acid is the best disinfectant, although he did not advise its use because of its corrosive action. Strange to say, Beilstein thought that, practically, aluminous sulphate was to be preferred to the free acid.

It is not only during the fear of cholera invasions, but at all times, that I would wish the sewage to be *slightly* acidified with sulphuric acid. Strict supervision should be maintained over all the sewers, to ascertain that the whole mass of flowing sewage is permanently acid. I am persuaded that this simple mode of disinfection would diminish considerably many infectious diseases.

During the cholera epidemic of 1884, in Naples, I did my best, in a series of letters I then published, to persuade the sanitary authorities of this mode of disinfection. But a strange confusion of ideas was then prevalent in Naples. Through the goodwill of Prof. Cantani, Member of the Sanitary Commission, some trials of the method I proposed were done, but not in a complete and systematic manner. Such experiments cannot be done easily in Naples, and the results cannot be conclusive until the system of sewers is in good working order. Indeed, in some parts of the soil of Naples it is difficult to know if there is more sewage inside or outside the sewers. It is no easy problem to disinfect and cleanse such an impure soil, and it is indeed to be wondered that the ravages of cholera were so limited in 1884.

My letters caused sulphuric acid to be used abundantly in the sewers and *pozzi neri* of Portici, Castellamare, Taranto, and, I believe, in other places; but this, like all other disinfections, was done under pressure of approaching cholera, and abandoned as soon as the danger passed, no observation being made to measure the influence of the sanitary method adopted on local infectious diseases. The defective system of sewers and of drainage in many Italian towns renders thorough disinfection scarcely possible, and prevents precision in testing any kind of disinfection.

In English towns sewers are generally well arranged, and often well ventilated; and vital statistics have taken sufficient development to permit the testing of sanitary reforms. When it is proved (and I think the proof can be easily given) that the present systems of sewage disinfection are not sufficient to prevent *entirely* bacterial development in the sewers, these systems cannot be considered good. I venture to hope that beneficial results would soon become evident if the sulphuric acid disinfection of sewage were thoroughly applied in English towns.

Portici, August 20 ITALO GIGLIOLI

Ozone at Sea

THE presence of this element in the atmosphere is alleged to be indicative of its healthiness, and it has been *investigated on land* frequently by observers with varying and uncertain results.

Records of its presence may be seen daily in the *Times*, furnished from the Observatory on Ben Nevis, but as yet little notice has been taken of its *prevalence at sea*, though it has been supposed to be more plentiful there than on land.

During a voyage around the United Kingdom on the s.s. *Ceylon* in August last, we entered into the investigation of its existence at sea, and used Moffatt's papers for the purpose, obtained from Negretti and Zambra. They were exposed in a perforated light wooden box, hung up in the open air on the deck of the ship in the shade, and noted and changed twice a day.

It was found most prevalent in *Cork Harbour* (4), less so in Bantry Bay (2) and Oban Harbour (2), and nearly absent in Kingstown Harbour (1) and Leith Roads (1).

In the open sea it was most shown in the *Irish Channel* (4) and off the Lands End (4); next in the North Seas (3) and in the English Channel (2), and least in the Irish seas (1) and western coasts of Scotland (1).

Ozone was found to be indicated in greater intensity during the prevalence of *westerly winds* in the English and Irish Channels, and Atlantic seas and Dutch seas, and less with *easterly* winds prevailing in the Irish seas, Firth of Forth, and west coasts of Scotland.

The *velocity* of the winds seemed also to create a higher manifestation, as was seen during the gale from the south-west in Cork Harbour and the fresh north-westerly breezes on the south coasts of Ireland and east coasts of England. None, however, of the observations approached those registered in the *Times* from Ben Nevis (8-9), which amounted to double those noticed in the seas around our coasts during the same period (August), supposing that the same papers and scale (Moffatt's) were used for both sets of observations.

Ozone was also found to exist in the *cabin of the ship* both day and night, but at a half intensity to that on the deck, due probably to the great difference in the movement of the air in the two places.

The degrees of manifestation of ozone at sea here shown by no means come up *to expectation* that it prevailed in all its potentiality on the ocean, but of course a whole year's observation would be required to enlighten the subject and furnish a comparison with that on the land.

Again, it may be possible that *altitude* may have something to do with its prevalence, more or less, as it appeared more on the top of Ben Nevis than on the level of the seas of the same coasts near it and at the same period of the year (August).

Should this idea be of any significance it might be as well to search for manifestations of ozone at the base as well as on the top of mountains, and if similar results followed to these here pointed out it would establish the *reputation of high* level sites for great salubrity of atmosphere. W. J. BLACK

August, 1885

THE INTERNATIONAL BOTANICAL AND HORTICULTURAL CONGRESS, ANTWERP, 1885

THE International Botanical and Horticultural Congress met at Antwerp on Sunday, August 2, in the hall of the Artistic, Literary and Scientific Club, the opening meeting being honoured by the presence of a good many ladies. The gathering was a representative one, and included many well-known European botanists and horticulturists. The Burgomaster of Antwerp opened the proceedings with a few appropriate remarks, and Prof. Ed. Morren, of Liége, having been made President of the Congress, took the chair, and a discussion was held on the flora of the Congo. After a short discussion the meeting adjourned to the Exhibition building, where the International Horticultural Show was being held, and which was formally opened at one o'clock. Many of the plants exhibited were of great interest, and the whole of the collections were nicely and artistically arranged. At five o'clock the Congress visited the Plantin Museum, the old printing office of the Plantin Moretus family. The Museum is full of interest, and as the printing office from which the works of Lobel, Dodonaeus, and Clusius issued, doubly interesting to all botanists. Through the kindness of the Burgomaster of Antwerp a sheet had been struck off for the members of the Congress, so that each was presented with a souvenir of the three great herbalists.

In the evening there was a concert in the garden of the Exhibition in honour of the members of the Congress.

During Monday, Tuesday, and Wednesday the two sections of the Congress—the Botanical and Horticultural—met in the Botanic Garden in the upper and lower halls of the Botanical Institute. The different subjects contained in the programme were duly discussed, and a resolution of Congress on the different points raised terminated each discussion. The method adopted at these meetings was one which might well be followed in other assemblies, and is one which reflects great credit on the President of the Organisation Committee, M. Charles de Bosschere. All the subjects to be discussed were treated of in longer or shorter papers, all of which were printed in the four fasciculi of the *Preliminary Reports* issued to the adherents of the Congress. In this way all the members had the subjects before them in a tangible form, and discussion was easy. Might not the British Association take a hint from this? Without giving up the method at present followed, let the British Association add to their work a discussion on one or two subjects of importance, papers by special men to be printed beforehand, so as to be in the possession of those who can discuss the subject at the meeting.

The subjects of discussion—twenty-two in number—were mostly of considerable botanical interest, others being purely horticultural, the question of the Congo being general. Perhaps the most important subjects were the discussions on botanical laboratories, on the amount of instruction in cryptogams to be given in different parts of the botanical course of study and the recent progress of botany in different countries. It is important to notice that the general opinion of the Congress was in favour of two kinds of botanical laboratories, those of instruction and those of research, and there can be no doubt that in every society research should be encouraged in every way and be the highest object of their organisation.

On the evening of August 3 the Burgomaster of Antwerp held a reception at the Hôtel de Ville, which was very largely attended by the members. On the evening of August 4 Dr. Henri Van Heurck, the Director of the Botanic Garden, gave a most interesting series of microscopical demonstrations in the meeting-room of the Botanical Section. The application of the electric light to microscopic work was shown, and nothing could exceed the perfection of the arrangement employed by Dr. Van Heurck. *Surirella gemma*, *Amphipleura pellucida*, and Noberts's 19th band were shown in a manner which left nothing to be desired; and in the case of Amphipleura, not only were the striæ shown as distinctly as one is accustomed to see them in *Navicula rhomboides*, but, by illumination through the object-glass, the striæ were distinctly resolved into beads; by oil-immersion lenses, of which, as of other object-glasses by all the best makers, Dr. Van Heurck possesses a remarkable series. The electric light employed is obtained by a bichromate battery (Trouvé's) and Dr. Helot's photophore. As the photophore works equally well with an accumulator, and where there is no difficulty in getting the accumulators charged, no better illumination can be got, and this I would strongly recommend to all microscopists. Altogether Dr. Van Heurck's demonstration will be remembered as one of the most interesting things connected with the Congress. On the evening of Wednesday there was a grand banquet, when the members spent a very pleasant evening together.

On Thursday morning the Congress left by train for Brussels. On arrival, the members went to the Natural History Museum, and were shown through the building by the Director, who kindly admitted the members of the Congress at an early hour. Next, the party proceeded to the Botanic Garden, where they were received by Prof. Crepin and others. The herbarium, museum, garden, and hot-houses were all inspected, and then the Members of the Congress were entertained in the orangery of the garden to a luncheon given by the Members of the Royal Botanic Society of Belgium. After luncheon the party proceeded by tramway to Laeken, to visit the Winter Garden, which had been opened to them by his Majesty the King of the Belgiums. Mr. Knight, the Inspector of the Royal Gardens, accompanied the party, and pointed out the objects of interest. Friday was to be devoted to an excursion to Ghent, and Saturday to a botanic excursion in the neighbourhood of Herrenthals, Dolen, and Gheel, where the Members of the Congress were to disperse. I left the party at Brussels, spending Friday at Liége with Prof. Morren, who showed me the splendid new laboratory in the pretty little garden under his charge. I afterwards visited Prof. Suringar at Leyden, and saw some of the treasures he has just brought back with him from the Dutch West Indian Islands, where he has been able to make extensive botanic collections of living and dried specimens. W. R. McNab

August 31

THE FAUNA OF THE SEA-SHORE[1]

THE marine fauna of the globe may conveniently, in the pursuit of certain lines of scientific study, be divided into three groups according to the regions inhabited by it. There is the littoral fauna comprising the animals inhabiting the sea-shore and the shallow waters in its immediate neighbourhood, the deep-sea fauna, and the pelagic fauna, the latter occupying the surface waters of the ocean. Each of these regions presents certain marked peculiarities of conditions of existence, and exhibits, in accordance with these, certain special characteristics in the composition and history of the origin of its fauna. The deep-sea is devoid of sunlight and therefore of plant life. It is dark, cold, and monotonous, being devoid of day and night and periodical or irregular changes of any kind. Its habitation probably dates from no very great antiquity. The ocean surface can support only a peculiar fauna of animals adapted for floating or constant swimming, and affords no shelters nor resting-places.

As Prof. Lovèn writes[2]: "The littoral region comprises the favoured zones of the sea, where light and shade, a genial temperature, currents changeable in power and direction, a rich vegetation spread over extensive areas, abundance of food, of prey to allure, of enemies to withstand or evade, represent an infinitude of agents competent to call into play the tendencies to vary which are embodied in each species and always ready, by modifying its parts, to respond to the influences of external conditions." It is in this littoral zone where the water is more than elsewhere favourable for respiration because of its aëration by the surf and where constant variation of conditions is produced by the alternation of the tides that the ancestors of all the main groups of the animal kingdom came into existence, and all the primary branches of the animal family tree first commenced to grow. It is here, probably, that the first attached and branching plants were developed, thus establishing a supply of food, and rendering possible the colonisation of the region by animals.

The animals inhabiting the littoral region are adapted in most various ways to withstand and endure the special physical conditions which they there encounter—the action of the surf, the retreat of the tides, the numerous enemies. Either they burrow deep in the sand, or cling tight to, or even bore into, the rocks, or develop hard shells or skeletons, or protect themselves by other modifications. Probably all hard shells and skeletons of marine invertebrata have thus originated in the littoral

[1] A Friday evening lecture at the Royal Institution, delivered January 23, 1885, by Prof. H. N. Moseley, F.R.S.

[2] "On Pourtalesia, a genus of Echinoidia." by Sven Lovèn. (Stockholm, 1883, p. 86.)

zone for purposes such as these. It is found that these hard structures tend to degenerate and disappear both in the pelagic and deep-sea regions.

It is a most remarkable fact that almost all these shore animals in their early development from the egg pass through free-swimming larval stages which are closely alike in form for very widely different zoological groups. As a familiar example may be taken the case of the common oyster. The egg of the oyster develops into a peculiar free-swimming larva known as a Trochosphere. It is globular in form and divided by a transverse band of cilia into a smaller anterior and larger posterior area. The mouth opens just behind the ciliated band. The larva swims actively by means of its cilia. After a time it develops a pair of shells, and becomes metamorphosed into an oyster, and attaches itself immovably by one of its shells to the sea-bottom. Its shells increase in size and thickness, and form a protection against its enemies. This same trochosphere larva is common to a very large number of Mollusca of all varieties and shapes in the adult condition, and an essentially similar trochosphere is common to a large number of annelids. It is most remarkable that there should be so close a resemblance between the larva of two adult forms so widely different in all respects as an oyster and a worm. An old explanation of such facts was that such actively-moving larvæ were contrivances for procuring the wide diffusion of sedentary or less active adult forms, which might thus be conceived as of later origin than the forms themselves. But if this were the case, it is inconceivable that having arisen from so widely different starting points, the larvæ should have attained so closely similar a structure. The only real explanation of the matter is that the common larval form represents a common ancestor, from which the various adult forms, in the existence of which it is now only a phase, diverged. There was thus a common freely-swimming ancestor of the annelids and mollusca, and it seems probable that the entire littoral fauna must have been derived originally in remote antiquity from small primitive and simply organised free-swimming ancestors. All evidence seems further to point to the conclusion that the primitive ancestors of all plants were also free-swimming. The free-swimming ancestral representatives of life no doubt partly inhabited the open sea, leading a pelagic existence, partly swarmed in sheltered bays and pools on the coasts, as the larvæ of the littoral animals do now. The free-swimming plants gradually produced attached descendants, which colonised the shores, and the animals, finding there a supply of food, gradually adapted themselves to the more complicated conditions of shore life. The late Prof. Balfour, in his far-famed work on "Embryology," in discussing the character of larvæ of the kind under consideration, spoke of them as possibly reproducing the characters of some ancestral forms "which may have existed when all marine animals were free swimming."[1]

A peculiar instance in which there can be but little doubt, is that of the common barnacles. These in the adult condition are firmly fixed to supports of various kinds, and withstand the most violent action of the surf. The common acorn barnacles cover the most exposed bare rocks of our coasts, where the waves are heaviest, and nothing else can live. They have developed the stoutest of shells to protect themselves. In the young larval condition, however, they are actively free-swimming larvæ of typical crustacean structure, evidently adapted for pelagic existence, and to be found in swarms at the sea-surface, actively engaged in it. They attach themselves, and become immovably adherent and sedentary, and invested by a shell. There can be no doubt in this case that the locomotive larva represents the ancestral form, for allied crustacea still exist in abundance as adults.

[1] F. M. Balfour, "Comparative Embryology," vol. ii. p. 305.

A most important instance is that of the Echinoderms, the adults of the various groups of which, the sea-urchins starfish, brittle stars, holothurians, and crinoids are most, widely different in form, and adapted in most various ways to shore life. Yet these all pass through free swimming larval stages which are most remarkably alike. Supposing the adult forms to have been antecedent, it is quite impossible that a series of larvæ could have been developed independently from starfish, echini, holothurians, and brittle stars, and have attained this remarkable coincidence of structure. This common larval form must represent the ancestral condition, the free-swimming pelagic ancestor from which the echinoderms have sprung.

The fixed and inert sponges are developed from free-swimming ciliated larvæ, and Prof. W. J. Sollas[1] has observed that the young larvæ of the sponge *Oscarella lobularis* are retained longer within the parent in the case of specimens occurring on the coast of Brittany than in that of specimens found in the Mediterranean. He attributes this difference to the influence of the quieter sea and absence of tides in the latter case. The larvæ have come to be longer retained where the risk of their loss by current and tide is greater. By the gradual action of similar influences, no doubt, the loss of larval stages in so many instances has come about. It is probable that there is a special tendency to such loss in the case of deep-sea animals. Hoek[2] has recorded the loss of the nauplius stage as a free-swimming one in the case of a deep-sea scapellum from a depth of 506 fathoms. One of the best examples of the special adaptation by modification of animals sprung from pelagic ancestors for littoral existence is that of the Madreporarian corals, the far-famed builders of reefs. Each coral colony is sprung from a locomotive planula larva, swimming by means of cilia. The larva attaches itself, and developes into a polyp, and acquires a hard skeleton, and by budding produces a large colonial stock. The massive stocks thus formed and strengthened form reefs which are barriers to the waves. They flourish in the water churned by themselves into surf, and thus specially aërated and fitted for their respiration, and between their branches and interstices they sift out the fine pelagic animals on which they feed from the surface water. Probably the advantages thus gained is the cause of their assumption of the colonial form and development of their stout and massive skeletons. Possibly this is the reason why scarcely any colonial Madreporaria occur in deep water, although other colonial animals are abundant in the depths.

The origin of the vertebrata is a complex question, but they are probably sprung from a very simple free-swimming ancestor, as is shown by the survival of a simple ciliated gastrula as an early stage in the developmental history of Amphioxus. An exactly similar developmental stage precedes the trochosphere form in the oyster, and the characteristic larvæ in the case of the echinoderms, and occurs as an early stage in a wide range of other forms. From this ciliated gastrula develops Amphioxus, one of the most interesting components of the fauna of the coasts, one of the most primitive of vertebrates now existing. The Ascidians, which are in the adult condition as inhabitants of the coasts, mere inert sacs, extreme instances of degeneration, are derived from free-swimming larvæ of pelagic habits which show distinct vertebrate structure and have myelonic eyes, which, as Prof. Lankester has pointed out, could only have originated in an animal of pelagic habits. The Ascidians, before reaching their vertebrate larva stage, pass through a gastrula stage like Amphioxus. It is possible, therefore, that their ancestors have twice taken from pelagic to littoral existence, having relinquished the shore for a period after their first experience of it, and returned to it again; whilst some of their close allies, such

[1] W. J. Sollas, *Quart. Journ. Micro. Sci.*, 1884, p. 612.
[2] Report on the Cirripedia. *Challenger* Report, Zoology, vol. viii. p. 75.

as Appendicularia, have never resought the shore, and consequently have never degenerated to qualify for littoral life. The peculiar breathing apparatus adopted by the vertebrata occurs nowhere else in the animal kingdom except in the extraordinary worm-like Balanoglossus. The apparatus, as is well known, consists of a series of slits, opening from the exterior at the sides of the fore part of the body directly into the throat, the anterior part of the digestive tract. The water to be respired is taken in at the mouth and ejected through the gill slits. The late researches of Mr. W. Bateson, of Cambridge, have shown that Balanoglossus, besides breathing by gill slits, shows many other remarkable affinities, both in structure and development, with the vertebrata. Now, Balanoglossus, a shore-inhabiting form which lives buried in the sand, is developed from a most remarkable larva known as Tornaria, which is intermediate in form between a Trochosphere and a star-fish larva. It is quite possible that this extraordinary larva Tornaria may point to the former existence of a primitive pelagic ancestor common to the Annelids, Echinodermata and Vertebrata. Possibly the use of gill slits as a respiratory apparatus first arose in a shore-inhabiting ancestral form, such as Balanoglossus, and hence their presence at the anterior extremity of the body, that nearest to the surface when the animal is concealed in the sand.

It appears not impossible that Amphioxus may once have possessed a larval stage somewhat resembling Tornaria, following on its gastrula stage, and has lost it just as one species of Balanoglossus has lost the Tornaria stage. The developmental history of only one species of Amphioxus is as yet known, and investigation of that of other species may yet reveal something of the kind suggested.

The littoral zone not only became itself stocked with an immense variety of specially adapted inhabitants, but has given off colonists to the three other faunal regions. The entire terrestrial fauna has sprung from colonists contributed by the littoral zone. Every terrestrial vertebrate, every frog, reptile, bird, and mammal, bears in its early stages of development the gill slits still perforating its throat as in its aquatic ancestor. The tadpole still uses them when young for breathing, though they close up completely in the adult frog and in all the higher vertebrates before birth. In some of the tailed Amphibia, like the Axolotl, the breathing is by external gills and also by lungs which are modifications of the air-bladder of fish. In these the gill slits remain open, although they have no longer any respiratory function. It is amusing to watch tame Axolotls when fed in aquariums with large worms. They snap the prey down hurriedly and close their mouths, but usually in a moment or two their throat begins to twitch uncomfortably as if intensely tickled, and one end of the worm appears out of one of the gill slits, and the worm soon wriggles its way out again. Often the Axolotl catches it again by the free end before the other is completely out of the gill slit, and begins another attempt to swallow it, and the process is sometimes repeated several times before actual deglutition is effected. The gill slits are evidently a considerable inconvenience to the Axolotl. The frog is much better off in having them closed, but man himself is not in a position entirely to despise the Axolotl: his lungs are derived from the same source originally, namely, modifications of the air-bladder of a remote aquatic ancestor, an inhabitant of the sea-coast, and they open into the throat just behind the tongue. In man there is a lid to close this opening and a contrivance to pull it under the tongue when swallowing takes place; but every one knows the agony entailed by getting a crumb the wrong way—an accident very much akin to that of the Axolotl, and similarly entailed by the use of a single passage for two different purposes—feeding and respiration. At such moments of suffering the naturalist is inclined to turn traitor and long that he had been produced in accordance with the hypothesis of special creation rather than evolved under the laws of natural selection. The existing arrangement must not be regarded as of inevitable necessity. The vertebrates are the only animals which breathe through their mouths. All other animals have separate passages for respiration and feeding. The common snail has a separate breathing passage completely apart from its mouth, the land crab breathes by openings at the bases of its legs, the scorpion by openings on its abdomen, and the insect by numerous apertures on the sides of its body. All these animals cannot, like man, choke themselves.

Only the pentadactyle vertebrata have adapted themselves completely for terrestrial respiration, but several fish have, by special modification of their gills, become able to remain out of water for almost indefinite periods. Most remarkable amongst these is Periophthalmus, one of the Gobiadæ inhabiting mud flats on the sea-shore in Australia, Ceylon. Fiji, and other eastern tropical regions. It hops along the mud with the greatest agility and so fast that it is most difficult to capture, and even refuses to take to the water when driven to it, skipping along its surface, and resting on projecting stones. It even climbs high up the mangrove trees and sits on the branches. All modes of air-breathing are derived by modification from aquatic breathing apparatus, except, perhaps, in the case of the air-breathing tracheata, the insects and their allies, in the ancestor of which, represented by Peripatus, the respiratory tubes or tracheæ were probably first formed as modifications of skin glands.

Littoral animals of most various kinds have taken from marine to terrestrial life no doubt by gradual adaptation, owing to exposure by the tides. Crustacea seem to have the greatest power of thus adapting themselves to aërial respiration by slight modification of their gill apparatus, so as to permit it to act as a lung. Nothing is more astonishing to the naturalist in tropical countries than to find large crabs amongst the vegetation far inland and high up mountains. But land crabs are not confined to the tropics; in Japan they may be met with walking across the high roads far inland, and 4000 feet above sea-level. One of the most remarkable instances is that of the cocoanut climbing crab, *Birgus latro*, which has developed, as Prof. Semper has shown, a regular pair of lungs out of the walls of its gill cavities. The animal was originally a hermit crab, but got too large for any shell, and thus developed hard plates on the surface of its body for protection instead. Close allies, but of much smaller size, swarm in some Pacific islands. They always bear shells, and carry them with them when they climb the trees and bushes. I have caught hold of the shell of one of them as it clung to the top of a branch, thinking that it was a land-mollusk, and have been astonished by receiving a sharp nip from a pair of claws.

The oldest-known air-breathing animals, so far as geological evidence goes, are scorpions and insects. An ally of the cockroach and two scorpions have lately been obtained from Silurian strata. The close affinities of the scorpions with the king crabs, and thus with the Trilobites, is a most interesting matter, which has lately been urged by Prof. Ray Lankester. He suggests that the lungs, by means of which the scorpions breathe air, are modifications of the gill plates of the king crab, which have become inverted for the purpose. The lung openings of Scorpio correspond with the gill plates of Limulus in position and number. Hence, possibly, the scorpions, and with them the rest of the Arachnida, are sprung from ancestral allies of the king crab and the Eurypterids, having passed from a littoral to a terrestrial existence.

It seems possible that birds were originally developed in connection with the sea-coast, and were fish-feeders. The tooth-bearing birds discovered by Prof. Marsh, such as Hesperornis and Ichthyornis, were marine aquatic birds. Hesperornis lived in a shallow tropical sea surrounding the present Rocky Mountains, then a group of islands. The modern penguins show some remarkable points of affinity to reptiles in the structure of their feet, and probably their embryonic development, when worked out, may throw much light on the past history of birds.

Some of the extinct Dinosauria which show remarkable affinities with birds were at least aquatic in habits.

The fauna of the coast has not only given origin to the terrestrial and freshwater faunas, it has throughout all time since life originated given additions to the pelagic fauna in return for having received from it its starting points. It has also received some of these pelagic forms back again to assume a fresh littoral existence. The terrestrial fauna has returned some forms to the shores, such as certain shore birds, seals, and the Polar bear; and some of these, such as the whales and a small oceanic insect, Halobates, have returned thence to pelagic life.

The deep-sea fauna has probably been formed almost entirely from the littoral, not in most remote antiquity, but only after food derived from the *débris* of the littoral and terrestrial faunas and floras became abundant in deep water. It was in the littoral region that all the primary branches of the zoological family tree were formed; all terrestrial and deep-sea forms have passed through a littoral phase, and amongst the representatives of the littoral fauna the recapitulative history, in the form of series of larval conditions, is most completely retained. It is for this reason that the researches carried on at marine laboratories on the coasts have yielded in the last few years such brilliant results.

BALLOON PHOTOGRAPHY[1]

RECENT experiments in photographic aërostation, carried out by M. Gaston Tissandier, with the assistance of M. Ducom, have been attended with very complete and satisfactory results. The photograph reproduced by heliogravure in Figs. 1 and 2 was taken at an altitude of 605 metres over Paris; others which were taken did not give such perfect results; nevertheless, some of them surpass in distinctness any yet taken by the same method. The ascent took place at Auteuil on June 19, M. Ducom attending specially to the photography, while M. Tissandier looked after the balloon. The photographic apparatus arranged in the car is shown in Fig. 3. The ascent took place at 1.40 p.m. with a south-west wind. Ten minutes after starting a first photograph was taken at 670 metres; soon afterwards another was taken at about the same height, in which a bridge, quay, public office, fifteen cabs, a tramway, and the people in the streets were clearly reproduced. At 605 metres the photograph here reproduced was obtained, but unfortunately heliogravure does not produce an exact *fac-simile* in the fineness of the details. The smaller plan (No. 2) shows the exact topography of the place. When the photograph itself is examined through a magnifying glass many details are discovered, such as the coils of a rope mooring a boat to the shore, the passers-by, &c. On the photograph, too, the chimneys may be counted forming a number of small black spots on the roofs. A picture of great clearness, but rather greyish, was taken a few minutes later at an altitude of 800 metres above the prison of La Roquette; and another at the moment of leaving Paris at 820 metres. Beyond the city two more

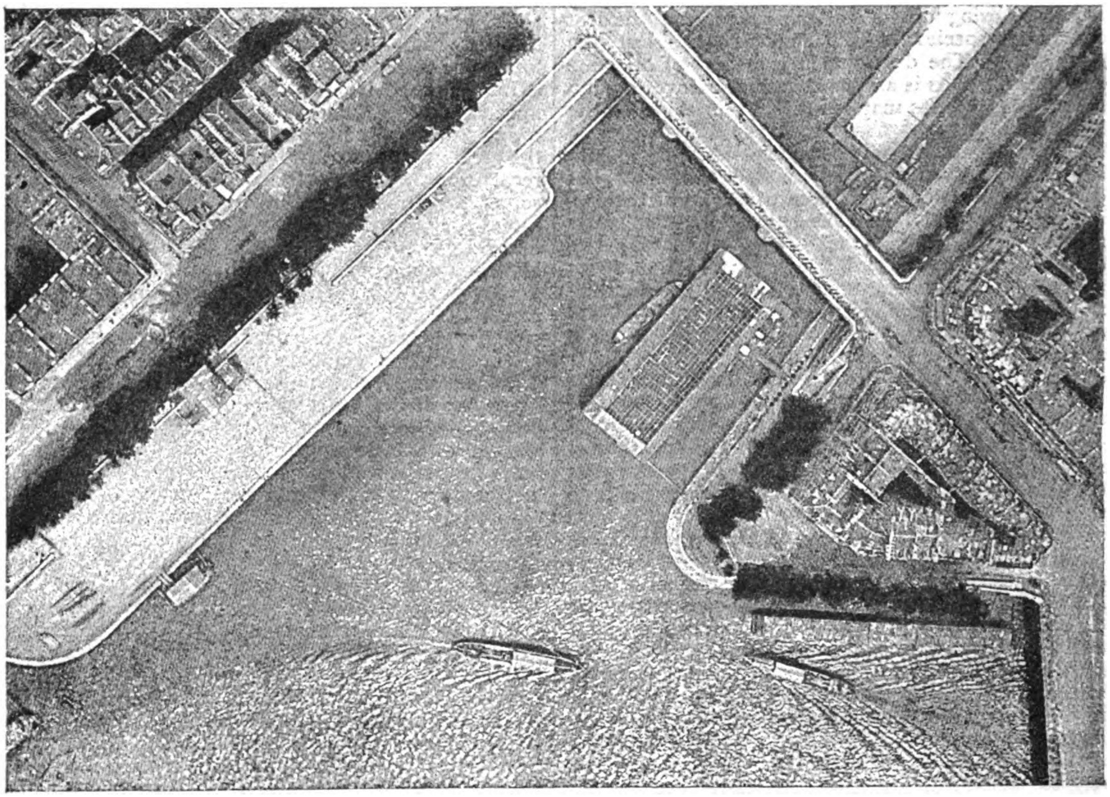


FIG. 1.—Reproduct'on by heliogravure of a pla:e taken at a height of 605 metres above Paris, showing the Seine, with two boats, Pont Louis-Philippe, gate of the Hôtel de Ville, &c.

[1] Abstract from *La Nature*.

photographs were taken at greater altitudes—one at 1000, and one at 1100 metres. Hence in crossing Paris, between 1.40 and 2.12, or in twenty-two minutes, five photographs were obtained. It would be easy to have two or three photographic apparatus with an operator in the car for each, and thus to obtain a series of views. By this method a series of topographical documents of incomparable precision might be obtained. Amongst the views taken during this ascent those which are perfect in point of clearness are those taken at the moment when the rays of the sun fell directly on Paris. Good light is absolutely indispensable, and, in spite of the photographs being instantaneous, the car should be kept perfectly free from oscillation at the moment the picture is being taken. The operator and occupants of the car must at that moment remain perfectly still. The movement of the balloon has no injurious effect on the clearness of the proofs obtained; in the present instance the current of air was somewhat rapid, for the balloon traversed Paris at its greatest width, 11 kilometres, in thirty-two minutes. The rapidity of the wind increased subsequently to much more than this. After taking photographs of the earth below, the apparatus was turned upwards to obtain views of the clouds; but the white clouds which reflect the rays of the sun with great intensity, did not give good results. The apparatus will require special arrangement for this work, and in their next expedition the aëronaut-photographers hope to obtain something more complete than they have done. Their experience on the whole is that photographs may be obtained in a balloon as beautiful and clear as the best produced on *terra firma*. Thanks to the instantaneous process, to the extra-sensitive plates produced to-day, and to other modern improvements, aërostatic photography has a great future. It will give plans which will exceed in precision and clearness the most pains-taking maps; it will be a powerful ally of military art, for it will admit of obtaining a reliable plan of fortresses or of hostile works. At a height of 600 metres a balloon has nothing to fear from artillery fire,

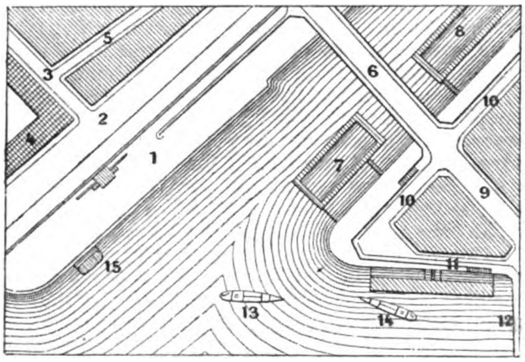


FIG. 2.—Explanatory plan of above:—1. Gate of the Hôtel de Ville. 2. Quay of Hôtel de Ville. 3. Rue de Brosse. 4. Old Lobau Barracks. 5. Rue de l'Hotel de Ville. 6. Louis Philippe Bridge. 7 and 8. Baths. 9. Rue de Bellay. 10. Quai de Bourbon. 11. Quai d'Orleans. 12. Pont St. Louis. 13 and 14. Boats. 15. Pier.

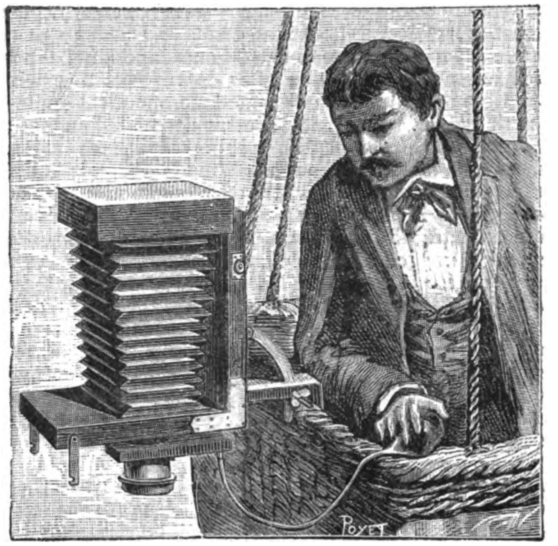


FIG. 3.—Arrangement of photographic apparatus in the balloon.

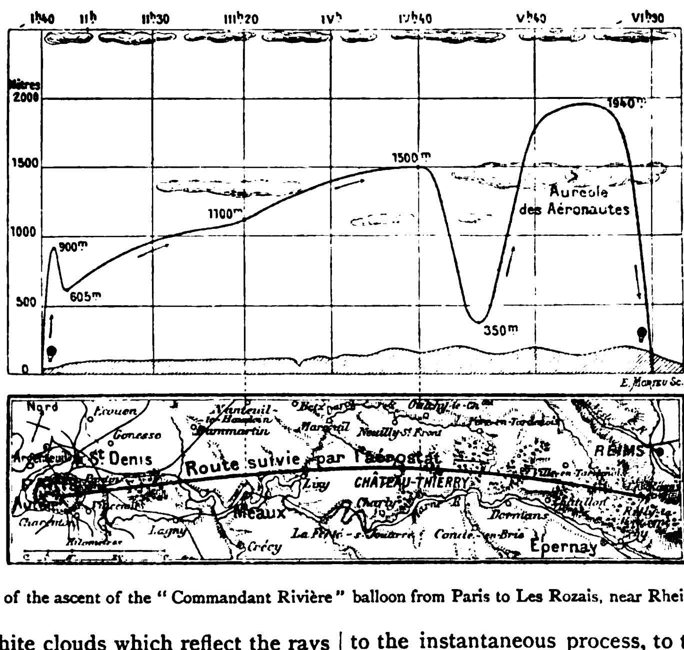


FIG. 4.—Diagram of the ascent of the "Commandant Rivière" balloon from Paris to Les Rozais, near Rheims, June 19, 1885.

and the photographer can operate as safely in his car as in his studio. It will also add to the resources of photography, for there are no places on the earth's surface inaccessible to a balloon.

The ascent here described had for its main purpose photography; but it had also some meteorolcgical interest. The ascent began at 1.20; and at 3.20, at an altitude of 1100 metres above Meaux, another balloon, which ascended some time after them, was met with. They were actually in a frequented aëronautical route—an aërian river. At Meaux Nadar descended in 1863; M. Tissandier himself landed at the same place in 1872, and several other descents were made there. A little farther, at Château-Thierry, on a prolongation of the line from Paris to Meaux, M. Tissandier and M. de Fonvielle made an extraordinary descent in a storm in 1869, when they were dragged along the ground four kilometres in five minutes. They travelled from Paris to Château-Thierry, a distance of 80 kilometres as the crow flies, in 35 minutes—the most rapid balloon voyage on record. On the present ascent, at an altitude of 1000 to 1400 metres, an aërial current of considerable speed prevailed; it was estimated at about 40 kilometres an hour. At 1400 metres a mass of white translucid clouds stretched across the sky and floated in the upper part of the aërial current. Above this, again, the air was calm; small white clouds remained immovable at 2000 metres, and the sun was very hot. After having descended close to the earth above Château-Thierry, it was decided to rise above the clouds amongst which the aëronauts had just been. At 6 o'clock, at a height of 1900 metres, they observed the shadow of the balloon projected on a white ground of clouds; the latter formed a small greyish circle, surrounded by an aureole of the seven colours of the rainbow. When they approached the clouds, it was only the shadow of the car and of the lower part of the balloon of which the projection could be distinguished, and the aureole assumed a larger diameter. This remarkable and beautiful phenomenon resembles that of the spectre of the Brocken. At 6.10 the descent commenced; the balloon crossed the bank of clouds, and the surface of the earth, when it came in sight, looked grey and dull compared with the magnificent regions of the upper atmosphere.

RADIANT LIGHT AND HEAT[1]

III.

Radiation and Absorption—Terrestrial Applications.

HAVING now established the Theory of Exchanges, let us inquire at greater length into the nature of the radiation from bodies of different kinds. For this purpose we shall adopt the well-known classification into solids, liquids, and gases, and shall select as the type of a solid body (as far as radiation is concerned) a black substance like carbon. We must do this because, in order to obtain the greatest amount of radiation from such a body at a given temperature, it must be of sufficient depth to be practically opaque, or *athermanous*, for the heat of that temperature, and it must have a non-reflective surface. Now carbon or lamp-black possesses these properties, if not completely, yet to greater perfection than any other substance that we know of; and on this account we shall select it as the type of radiating solid bodies.

Then as regards liquids, we have no doubt an amount of surface-reflexion, which will have the effect of diminishing the radiation, and also of polarising it, to some extent. In this respect a liquid surface may be regarded as equivalent to a polished solid surface, so that liquids and polished solids may be classed together as giving out an amount of heat somewhat less than that given out by the typical black surface.

But while there is no marked distinction in radiation between solids and liquids, if only the depth of substance be sufficiently great, the radiation of gases is essentially different. This difference consists in the fact that while solids and liquids radiate all kinds of heat possible to the temperature, gases radiate only a few. We shall best perceive this distinction if we confine ourselves to rays which affect the eye, and view these by means of the spectroscope.

We have already explained how this instrument draws out a thread of white light into a parti-coloured ribbon, red at the one end and violet at the other. Now if our thread of white light be a thread of platinum, or, better still, of carbon rendered incandescent by means of electricity, we shall no doubt obtain the spectrum above mentioned. But if our source of light be a row of incandescent gaseous particles, we shall obtain something very different. Instead of a long, continuous, variously-coloured ribbon, we shall have a few discontinuous threads of light emerging from a dark background, each such thread or image having of course its proper spectral position; that is to say, if the gas gives out a yellow ray, this will appear in the yellow region of the spectrum; if a red ray, in the red region, and so on. Such spectra may either be thrown upon a screen, or viewed through a telescope—sometimes it is possible to throw them upon a screen and render them visible to a large audience, but sometimes this is not possible. In all cases, however, they may be thrown into a telescope and viewed by the individual observer.

We are thus in a position to formulate the distinguishing characteristic between the spectra of solids and liquids, and those of gases, the former giving out a continuous spectrum, consisting of all the rays of light possible to the temperature, while the latter give a discontinuous spectrum, consisting of a few bright lines on a dark background.

We can, in an imperfect manner, assign a reason for this behaviour. In a solid, or even a liquid, the various molecules are near together, so that no individual is free from the trammels of its neighbour in its vibrations. On the other hand, it is not so in a gas, or at least in a gas of which the molecules are very far from one another.

Here one individual is for the most part of its existence free from the trammels of its neighbours, and is able to vibrate after its own fashion and in a way to suit itself, just as freely as a bell, or the string of a musical instrument. It thus gives out, as it were, its own peculiar note, or series of notes, these notes being here, however, rays which have a definite place in the spectrum, instead of sounds which have a definite place in the musical scale. But whilst there is a great amount of freedom amongst the molecules of a gas, we must not carry this conception of things too far, or suppose that in a compound gas at ordinary temperatures we have nothing but a series of perfectly similar molecules practically independent of one another.

The particles or molecules of such a gas are far from being in a state of rest, and we may imagine them to be running about in straight paths, except when they are deflected by dashing against a neighbour, or against the sides of the containing vessel. It will thus be seen that the molecules are not quite free. In fact, a molecule perfectly remote from neighbours, travelling, for instance, in free space, and remote from the sun, would have no more inducement to vibrate than a bell would have under similar circumstances. It is the collision with its fellows that will generally cause it to vibrate, but it is sufficiently independent to vibrate according to its own laws. Indeed, we are in a position to assert that a great portion of that energy which constitutes ordinary heat in a gas is derived from this motion of the molecules in straight lines, while, again, the radiation of the gas is caused by the vibrations of the molecules after they have been in collision with one another, or with the sides of the containing vessel.

[1] Continued from page 399.

Now in a compound gas these collisions sometimes cause dissociation of the compound molecule into more elementary constituents, which constituents will probably afterwards combine again, so that we may imagine that in such a gas (see "Heat," by Prof. Tait, page 203) equilibrium is maintained by a constant amount of dissociation, accompanied by an equal amount of recombination. It is thus apparent that we have not here perfect simplicity and uniformity of molecular structure, and without discussing the question whether a simple molecule might or might not be expected to vibrate in only one way, we can readily imagine that the spectrum of such a gas should present us with more than one mode of vibration; that is to say, more than one spectral line.

Again, circumstances which conduce to proximity of molecules, and to the action of molecules upon each other, tend to bring about a state of things similar to that which we have in liquids and solids; that is to say, they will favour the emission of various kinds of rays, while on the other hand, the characteristics of a gaseous spectrum will be best shown by a perfect gas, that is to say, by a gas which is far removed from any tendency to condensation. A rare gas at a high temperature will possess these properties.

Having now defined the characteristics of the spectra of solids, liquids, and gases, let me say a few words about the methods by which we obtain gaseous particles heated to a high temperature. These are obtained in two ways. First, by means of flames, such as that of a Bunsen's burner, into which the particles are introduced. In such flames we may imagine that we have before us a certain number of the particles of a certain gas all, or nearly all, heated to a temperature somewhat approaching that of the flame. The substance will probably have been introduced into the flame in a different chemical state from that in which it appears in giving out the light; for instance, we may introduce into a spirit-lamp a little chloride of sodium, or into a Bunsen's burner a little bicarbonate of soda. The flame becomes immediately of a yellow nature, giving us the double line D, or the yellow line of incandescent sodium vapour, and this affords us evidence that dissociation has taken place. In like manner the red line produced by salts of Lithium, the green line produced by those of Thallium, and so on, are indications that the compound saline molecules have become dissociated in the flame.

The second way of producing gaseous spectra is by an application of electricity, as when a high tension spark is sent through a tube containing a small quantity of a given gas, or a vacuum tube, as this is sometimes called. We have then a momentary flash, consisting of the rays which characterise the spectrum of the gas through which the discharge has passed. It is probable that in this case only a portion of the particles filling the tube have been brought to the high temperature which is denoted by the discharge.

Before proceeding further, it may be well to mention that while from the title of our subject we must necessarily consider the spectrum to some extent, yet this is not to be regarded as a treatise on the spectroscope and its applications, which formed the subject of a previous set of essays in the NATURE Series by Mr. Lockyer. We shall discuss the subject in a somewhat different manner, and also give more especial attention to those branches which had not yet been developed when Mr. Lockyer wrote his work. With these preliminary remarks, we shall divide the subject before us into two sections.

(1) Radiation and its consequences.

(2) Absorption and its consequences.

In the first we shall discuss radiant spectra to a considerable extent, but shall not entirely confine our remarks to these phenomena; while in the second we shall discuss absorption spectra to a considerable extent, but shall not entirely confine ourselves to spectral absorption.

There is likewise another convenient way of dividing our subject, namely, in its application to terrestrial and celestial phenomena.

Combining, therefore, these two principles of subdivision, we shall, in the first place, treat of terrestrial applications of the laws of radiation and absorption, and in the next place of their celestial applications; and, finally, we shall discuss the light which both of these branches together appear to throw upon the ultimate constitution of matter.

With regard to our own Earth, it is abundantly evident that the great bulk of the heat which it receives is from the radiation of the sun, while, on the other hand, the great bulk of the heat which it loses is through radiation into space.

There is a sort of balance kept up between the gain on the one hand and the loss on the other, in virtue of which we are placed under conditions in which life is endurable, and for the most part pleasant. The variations in these conditions in temperate latitudes may sometimes cause distress to the weak, but they are not less the source of enjoyment and vigour to the strong; and, as a matter of fact, the most energetic races of mankind are they which dwell in those favoured regions that are neither too cold nor too hot.

Inasmuch as the regions near the equator are hotter than those near the poles, it follows that there is greater radiation into space from the former of these than from the latter. If, therefore, we could imagine an observer to be placed many thousand miles above the earth, having an eye capable of distinguishing dark rays, and to regard that portion of the earth unilluminated by the sun, his eye would receive more rays from the equatorial than from the polar regions.

On the other hand, the polar regions being manifestly colder than those of the equator, we have convection currents of hot air passing in the upper atmospheric regions from the equator to the poles, and currents of cold air passing in the lower atmospheric regions from the poles to the equator. These latter are known as the Trade Winds, and the former as the Anti-Trades. In like manner we have in all probability currents of hot water passing in the upper oceanic regions from the equator to the poles, and currents of cold water passing in the lower oceanic regions from the poles to the equator. It is not, however, our object to dwell on these phenomena here; suffice it to say, that our well-being depends on the balance between the radiant heat which we receive from the sun and that which we give out into empty space.

The phenomena of dew form an exceedingly good illustration of the laws of radiation. This subject was first investigated by Dr. Wells, an English physician. When the sun has sunk beneath the horizon of any place, bodies of small mass and great radiating power for dark heat, such as the leaves of plants, become quickly cooled by their uncompensated radiation into space. They thus cool the air around them, until this air becomes so cold that it can no longer retain in the viewless state the aqueous vapour which it holds; part of this is consequently deposited in the form of dew, or of hoar-frost, if the temperature be sufficiently low.

The following are the laws which regulate the deposition of dew:—

(1) Dew is most copiously deposited under a clear sky.

(2) And with a calm state of the atmosphere.

(3) It is most copiously deposited on those substances which have a clear view of the sky.

(4) And which are good radiators and of small mass.

(5) And which are placed close to the earth.

The first of these conditions is essential, because the cooling which precedes the deposition of dew is owing to radiation into free space.

If there are clouds, these will radiate back to the body, and thus prevent it from cooling fast enough. We see, likewise, the necessity for a calm atmosphere, when we reflect that dew can only be deposited by means of the body cooling the air around it; now if this air is constantly renewed, it cannot cool this large body of air to any great extent, and hence dew cannot be formed.

It is very manifest why the body must have a clear view of the sky, and why it must be a good radiator in order to promote the deposition of dew. Also why it must not be of a great mass, for, if it were, the heat from the interior might be conducted to the surface, and thus keep up the temperature.

Finally, the substance must be near the earth, for, if not, the cooled air will fall down, giving place to warmer air. The body will thus have a larger mass of air to cool, and it will less easily succeed in bringing this mass below the dew point. I shall return to this subject at a later stage, when the part played by the aqueous vapour of the air is taken into account. Let me here state that there are regions in the earth where dew forms an important factor in agricultural operations.

The artificial warming of our rooms is at present accomplished very much by radiation. An ordinary fire of coal or wood acts by this process. The heated carbonic acid gas which is the product of the combustion is carried up the chimney and out into the air, so that all that remains to heat the room is the light and heat given out by the glowing fire.

It is by no means an economical use of heat, but there are other considerations besides those derived from economy, and an open fire will always be cherished by those nations whose social life is greatly within doors.

The burning of gas in order to obtain illumination has nothing to recommend it. As it is used at present, it gives out a great deal of heat compared to its light, as well as a quantity of carbonic acid, and other products still more deleterious.

It ought to be replaced by some kind of electric light, such as that proposed by Swan, where a thread of carbon is kept at a high temperature in a glass vacuum by means of an electric current. There the luminous effect is very large in comparison with the heat produced, besides which there is no foul air or other hurtful product.

If we regard radiation as a means of increasing our knowledge, apart altogether from its primary and indispensable action in rendering us acquainted by means of vision with the objects around us, we cannot have a better instance than that which is given us in spectrum analysis. Here, in the first place, a little reflection will convince us that we can gain hardly any knowlege by this means of the nature of a luminous solid or liquid body, for all such bodies at the same temperature will give out all the various rays which are possible to that temperature. There is, therefore, no means afforded us by their spectra of distinguishing one from another, so that spectrum analysis is here impossible.

It is very different, however, when we come to gases which give out spectra consisting of bright lines in a dark background. Here there are various laws which combine not only to make spectrum analysis possible, but to constitute it an extremely delicate instrument of research. *In the first place*, we have the law that the lines given out by any one elementary vapour are different in spectral position from those given out by any other. *Secondly*, as a rule such bright lines remain in their places throughout a great temperature range. *Thirdly*, an exceedingly small amount of the element in question is generally sufficient to produce the lines.

It is stated that by means of the spectroscope the presence of less than one two-hundred-millionth part $\left(\frac{1}{200,000,000}\right)$ of a grain of sodium may be detected. Indeed, the difficulty is to get rid of the sodium line in an insular climate like ours, surrounded by sea-water which contains chloride of sodium.

There are three chief points for consideration in the study of gaseous spectra:—

(1) The effect produced by increasing the pressure of the gas.

(2) The effect produced by giving the gas a motion to or from the observer.

(3) The effect produced by increasing the temperature of the gas.

The effect produced by increase of pressure consists in a widening of the bright lines. This subject was first studied by Frankland and Lockyer, who found that all lines are not affected by pressure to nearly the same extent. The F line produced by incandescent hydrogen was found by them to be peculiarly subject to an increase of pressure, widening out in certain cases to a really remarkable extent.

Lockyer, who has since greatly studied this subject, is of opinion that it is not *pressure per se* that is influential in thickening the lines, but rather *the frequency of encounters of precisely similar molecules*. An important application of this law of pressure has been made by Lockyer, who has for this purpose used the electric arc, placing the slit of his spectroscope so as to embrace a section of this arc mid-way between its terminals and at right angles to its length. Now in the heart or central axis of this arc the gaseous particles which give out the light may be supposed to be somewhat near together, whereas at the border or circumference they are comparatively far apart. When the spectrum of such a transverse section is taken, this is found to consist of a number of bright lines, some long and some short. The long lines are those which remain visible even when the particles are far apart, while the short lines are those which require a greater nearness of particles to come out, and are therefore confined to the central regions of the arc.

Suppose now that we take the spectrum of such an arc, from terminals composed of absolutely pure iron, and that by this means we obtain a number of long and short lines, characterising the spectrum of this metal in the state of vapour.

Suppose next that we obtain the spectrum of some other metal, such as copper, which is not chemically pure, but which, we suspect, contains a little iron. We shall obtain, of course, the copper lines well defined and intense, *plus* an indication of the iron lines; but inasmuch as the iron particles are here few and far between, the iron lines which make their appearance will be those which do not require great nearness of particles in order to come out—in other words, they will be the long iron lines, and not the short ones. In searching spectroscopically for an impurity it is thus only necessary to direct our attention to the long lines of the various metals which we suspect to be present. Thus the whole process of comparison is made much simpler, and we are enabled likewise to obtain with comparative ease the true spectra of the various elements.

Let me now say a few words about the effect produced by a motion of the radiating gas to or from the observer. Suppose that a tram car starts from a station every five minutes in a certain direction, and that we are walking briskly *towards* this station, we shall meet the cars oftener than every five minutes. On the other hand, if we are walking briskly *from* the station, they will overtake us less frequently than every five minutes. Suppose, again, that the whistle of a locomotive engine strikes the air 1,000 times every second, then if the locomotive be at rest, we know from the theory of sound that the one blow will have advanced about 13 inches before the next is delivered to the air.

If, however, the locomotive engine be itself travelling in this direction, it is evident that the interval between the blows will be less, for the engine may have itself advanced one inch during the time that the last blow has advanced 13 inches, and thus the distance between the two blows will be 12 inches, or one foot. If, therefore, an observer be standing on a railway platform and a railway engine be advancing at full speed whistling as it comes, the interval between the blows will be less than usual, or the note will be shriller than if the engine were at rest. On the other hand, when it has passed the station and is rapidly receding from the observer, the interval will be greater than usual, and the note less shrill.

It is precisely the same with regard to light. If a luminous body emitting rays of definite wave length be moving towards the observer, the wave length will be lessened and the ray pushed forwards to the more refrangible side of the spectrum. If, on the other hand, it be moving from the observer, the wave length will be increased, and the ray pushed backwards to the less refrangible side of the spectrum.

The only difference between light and sound is that the former moves so fast, that in order to get an appreciable alteration in wave length we must have a luminous body moving from or towards us with velocities much greater than we can produce experimentally, whereas in the case of sound we can make the experiment.

Nevertheless if we go to the surface of the sun, or to the fixed stars, we shall find luminous objects moving from or towards us with velocities sufficiently great to suit our purpose.

Let me now say a few words on the effect produced on some gaseous spectra by increasing the temperature of the gas. It is quite certain that at comparatively low temperatures such spectra are more complicated than they are when the temperature is high. In the former case they frequently present a fluted appearance, while in the latter we have spectra composed of a few bright lines on a dark background.

In some cases an increase of temperature entirely changes the character of the spectrum, so that certain so-called elementary substances may be said to have two or more spectra. In general, however, we have, notwithstanding these remarks, the great feature already mentioned of a persistence of the more permanent spectral lines, more especially in the case of metals, throughout a large temperature range.

By means of spectrum analysis we have discovered the existence of several new elementary metals, all of which are very sparingly distributed.

Bunsen was the first to detect two new elementary metals, cœsium and rubidium. Shortly afterwards Crookes discovered thallium, Messrs. Reich and Richter indium, and other elementary metals have since been discovered by the same means.

It is now time that something should be said about the phenomena of absorption. Since gases have small radiating powers, they may naturally be supposed to have small powers of absorption. We know, for instance, how feeble is the absorption of pure air for luminous rays, or even for ordinary heat rays. Tyndall has studied the absorptive power of gases for low temperature heat, and has come to some very interesting conclusions. The following table embodies the results of his experiments:—

Comparative absorption of various gases, each of the pressure of 1 inch.

Air	1	Nitric oxide	1590
Oxygen	1	Nitrous oxide	1860
Nitrogen	1	Sulphide of hydrogen	2100
Hydrogen	1	Ammonia	7260
Chlorine	60	Olefiant gas	7950
Bromine	160	Sulphurous acid	8800
Hydrobromic acid	1005		
Carbonic oxide	750		

By this we learn that the absorptive power of the three permanent simple gases for dark heat is very small, while that of compound gases is very considerable. Tyndall imagines that the molecule of a compound gas may be more inert and less nimble in its vibrations than that of a simple gas. That is to say, the compound molecule will vibrate more slowly than the simple one, and will thus give rise to rays of great wave length; and inasmuch as its absorption and radiation are connected together, it will be peculiarly liable to absorb rays of great wave length.

Its absorption for dark heat may therefore be very great, even although it may appear perfectly transparent for ordinary light rays.

Tyndall has found, as the result of his inquiries, that aqueous vapour absorbs many more dark rays than dry air, and justly concludes that the aqueous vapour present in the atmosphere plays a very important part in terrestrial economy. Being transparent for rays of high temperature it stops but a small proportion of those which come to us from the sun; on the other hand, being comparatively opaque for rays of low temperature, it stops the radiation into space from the surface of the earth. To speak more accurately, it does not absolutely prevent this radiation, but absorbs it and returns as much or nearly as much again. Its action, in fine, is virtually the same as that of a cloud in preventing the refrigeration which accompanies dew. Tyndall remarks that in those regions where the air is very dry the nights are often intolerably cold, owing to this uncompensated radiation into space.

Such regions are those in Central Asia and the great African desert, in the latter of which water can readily be frozen after the sun has sunk. The glass of a greenhouse acts in the same way as the aqueous vapour of the air. It allows the sun's rays freely to penetrate and to heat the air within; but it stops the dark heat of the plants and of the soil from being radiated outwards into free space. Even a loose frame of glass may save the tender blossoms of the peach, and other wall fruit, from being destroyed by nocturnal refrigeration.

BALFOUR STEWART

(*To be continued.*)

NOTES

ON Monday Prof. Michel Eugene Chevreul entered upon his 100th year. Apart from the fact that among men whose lives have been devoted to active scientific research no one has before attained such an age, M. Chevreul stands conspicuous for the vast amount of work he has done and for the great practical effect his work has had on the industries of the world. When Dumas in 1852 addressed M. Chevreul on the occasion of handing to him the *prix* of 12,000 francs accorded to him by the Société d'Encouragement pour l'Industrie Nationale, he said:—"Le prix consacre l'opinion de l'Europe sur des travaux servent de modèle à tous les chimistes; c'est par centaines des millions qu'il faudrait nombrer les produits qu'on doit à vos découvertes." More recently, in 1873, when the award of the Albert medal was made by our Society of Arts, the terms in which the Council expressed the grounds of the award were:—"For his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world." His scientific work, apart from its commercial outcome, was in this country recognised by the Royal Society as far back as 1826, when he was elected a foreign associate. In 1857 the Copley medal was awarded to him. Other countries have also paid him honour, while the distinctions of his native land have showered upon him. Born in Angers in 1786 (on August 31), where his father was a physician of note, he was but seventeen when he went to Paris to be "manipulateur" in the laboratory of the celebrated Vanquelin. At the age of twenty he published his first chemical paper, and in the next half dozen years he had published more than a score on different subjects. Then began that series of papers (commencing in 1813), "Recherches chimiques sur plusieurs corps gras, et particulièrement sur leurs combinasions avec les alcalis," which extended for many years and were compiled and rearranged in the volume "Les corps gras," issued in 1823 with the dedication "à Nicolas-Louis Vanquelin, mon maître." In 1824 he was appointed Professor of Chemistry at the famed factory of Gobelins, and the energy and untiring industry which was one characteristic of his work soon accumulated stores of knowledge based on experiment. To exact experiment he attached the highest importance. He wrote in 1823 "experiment is not chemistry, facts alone do not constitute that science, but we cannot have discoveries without exact experiment." His "Recherches sur la Teinture" is an elaborate work, and his "Moyen de définer et nommer les couleurs" occupies the whole of vol. xxxiii. of the *Memoirs* of the Institut. It has often been remarked that it is difficult to believe that the Chevreul of "Corps gras" fame and the Chevreul who wrote on colours are one and the same man.

WE regret to have to announce the death, on August 27, of Lieut. L. Brault, of the French navy, who had charge of the Meteorological Service at the Depôt des Cartes et Plans, Paris. M. Brault was the author of several important meteorological works, among which may be specially mentioned one on the circulation of the atmosphere in the North Atlantic and a treatise on astronomy and nautical meteorology. But the great work to which he devoted the larger part of his energy was the preparation and publication of wind charts for the Atlantic, Indian, and Pacific Oceans, a work begun in 1869 and finished in 1880. It consisted of sixteen large charts giving for each *quarter*, and for squares of 5°, the probable direction and force of wind over those oceans. At the time of his death he was employed in the extraction and tabulation of observations from ships' logs, with the view of publishing *monthly* charts of various elements as soon as he had collected sufficient data. It is sad to see so able a man cut off in the midst of such useful work.

MR. GEORGE FREDERICK ARMSTRONG, M.A., F.G.S., C.E., some time Professor of Engineering in the M'Gill University, Montreal, and in the Yorkshire College, Leeds, has been appointed to the Regius Professorship of Engineering in the University of Edinburgh, vacant by the death of Mr. Fleeming Jenkin, LL.D., F.R.S.

THE Queen has been graciously pleased to confer the distinction of Knight Commander of St. Michael and St. George on Mr. John Fowler, C.E.

WE regret to learn that Mr. Trelawney Saunders has retired from the post of geographical assistant to the India Office, a position which he has held with credit to himself and advantage to the public service for the period of seventeen years.

PROF. CALLADON, of Geneva, writes a correspondent to the *Times*, has communicated to the local press a description of a remarkable atmospheric phenomenon which was noticed on August 6. Until after five o'clock p.m. the sky had been calm and serene over all the valley of the Leman, but at half-past five, albeit the atmosphere above the lake and neighbouring mountain remained remarkably still, vapours were seen at a great height (evidently produced by a strong and warm south-west wind in the upper air) advancing rapidly towards the north-east, and taking the undulatory forms which characterise clouds strongly charged with electricity. At half-past eight the aspect of the sky had become decidedly stormy. The thick cloud-masses were oscillated wildly, albeit their general movement was still from south-west to north-east. After nine o'clock these clouds, drawing away, rendered visible the sheet of cirrus which stretched above them. The cirrus was phosphorescent, and looked as if lighted up by a bright moon. On the north-western horizon the sky along all the chain of the Jura was obscured by thick clouds that from time to time were illuminated by flashes of lightning. It was the same over Mont Galène, above which the lightning played every few minutes. A long black cloud stretching from the Dôle to the Galène presented on each side a broad phosphorescent border, and about a quarter past nine there became suddenly visible in that part of the cloud nearest the Jura a luminous centre whence escaped two or three phosphorescent rays pointing towards the south-west. This phenomenon lasted some twenty minutes, and was sufficiently striking to be remarked by many observers. From a quarter past nine to eleven o'clock, moreover, the south-western extremity of Mont Galène was illuminated by a phosphorescent light so intense that its rays were visible from every part of the horizon. The general appearance of this south-west section of the Galène resembled that which is presented by the city of Geneva in thick weather when the mists of evening are lighted up by the gas of the streets. Some rare instances are on record of forests of resinous trees becoming phosphorescent in stormy weather, but the distance from Geneva was too great to enable observers to determine whether the light resulted from the phosphorescence of the fir trees which cover the sides of the Galène or from that of other parts of the mountain. The Central Meteorological Bureau publishes, about eight o'clock every morning daily, accounts of the general condition of the atmosphere throughout Europe, and special reports from twelve stations in Switzerland at eight o'clock a.m. and one o'clock p.m. These reports are received at Geneva on the following day, and those of August 5 and 6 show that on the dates in question there took place a complete change in the atmospheric equilibrium of western Europe, and that the high pressures which for several weeks previously had prevailed over England and the Channel suddenly ceased and gave place to warm, vapour-charged winds from the south-west.

IF original scientific work has been poured forth principally from the old settled countries of Western Europe, it is not a small labour which America seems to be undertaking to thoroughly collect and arrange in available order, not indeed the knowledge, but even the confused heaps of publications from which such knowledge may be painfully extracted. Another valuable catalogue compiled by Dr. H. C. Bolton appears as one of the valuable publications of the Smithsonian Institution. With the unexplained exception of medical science, it contains a list of all the scientific and technical periodicals published in Europe or America since the rise of this literature. It does not include the *Proceedings* and *Transactions* of Societies already indexed in Mr. S. H. Scudder's Catalogue of Scientific Serials, published in 1879. As this latter did not contain the titles of technical journals, the two publications are complementary, and together make up a most valuable list to any seeking information; a large proportion of papers, however, neither technical nor Societies' Proceedings, being, of course, found in both. The many large libraries open to the public which form such an item in the wealth of the United States have much assisted in this work, and a list most useful to a student is appended, showing in which of more than 120 of them each publication is to be found. A table, in chronological order, commencing with 1728, is also given, showing during which years each of 500 publications was carried on, and this is provided also with an index by which the place of each in the list may be found. Another index of subjects referring the reader to the principal publications in which each is treated adds greatly to the practical value of the whole work.

DR. JOSIAH PARSONS COOKE has just published a volume entitled "Scientific Culture and other Essays." *Science*, in referring to the volume, says that the most important statements which are made in these essays are quite independent of the subject-title. They should be printed after the manner of certain biblical texts, and displayed on the walls of every collegiate hall in the land. We append a few of these paragraphs:—"There is no nobler service than the life of a true teacher; but the mere taskmaster has no right to the teacher's name, and can never attain the teacher's reward" (p. 85). "The teaching which a professorship implies, instead of being a hindrance, ought to be a great stimulus to scientific investigation. Of course this influence is greatly impaired, if, as in many of our colleges, the available energies of the teacher are exhausted by the daily routine of instruction, or by outside work required to supplement his meagre salary; but if the teaching is only moderate in amount, and in the direction of the professor's own work, there is no stimulus so great as that which the association with a class of earnest students supplies" (p. 280). "Men of affairs should resign the endowments intended for the maintenance of scholars to those whose zeal is sufficient to induce them to make gladly the sacrifices which the advancement of knowledge usually entails" (p. 277).

MR. EDWARD SAUNDERS writes as follows to the September number of the *Entomologist's Monthly Magazine*, under date August 6, on the subject of "Dead Humble-bees under Lime Trees." Dead humble bees, more or less mutilated, have often been observed in large numbers under lime trees, and various suggestions have been offered to account for their presence in such a position. Some observations which I was able to make the other day suggest the probable reason for the death and evisceration of such bees, and, therefore, may be worth recording. While walking on Hayes Common, Kent, on the 3rd of this month, I noticed, under a large spreading lime tree, in full flower, that the ground was strewn with bodies of humble-bees of several species; I and one of my children picked up a number of them, and found several still moving their legs, and evidently only quite recently mutilated, nearly every specimen appearing to have been killed in the same manner, having a large hole in the upper surface of the thorax, and another at the apex of the abdomen, the apical segments being removed; thinking that it would be a good opportunity to try and find out who or what was the cause of their death, I sat down close to the tree and watched. The tree was covered with bloom, and hive-bees and humble-bees abounded, but I could not see any wasps, so I at once abandoned the idea that they were the culprits, as some have thought probable; everything seemed peaceable, and for some time I could see no possible enemy to suspect. At last, I saw among the higher branches a bird, and from the exact spot where it was fidgeting about down dropped a carcase of a bee. I at once picked it up, and found the legs still twitching convulsively; although I did not actually see the bird drop the bee, I think there can be little doubt that it did. I went back again, and sat down to try and discover what bird it was, and after a little time a bird, which was in all probability the same, although I had lost sight of it while examining the bee, came out into a less leafy part of the tree, and I was able to identify it as a great tom-tit; and although I have no positive evidence whereby to convict *Parus major*, I think the probabilities of his being the culprit are so strong, that it is hardly necessary to seek further for the murderer of these humble innocents.

ADVICES received by the last mail from Iceland state that the weather in the island during the summer has, in common with everywhere else in North Europe, been very cold and stormy. Even in the middle of July night-frosts occurred frequently in the higher-lying districts, and sometimes also by the coast. The grazings have suffered greatly in consequence of the weather, being in many places in a miserable state. During June and July severe storms devastated the island, killing the sheep in many places, notably in the Westfjord. The fishing has been fairly good in some places where the herring have been plentiful this summer. The fish was fat and in excellent condition.

ON the west coast of Norway, too, very unusual weather has been experienced this summer, snow having fallen in several places, whilst night-frosts have injured the crops. Tourists from the interior state that they never have experienced so backward a season in that part. The cold weather is being ascribed to the enormous ice-masses which have descended from the Polar regions into the Gulf Stream in the spring, and the large quantity of drift ice in motion to the north and north-east of Norway.

INTELLIGENCE received from North and Central Sweden states that the migratory birds are already leaving in large numbers. Between August 16 and 18 thousands of wildfowl were seen passing over Stockholm, their progress lasting for hours at the time. During the night, too, their calls were heard. That the birds have previously left their summer haunts so early is unknown.

A QUICK change of temperature arrived on the U.S. Atlantic coast on the afternoon of August 25, the mercury falling 40°. A hurricane along the Florida and Caroline coasts accompanied it, causing serious damage. Charleston, South Carolina, had one fourth of its houses unroofed; church steeples were blown down and the wharves were overflowed and damaged, the wind blowing at the rate of seventy miles per hour. The hotels and summer-houses on Sullivan's Island were partly destroyed. The damage is reported to amount to $1,000,000. Savannah reports serious losses from the overflow and the wind. Jacksonville and and Fernandina, Florida, report heavy losses with wrecked vessels. The storm, which extended northward with less severity, was general along the Atlantic coast.

AT the last meeting of the Asiatic Society of Japan (reported in the *Japan Mail*) a paper by Mr. H. Pryer was read on the relation between the Lepidoptera of Great Britain and Japan. From the statistics given it appears that about 16 per cent. of the British species are found in Japan. At first sight there does not seem to be any strong resemblance between the Japanese and British specimens of certain species; but the differences are demonstrably due simply to the effect of temperature. In Japan the temperature forms are very numerous, because of the fluctuations in temperature which are so peculiar to the country. When the great distance separating the countries and the striking climatic differences are considered, the identity of such a large percentage of species is a fact of the highest interest to the entomologist.

THE syllabus of the day and evening classes of the Mason Science College, Birmingham, for the session 1885-86 has been published.

THE Asiatic Society of Bengal has just issued a centenary review of the work accomplished by it. The first meeting of the Society took place during the Governor-Generalship of Warren Hastings, in the year 1784.

IT is stated that various lines of telegraphs are to be constructed in Corea under the superintendence of Chinese officials. The preliminary surveys have already been commenced between Gensan and Seoul, and at various points on the Chino-Corean frontier. The length of the lines actually undertaken is over 400 miles.

THE recent earthquakes in Java appear to have extended all over the Eastern Archipelago. The official journal of Batavia contains a report from the Government resident at Amboyna stating that on April 30 violent shocks were felt at Amboyna, in

Banda, and Kayeli, and on the following day at Kairatu. Villages on the beach were overwhelmed by the sea. At intervals of about twenty minutes the sea receded to a distance of 300 yards from low water mark, and then returned to overflow to a depth of 34 feet the broad plain near the beach, fifteen miles west of Kayeli. This phenomenon does not appear to have been general, but to have confined itself to the locality mentioned.

EARTHQUAKE shocks were felt on August 26 in the valley of the little river Mürz, in Styria. They caused no damage beyond loosening the foundations of a few cottages. Several shocks were felt in the same district last May.

THE *Nacion* of Guayaquil gives details of the eruption of the volcano of Cotopaxi early on the morning of July 23. It states that about one o'clock in the morning people were awakened by a sound as of heavy artillery fire, apparently from guns of the heaviest calibre. The explosions followed one another with wonderful rapidity, sometimes causing a continuous roar, shaking the earth and causing the windows and the doors of the houses to rattle. At Chimbo, which is situated almost at the foot of the volcano, there was what the residents along the river Yana-Yacu call an "aluvion." The phenomenon so-called is really the stream of lava which descends the mountain sides, melting the snow with which it is covered, and pouring down a tremendous mass of lava, mud, stones, and all obstacles encountered in its progress. Investigations during the day showed that the shocks produced by the explosions during the night were exceedingly heavy. The smoke hung like a pall over the face of the country, and the steady fall of ashes thrown constantly out of the terrible crater intensified the darkness. Accounts from Latacunga state that the eruption began with a terrible storm. The damage done was considerable, but the number of victims is not known A similar catastrophe occurred in June 1877.

THE "Bureau Scientifique Central Néerlandais," established in 1871 at Haarlem, after the death of its first Director, the lamented Prof. E. H. von Baumhauer, has been taken in hand by Dr. P. P. C. Hoek, at Leiden. The Bureau is in relation with the Smithsonian Institution, Washington, the "Ministère de l'Instruction publique en France," the "Commission des Echanges Internationaux à Bruxelles," with bureaus in Christiania, Stockholm, Copenhagen, &c. Packages sent as *donations* or *exchanges*, and destined for Dutch learned societies or scientists, henceforth are to be sent to the new Director at Leiden or to be delivered to the agent of the Bureau at London *free of expense*. The agents of the Bureau are Messrs. Williams and Norgate, 14, Henrietta Street, Covent Garden, London.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. H. J. Thimbleby; a Binturong (*Arctictis binturong* ♂) from Malacca, presented by Mr. T. H. Haynes; a Great Kangaroo (*Macropus giganteus*) from New South Wales, presented by Mr. A. McIlwraith; two Golden-crowned Conures (*Conurus aureus*) from South-East Brazil, presented by Mr. Cuthbert D. Middleton; a Common Cuckoo (*Cuculus canorus*), British, presented by Mr. R. B. Spalding; two Javan Sparrows (*Padda oryzivora*) from Java, presented by Miss Coleman; a Black-headed Gull (*Larus ridibundus*), European, presented by Mr. Humphries; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Miss Simpson; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Master Cecil Guy Dart; a Robben Island Snake (*Coronella phocarum*) from Robben Island, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Macaque Monkey (*Macacus cynomolgus*) from India, a Siamese Blue Pie (*Urocissa magnirostris*) from Siam, an American Black Snake (*Coluber guttatus*) from North America, a Smooth-headed Capuchin (*Cebus monachus*), a Squirrel Monkey (*Chrysothrix sciurea*) from South America, deposited; two Axolotls (*Siredon mexicanus*) from Mexico, purchased; fourteen Striped Snakes (*Tropidonotus sirtalis*), born in the Menagerie.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, SEPTEMBER 6-12

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on September 6

Sun rises, 5h. 22m.; souths, 11h. 58m. 8·3s.; sets, 18h. 34m.; decl. on meridian, 6° 18′ N.: Sidereal Time at Sunset, 17h. 38m.

Moon (New on September 8) rises, 2h. 11m.; souths, 9h. 44m.; sets, 17h. 6m.; decl. on meridian, 14° 3′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 53	11 28	18 3	6 14 N.
Venus	8 29	14 0	19 31	6 23 S.
Mars	0 32	8 40	16 46	22 14 N.
Jupiter	5 30	12 6	18 43	6 31 N.
Saturn	23 18*	7 27	15 35	22 23 N.

* Indicates that the rising is that of the preceding day.

Sept.	h.	
8	4	Mercury in conjunction with and 0° 27′ south of the Moon.
8	—	Total eclipse of Sun, visible only in regions near the south pole.
8	22	Jupiter in conjunction with Sun; also in conjunction with and 1° 57′ north of the Moon.
11	9	Mercury stationary.
11	10	Venus in conjunction with and 2° 27′ south of the Moon.

GEOGRAPHICAL NOTES

MR. GARDNER, British Consul at Newchwang, publishes with his annual trade report this year (China, No. 6, 1885) a most interesting account of his consular district, which embraces the whole of Manchuria. It contains an area of about 300,000 square miles and a population estimated by the Roman Catholic missionaries at 15,000,000. Its boundaries are, on the north, the Amour, separating it from Eastern Siberia, on the east the Ussuri River and Sihoti Mountains separating it from the Russian province of Primorsk, on the south the Tiumen and Yalvo Rivers separating it from Corea, the Yellow Sea and the Gulf of Liao-tung, on the west China, Mongolia, and Russian Siberia. The first part of the report deals with the ordinary trade and productions of Manchuria, and gives a summary of the statistics of foreign trade since the port of Newchwang was opened to trade in 1861. The second part is devoted to geographical notes on Manchuria, its three provinces, Heh-lung-Kiang (or Sagalien), Kirin and Fêngtien being taken separately. The history, government, military force, and divisions in towns are the heads under which these provinces are described. Various appendices contain an account of a journey from Moukden to San-sing, an essay on Christian missions in Manchuria, and a sketch of the botany of South Manchuria by Dr. Morrison. The latter is, from a scientific point of view, the most important part of the report. The lists given are defective, as the greater part of Dr. Morrison's collections remain unidentified, there having been no opportunity of visiting herbaria or consulting published accounts of Northern Chinese plants.

THE report of the Resident in the State of Selangore in the Malay peninsula for the past year contains some curious information with regard to "aboriginal tribes" called the Sakeis, who number between 700 and 800. They are in nine divisions, under head-men called Batins, and they live mainly by collecting gutta, rattans, and other jungle produce. As far as is known they have no form of religious worship, but they are very superstitious, believing in good and bad omens, the sacred character of certain birds, and they always desert a village as unlucky on the death of any member of the tribe. They tattoo figures on their arms, but apparently only for the sake of ornament, and do not use any specially significant figures, peculiar to each tribe, analogous to the totems of the North American Indians. They consider no kind of edible food unclean, but eat even monkeys, snakes, and scorpions, which they kill by means of a blow-pipe, throwing a dart poisoned with the juice of the Ipoh or Upas tree. For large game they use a kind of cross-bow, consisting of a sharpened bamboo spear placed horizontally on a grooved log, and a bent sapling fastened back by a rattan cord. This cord is stretched across a path in the jungle, and, on being touched, releases the sapling with sufficient force to drive it completely through a deer's body. The Sakeis live in small huts built of bamboo and thatched with leaves of the Bertam palm, raised eight feet or more above the ground. They are shy and easily frightened, but are quite harmless, and are gradually becoming accustomed to Europeans, by whom they are employed to track game and to cut paths through the jungle. They are smaller in stature, but are otherwise very similar in appearance to the Malays, from whom they differ, however, in usually having wavy instead of straight-growing hair. A few Malays are attached to every Sakei community to act as go-betweens in the sale of their produce, and the officials have received special instructions to protect these aboriginal tribes.

THE last issue (Bd. xxviii. Nos. 7 and 8) of the Vienna Geographical Society contains a paper by Dr. B. Jirus describing several visits made by him to the Scoglios, or small reefs off the Dalmatian coasts.—Dr. Polek writes on the colonies of Lipporwans, or Ras Kolniks, Russian schismatics who fled in the middle of the seventeenth century into Bessarabia and Moldavia, which they subsequently left for Bukowina in a romantic way. The writer discusses the history of their flight, and describes their manners and mode of life. The charm of mystery hangs around this small sect of the Greek Oriental Church.—Mr. H. Polakowsky discusses the historical value of the Spanish heroic poem "Araucana," recording the struggles the Spaniards for the possession of the central part of the present Republic of Chili. The object of the author of the paper is to draw attention to this poem, and its translation into German, and by a complete critical examination to separate the historical and actual from the poetical and imaginative.—Herr Baumann describes the projected geodetic work of Dr. Lenz's Congo expedition, and also writes from the vessel taking out the expedition on the present position of the question it is going out to solve.

THE Geographical Society of Hamburg has published a memorandum showing the territorial extent of the recent German annexations in the Pacific Ocean. Reduced to English measurements the German estimates are as follows:—Kaiser Wilhelm's Land (German New Guinea), 34,508 square miles; New Ireland, 3,398·8 square miles; New Britain, 9,348·8 square miles; the Bismarck Archipelago, 15,261·6 square miles: in all about 65,512 English geographical square miles. The same authority estimates the area of New Guinea taken under British protection as 65,517·76 square miles, or about the same as the total of the German annexations in the Pacific, and in each case the area acquired is rather more than twice that of Ireland.

THE *Indépendance Belge* announces that the two Portuguese explorers, Capt. Capello and Commander Ivens, who started last year upon an expedition across Africa, have reached the Cape after a most adventurous journey. Leaving Mossamedes in March, 1884, with an escort of 120 men recruited along the coast between that place and St. Paul de Loanda, they reached Quillimane, upon the eastern coast, to the south of Mozambique, in May, 1885, after having discovered the watershed whence the rivers of Central Africa flow north and east towards the sea. They travelled over 4500 miles of territory, and they are said to have discovered the sources of the Lualaba. They also came upon a region which is extraordinarily rich in copper, this being the district of Yaranganga, situated between the Lualaba and the Luapala. The chief of the country, however, was so hostile that they could not visit it in detail, but they think that as this was the first visit of white men his hostility may be appeased by judicious presents. Messrs. Capello and Ivens found that the tsetse fly was very abundant. The *Indépendance Belge* adds that the two explorers started again at the beginning of last month for Mossamedes, with the intention of returning to Europe by way of the Congo.

THE Calcutta correspondent of the *Times* states that the Government of India has conferred the title of Raj Bahadoor and a grant in perpetuity of a rent-free village in Oude on Pundit Kishen Singh Milwal, an *employé* of the Survey Department, who is well known to all geographers for his explorations in Thibet, which have been published under the initials "A. K."

ON August 10 Col. Lockhart was at Hargil, near Gilghit, and is now probably marching to Chilval. His mission is expected to largely increase our knowledge of the country towards the upper waters of the Oxus.

THE IRON AND STEEL INSTITUTE

THE autumn meeting of the Iron and Steel Institute is being held in Glasgow this week, under the presidency of Dr. Percy, F.R.S.

On Tuesday, after the President had acknowledged the welcome given to the Institute by the Corporation of Glasgow and referred to the depression of trade, due, in his opinion, to over-production, and to be remedied only by a diminution of production or increased consumption, the three following papers were read, of which abstracts are given below.

On the Iron Trade of Scotland, by Mr. F. J. Rowan.—The author separates the history of iron-making into two periods—the *empirical*, characterised by rude and imperfect appliances; and the *scientific*, in which exact methods of working are employed, the introduction of the hot-blast in 1830 closing one and opening the other period. At this period there were in Scotland 27 blast-furnaces making 37,5000 tons; at present there are 92 in blast, with an average production of 200 tons per week each, and 269 puddling-furnaces at work, each producing annually 732 tons. There has been a steady increase in the production per furnace, and reduction in the amount of coal used to produce a ton of pig iron, the latter result being due to the introduction of closed tops, higher furnaces, and higher temperatures of blast. About two-thirds of the coal raised have been from the coal-measures, and one-third from the carboniferous limestone series. It is remarkable that the increased production of coal that has recently taken place has been accompanied by a reduction in the proportionate number of persons employed due to mechanical haulage and other improvements both below and above the surface. The increased manufacture of open-hearth steel, which employs a large quantity of Spanish and African ore, has caused a diminution in the output of ironstone, and has also had an influence on the pig-iron trade; this, however. has been compensated for by the malleable iron tube manufacture, the manufacture of boiler tubes having increased ten times in the last twenty-five years. The author claims for Scotland a good record of advancement and improvement in connection with the iron trade—the first cylinder-blowing engine, the first use of raw coal in the blast-furnace, the discovery of blackband ironstone by David Mushet, the invention of the hot blast by Neilson, and the collection and utilisation of the gases from the tunnel-head. The spirit of enterprise is still potent among Scottish ironmasters, and it is hoped more prosperous times will soon reward and further stimulate the energy and ability which are to be found in all branches of the iron trade in Scotland.

The Rise and Progress of the Scotch Steel Trade, by James Riley.—The author first makes a short reference to the manufacture of cast steel in crucibles, which is carried on only to a very small extent.

As regards the Bessemer process, the first trial, which proved unsuccessful, was made in 1857, at the Coats Iron Works, by Mr. T. Jackson, the apparatus being fitted up from the drawings and letterpress in the *Illustrated London News*.

Other attempts on a small scale were afterwards made to introduce the manufacture, but since the application of the basic lining to the Bessemer converter, by which the pig-iron of the district will become available, the process has again received attention, and a large production is anticipated.

The history of the Scotch steel trade really commences with the formation, in 1871, of the Steel Company of Scotland, which manufactured open-hearth steel by the processes of the late Sir William Siemens, their output being principally boiler and ship plates, angles, bars, castings, and forgings. The extension of manufacture in these directions has been dne to the fact that the Admiralty in 1875 declared for steel, "giving Siemens's steel a preference," and that in 1879 concessions were made to steel by Lloyds' and the Board of Trade, which has caused a great demand for shipbuilding and for the purposes of the civil engineer, who has recognised that by the use of steel, difficulties in constructive engineering can be overcome which would otherwise have been most formidable.

Mr. William Jones read a paper on processes for the recovery of tar and ammonia from blast-furnaces fed with raw coal. The coal generally employed is what is known as Scotch splint coal; it contains on an average 40 per cent. of volatile matter and 50 to 55 per cent. of fixed carbon. The average amount of nitrogen in the coal is 1·35 per cent.; if all this nitrogen was evolved as ammonia and this again converted into sulphate, it would amount to 142½ lbs. of pure sulphate, equal to 152·8 lbs. of commercial sulphate containing 24 per cent. of real ammonia; in blast-furnace practice only 17 to 20 per cent. of the theoretical quantity, or 25 to 28 lbs. per ton, is recovered, whilst in gas-works 14½ per cent. is evolved. Two methods are mainly employed: the one depending on the condensation or cooling of the gas from the blast-furnace, and the other on the treatment of the hot gas with either dilute sulphuric acid or sulphurous acid, which absorbs the ammonia in the gas; towers or scrubbers have to be used for washing the gas in both methods of treatment. The paper contains a detailed description of the various processes employed in carrying out these two methods for the recovery of by-products. The make of sulphate of ammonia from blast furnaces in Scotland has been greatly exaggerated. Even a year hence, when the whole plant being laid down will be available, the make will not exceed 4000 tons per annum. If the gases of the whole of the blast-furnaces in Scotland at present in blast were being treated for ammonia, the turn-out of sulphate of ammonia would be some 18,000 tons per annum, equal to about 22 per cent. of the present British production.

With the discussion of this paper proceedings on Wednesday began; after which Mr. J. Riley read a paper descriptive of an experimental cupola-furnace, which it is proposed to employ in connection with the open-hearth process, with the object of shortening the time employed. Many years ago Mr. Hackney tried at Landore the experiment of pre-melting the pig-iron in a cupola, whence the fluid charge was quickly and readily transferred to the melting-furnace. Instead, however, of saving three or four hours by charging fluid metal, it was found, on repeating the experiment at Hallside, that there was only a saving of about a quarter of an hour in time, obtained at the expense of the coke and labour expended at the cupola. This is due to the circumstance that during the melting of a charge in the open-hearth furnace a large proportion of the silicon and carbon is removed, leaving little more than half the carbon to be eliminated in subsequent operations. Now in the case of the fluid charges, which had been pre-melted with coke in the cupola, these changes have not taken place, and the time required to remove the impurities from the fluid metal, after being charged on the open-hearth furnace, is almost as long as that required to melt and purify the solid charge. The idea occurred to the author to substitute gaseous for solid fuel in the cupola. The gas generator has a closed grate and is dependent upon forced blast, and the air for supporting combustion in the body of the furnace is also obtained from the blower, and is heated.

The experiments made with this cupola prove that not only is there a saving in time and fuel, but that the percentage of silicon and carbon in the pig-iron and steel scraps are very much reduced, so that it is anticipated that when the fluid metal can be charged direct into the open-hearth furnace, the time for its conversion into mild steel will be greatly shortened.

This paper caused a very lively discussion, with which the proceedings on Wednesday terminated.

On Thursday amongst other papers was one descriptive of the Forth Bridge by Mr. Baker, which we print below *in extenso*.

In the afternoon of each day the members visited various steel and iron works in the neighbourhood.

THE FORTH BRIDGE[1]

As the members of the Iron and Steel Institute purpose paying a visit to the Forth Bridge works, I have been requested by the Secretary to prepare a short paper on the subject for the information of the members, and do so with pleasure.

The North British Railway Company for many years have striven hard to obtain a physical connection of their lines north and south of the Forth by means of a bridge. Twenty years ago they were authorised by Act of Parliament to build a bridge across the Forth at a point five miles above the site of that now under construction, but borings 120 feet in depth showed nothing but soft silt and mud, and the bridge, which was to have been two miles in length, inclusive of four spans of 500 feet each, was luckily abandoned, as the difficulties with the foundations would have proved practically insuperable. In 1873 another Act was passed for a bridge across a narrower and deeper part of the Forth at Queensferry. At low water the width of the channel there is about 4000 feet; and the island of Inchgarvie affording a foundation for a central pier, it was possible to cross the 200 feet deep portion of the sea-way by a couple of spans from 1600 feet to 1700 feet each in the clear. Sir Thomas Bouch prepared a design for this bridge on the suspension principle, with towers 665 feet in height from base to summit, and the contract for its construction was let to Mr. Arrol. Owing to the subsequent fall of the Tay Bridge, public confidence in Sir Thomas Bouch's design was shaken, and in session 1881 a bill for the abandonment of the Forth Bridge was proceeded with. Whilst in Committee, the different companies interested, namely, the North British, Great Northern, North-Eastern, and Midland Railway Companies, ordered a final reference of the whole question to their respective consulting engineers, with the result that the abandonment bill was dropped, and the design for a cantilever or continuous girder bridge prepared by Mr. Fowler and myself, in consultation with Mr. Harrison and Mr. Barlow, was substituted for the original suspension bridge. In 1882 the necessary Parliamentary powers were obtained, and in January 1883 the works were commenced by Messrs. Tancred, Arrol, and Co., the contractors.

The total length of viaduct included in the contract sum of 1,600,000*l*. is about 1½ miles, and there are—

2	spans of	1710	feet each.
2	,,	675	,,
15	,,	168	,,
5	,,	25	,,

Including piers, there is thus one mile of main spans, and half a mile of viaduct approach. The clear headway is 150 feet above high water, and the tops of the great cantilevers are more than 200 feet higher still. There will be about 45,000 tons of steel in the superstructure of the bridge, and 120,000 cubic yards of masonry in the piers.

Piers.—The *South Queensferry* main pier consists of a group of four cylindrical piers of masonry and concrete, founded by means of pneumatic caissons on the strong boulder clay constituting the bed of the Forth at this point. Owing to the slope of the clay, the caissons required to be sunk to depths varying from about 70 feet to 90 feet below high water. The diameter ranges from 70 feet at the base to 60 feet at low-water level, above which the iron skin of the caisson is replaced by a facing of Aberdeen granite. At the base of the caissons is a working chamber 7 feet in height supplied with compressed air, and electrically lighted, for the men excavating the material. This chamber was kept clear of water by a pressure of air considerably less, as a rule, than that due to the head of water outside. For example, at 90 feet below high water, when the north-east caisson had been sunk through a considerable thickness of silt, the air-pressure required to be maintained at 18 lbs. per square inch only, although at the reduced depth of 57 feet it was found convenient to work at 30 lbs. air-pressure. Three shafts and air-locks were provided for each caisson, two for the excavated material, and one for the men. The former had two horizontal sliding doors actuated by small hydraulic rams, and the skip containing the clay and boulders was hoisted up the 90-feet shaft by a steam-engine mounted on the side of the air-lock. As a rule, from 200 to 300 skips of excavated material were raised per day of 24 hours by a force of from 20 to 30 men. The maximum number of skip-loads was 363, and of men 33. The size of the skips was 3 feet diameter by 4 feet 3 inches high. Owing to the extreme hardness of the clay it was necessary to provide a certain number of spades having hydraulic rams in the handles, which, abutting against the roof of the working chamber, sliced the clay readily.

At the present time three of the South Queensferry caissons have been sunk successfully to the full depth, and the fourth and last would also have been completed but for an unfortunate accident which happened to it at the beginning of the year. By some means the caisson, which had been floated into position for some weeks, accidentally filled with water, and sank and slid forward on the mud. It is now being carefully cased in timber to admit of the water being pumped out and the caisson floated again into position.

[1] Paper read at the Glasgow meeting of the Iron and Steel Institute by Mr. Benjamin Baker, M.Inst.C.E.

At *Inchgarvie* similar pneumatic caissons are used for two out of the four cylindrical piers, and the work on both is in full progress. Owing to the slope of the rock bottom, it is necessary to cut away as much as 18 feet in thickness of whinstone rock to form a level bench for the pier at 70 feet below high water, and the most convenient way of doing this was to convert the base of the pier practically into a great diving-bell 70 feet in diameter. In this case, there being no silt over the rock, the pressure of air necessarily is that due to the depth of water outside, and somewhat sensational "blows" occur with a falling tide. Rock drills are provided, and blasting goes on in the compressed-air chamber without necessitating the withdrawal of the men.

At *North Queensferry*, the four main piers were built either on dry land or within timber and clay cofferdams. Above low water the whole of the main piers are built of Arbroath masonry in cement faced with Aberdeen granite, and hooped occasionally with 18 inches wrought-iron bands. The cantilever end piers, and the viaduct piers, are built of rubble, concrete, and granite in cement.

Superstructure.—Although the piers of the Forth Bridge present many points of interest, it is the enormous span and novel design of the superstructure that has attracted the attention of the engineers of the world to the work now in progress at Queensferry. The chief desiderata in the biggest railway bridge ever proposed to be constructed are durability, strength, and rigidity under express trains and hurricane pressures; facility and security of erection, high quality of material and workmanship, and economy in first cost and maintenance. These, we considered, would be best met by a steel "cantilever" or "continuous girder" bridge. Since the commencement of the Forth Bridge, American engineers, ever bold and ready, have built three cantilever bridges of considerable spans, and practical experience has confirmed our anticipations as to the advantages of the system; the Niagara Bridge, over 900 feet in length, which was manufactured and erected across the rapids in the short time of ten months, having stood all the tests of actual working in the most satisfactory manner.

In the Forth Bridge, each span of 1710 feet is made up of two cantilevers, projecting 680 feet, and a central girder connecting the same, 350 feet in length. The cantilevers are 343 feet deep over the piers, and 40 feet at the ends. The bottom members consist of a pair of tubes tapering in diameter from 12 feet to 5 feet, and spaced 120 feet apart, centre to centre, at the piers, and 31 feet 6 inches apart at the ends.

The top members consist of a pair of box lattice girders, tapering in depth from 12 feet to 5 feet, and spaced 33 feet apart at the piers, and 22 feet 3 inches at the ends. Each tube has a maximum gross sectional area of 830 square inches, and each girder a maximum net sectional area of 506 square inches. Upon each cylindrical masonry pier is bolted a bed-plate carrying a "skewback," from which spring vertical and diagonal columns and struts. The former are 12 feet in diameter, and from 368 to 468 square inches sectional area; the latter are flattened tubes. Horizontal wind-bracing of lattice girders connect the tubes forming the bottom member of the cantilevers, and similar vertical wind-bracing connects the vertical and diagonal tubes, so that the whole structure is a network of bracing capable of resisting stresses in any direction and of any attainable severity.

The rolling load provided for is (1) trains of unlimited length on each line of rails weighing 1 ton per foot run; (2) trains on each line made up of two engines and tenders, weighing in all 142 tons, at the head of a train of 60 short coal-trucks of 15 tons each. The wind provided for is a pressure of 56 lbs. per square foot, striking the whole, or any part of the bridge, at any angle with the horizon, the total amount on the main spans being estimated at no less than 7900 tons. In practice only two trains, weighing 800 tons in all, would be on this length of bridge at the same time, so the wind pressure (if such a hurricane as 56 lbs. per square foot could ever occur) would be ten times as great as the train load. Under the combined stresses resulting from the test load in the worst position, and the heaviest hurricane, the maximum stress on the steel will not exceed 7½ tons per square inch on any portion of the structure, and on members subject to great variation in the intensity and character of stress, the maximum will not exceed 4 tons per square inch. For tubular columns and struts 34 to 37 ton steel, with an elongation of 17 per cent. in 8 inches, is specified, and for tension members 30 to 33 ton steel, with 20 per cent. of elongation. We have now about 15,000 tons of steel delivered and worked up, and are satisfied that the quality as supplied to us by the Steel Company of Scotland and the Landore Company is admirably adapted for bridge construction. In making the tubes the plates are heated in a gas furnace and bent hot between dies in a powerful hydraulic press. A slight distortion takes place in cooling, which is corrected by pressing the plates again when cold. After bending, all four edges are planed and the plates built up into a tube. Travelling annular drill frames surrounding the tube, fitted each with ten traversing drills, bore the holes at once through plates, covers, and stiffeners, so that when again fitted in place for erection every piece comes into exact juxtaposition. Similar travelling drill frames deal with the lattice box-girders, every hole being drilled as the machine advances. Generally the plant designed by Mr. Arrol for drilling the innumerable holes in the 42,000 tons of steel-work for the main spans is of signal merit and efficiency, and well worthy the attention of practical engineers.

At the present time, although, as already stated, about 15,000 tons of steel-work is on the ground, only the approach viaduct girders and some of the bed-plates of the main spans are erected and rivetted up. In a few weeks, however, the erection of the portion of the main spans over the North Queensferry piers will be proceeded with. The "skewbacks" and connecting tube will first be rivetted up, and then a platform of temporary girders and planking will be constructed, and raised gradually by hydraulic rams in the four vertical 12-foot diameter columns as the work of erection and rivetting-up progresses. This platform will carry cranes and other appliances, and the men will be thoroughly protected, so that work may be carried on with as much confidence at a height of 350 feet as at sea-level. When the portion of steel-work over the piers is erected, the first bay of cantilever on each side of the same will be added, the work forming its own staging. This will be followed by succeeding bays until the cantilevers are complete, and the central girders will then be erected, probably on the same plan.

It will be observed that for certain parts of the Forth Bridge we use steel of a higher tensile strength than is at present considered admissible either for ships or boilers. This has not been done without full and mature consideration of the whole question. Our experiments showed that steel, having a tensile strength of from 34 to 37 tons per square inch, offered a decided advantage over very mild steel, when compressive stresses and the flexure of long columns were concerned. Indeed, an inferior quality of steel, such as would be used for rails, will stand compression far better than the best boiler steel or Lowmoor iron. Thus, I found a column twenty diameters in length of common Bessemer steel carry 27 tons per square inch, where one of mild boiler steel has stood but 17 tons. It would be inexpedient, however, to use inferior steel, even for the compressive members of a bridge, and therefore a high quality and high tensile resistance were indicated. Although this steel takes a temper and becomes brittle if cooled in certain ways, it will stand the ordinary Admiralty temper tests, bending to a radius of double the thickness, after being made red-hot and cooled in the usual way. In a boiler the steel plates are subject to great changes of temperature and consequent stresses from expansion and contraction. In a ship almost every plate in the hull is subject to alternate tensile and compressive stresses when amongst waves; and, further, a vessel is liable to severe alternating stresses and shocks on taking ground, dry docking, and under other circumstances. In the compression members of the Forth Bridge the steel is subject only to a steady pressure of varying intensity, and a quality of steel was adopted which combined perfect facility in working with a high resistance to compression. Although an increased tensile strength is accompanied by a decidedly increased resistance to flexure in columns and struts, the latter is not proportional to the former. If the thing were practicable, what I should choose as the material for the compression members of a bridge would be 34- to 37-ton steel, which had been previously squeezed endwise in the direction of the stress to a pressure of about 45 tons per square inch —the steel plates being held in suitable frames to prevent distortion.

My experiments have proved that 37-ton steel so treated will carry as a column as much load as 70-ton steel in the state in which it leaves the rolls, that is to say, not previously pressed endwise. It would be a matter of much practical moment to ascertain if some convenient treatment could be devised which would endow steel with this greatly increased power of resistance to compression without injuring its resistance to tension, or its ductility, which remained unaffected by previous compression in my experiments. At least one-half of the 42,000 tons of steel in the Forth Bridge is in compression, and the same proportion holds good in most bridges, so the importance of gaining an increased resistance of 60 per cent. without any sacrifice in the facility of working, and safety belonging to a highly ductile material, can hardly be exaggerated.

Our experience has led us to the conclusion that sheared edges are a more fruitful source of fracture than partial tempering or other contingencies. All of our bent plates are made red-hot, and the effect of the shearing is thus eliminated even before planing. Those plates which are not heated have the edges carefully planed so as to leave no trace of the shearing, and we find that, whether we are dealing with 30-ton or 37-ton steel, the plates so treated stand all the desired tests. Experiments which I have made, and am still making, on the resisting power of different classes of iron and steel to repeated bendings, such as the shaft of a marine engine undergoes if the bearings get out of line, indicate that the superiority of low-tension steel is considerably greater than the increased ductility would indicate.

In conclusion I may state that the approximate value of the plant now at the Forth Bridge is 250,000*l.*, and of the work executed 600,000*l.*

SOCIETIES AND ACADEMIES

Sydney

Royal Society of New South Wales, June 3.—Prof. Liversidge, F.R.S., President, in the chair.—A paper was read by Mr. G. H. Knibbs on a system of accurate measurement by means of long steel ribands. The chief feature of the method of measurement is the application of such tensions to the riband as eliminate the effects of its suspension when it becomes necessary.—Mr. Law. Hargrave read a paper, notes on flying-machines, which consisted of deductions drawn from close observation of the behaviour of about fifty self-supporting flying-machines of various weights, from three-quarters of an ounce to four ounces. Sixteen models were exhibited. Mr. Hargrave stated that, although he believed the trochoided plane to be the true mechanical power used by birds in flight, he though its rejection as a scientific truth of very trifling importance compared with the judicious variation and adjustment of the details of the models, so that rules could be laid down for work on a larger scale

July 1.—Prof. Liversidge, F.R.S., President, in the chair.—A paper was read by Mr. H. C. Russell, B.A., on local variations and vibrations of the earth's surface.

Paris

Academy of Sciences, August 24.—M. Bouley, President, in the chair.—Note on human locomotion; mechanism of the jump, jointly communicated by MM. Marey and G. Demeny. This first communication on the subject of human locomotion begins with the action of springing or jumping, because, although not the most usual, it is regarded by the authors as by far the simplest, and much less intricate than walking or running, in which the body executes complicate movements in the direction of the three dimensions of space. The paper is illustrated by a *chromo-photograph* showing the successive positions of legs, arms, and shoulders in a man taking a standing leap (*saut de pied ferme*); also by diagrams of two high jumps executed on the dynamograph.—Observations on the prevalence and development of pestilence and cholera in Persia, where quarantine preventive measures have never been adopted, by M. J. D. Tholozan. The author, who has had twenty-eight years' experience of the action of these epidemics in Persia, is inclined to think that the quarantine system would have proved of little or no avail in arresting their progress. The paper was followed by a few remarks by M. Larrey, also pointing at the general inefficacy of quarantine measures.—Note on M. Hirn's paper on the crepuscular lights inserted in the *Bulletin* of the Colmar Natural History Society, by M. Faye. From his observatory at Colmar the author noticed this phenomenon at an altitude far higher than that of the terrestrial atmosphere. Without deciding on the merits of the different theories advanced to explain its origin, he considers that electricity alone would be capable of retaining at such an altitude the particles of matter causing the after-glows, whether these particles were derived from the Krakatoa eruption or from the interstellar spaces.—Observations of the new planet, 249 (discovered by M. Peters on August 16 at Clinton, New York), made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Observations of Barnard's comet made at the Observatory of Bordeaux with the 14-inch equatorial, by M. G. Rayet.—On the theory of revolving mirrors as a means of measuring the velocity of light, by M. Gouy.—Experiments on double refraction (four illustrations), by M. D. S. Stroumbo. By a simple contrivance the author renders visible to a large audience the course of two rays, ordinary and extraordinary, in a birefringent crystal: (1) when the two facets are artificial and perpendicular to the axis; (2) when they are artificial and parallel to the axis; (3) when they are the natural facets of the crystal parallel to each other.—Note on the alcoholic derivatives of pilocarpine, by M. Chastaign.—On the transmission of pathogenetic microbes from the mother to the fœtus and in the milk, by M. Koubassoff. From experiments made on the guinea-pig the author infers that the charbon virus, the bacilli of tubercular affections, and other germs of disease pass into the milk and remain there during the term of lactation, or till the death of the mother; also that the fœtus nourished on such milk do not catch the respective diseases, but survive even the death of the mother; lastly, that the transmission of microbes from mother to fœtus depends probably on the existence in the placenta of direct communications between the vessels of mother and fœtus.—On an alkaloid substance extracted from the liquid in which Koch's microbe was cultivated, by M. A. Gabriel Pouchet. An analysis of this liquid revealed traces of the presence of an alkaloid liquid presenting outward characteristics, such as small and toxic properties, apparently identical with those detected in the dejecta of cholera patients. Should these results be definitely established, they would furnish an indirect proof that Koch's microbe is really the pathogenetic agent in cholera.—Influence of the sun on the vegetation of the spores of *Bacillus anthracis*, by M. S. Arloing.—Action of the antiseptics on the higher organisms: iodine, nitrate of silver; fourth communication, by MM. Mairet, Pilatte, and Combemale.—A note was received from M. Sacc of Cochabamba, on an extremely rich deposit of alunite lately discovered in the Peruvian Andes.

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THURSDAY, SEPTEMBER 10, 1885

OUR PRESENT NEEDS

IF it be fair to forecast the success of a meeting of the British Association by the quality of the addresses delivered by the various presidents, then we may predict that the meeting of this year at Aberdeen, which began yesterday, will stand out among its fellows. We think it would be hard to find any prior occasion on which such a high standard of excellence had been reached all round.

The growing use as well as the growing feeling for the need of scientific methods comes out in a most unmistakable way, while there is no fear that either hearers or readers will be lulled into a Sleepy Hollow of satisfaction or a rest-and-be-thankful feeling. For that much remains to be done even in the way of initial organisation both of teaching and working, is frankly and fearlessly acknowledged by several of the speakers.

These present needs may well occupy our attention, and we may begin by those pointed out by the President of the Association himself, who speaks both as a man of Science and a politician. No one knows better than Sir Lyon Playfair how Science can aid the body politic, or knows better how each party when in office neglects or uses this powerful engine for the nation's good. He begins by quoting these noble words from the address of the President at the Aberdeen Meeting in 1859—the lamented Prince Consort:—"We may be justified in hoping . . . that the Legislature and the State will more and more recognise the claims of Science to their attention, so that it may no longer require the begging box, but speak to the State like a favoured child to its parent, sure of his paternal solicitude for its welfare; that the State will recognise in Science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand."

One can get no better idea of the Philistine condition of the Government and of the House of Commons in matters of science than from the fact that much of what follows in the President's Address has not been said in the House itself instead of at Aberdeen. The real reason perhaps is to be gathered from a remark made by Prof. Chrystal in his address in Section A:—

"We all have a great respect for the integrity of our British legislators, whatever doubts may haunt us occasionally as to their capacity in practical affairs. The ignorance of many of them regarding some of the most elementary facts that bear on every-day life is very surprising. Scientifically speaking, uneducated themselves, they seem to think that they will catch the echo of a fact or the solution of an arithmetical problem by putting their ears to the sounding-shell of uneducated public opinion. When I observe the process which many such people employ for arriving at what they consider truth, I often think of a story I once heard of an eccentric German student of chemistry. This gentleman was idle, but, like all his nation, systematic. When he had a precipitate to weigh, instead of resorting to his balance, he would go the round of the laboratory, hold up the test-tube before each of his fellow-students in turn, and ask him to guess the weight. He set down all the replies, took the average, and entered the result in his analysis."

Now if this view of our legislators is shared by men of such acumen as Sir Lyon Playfair and others in the House of Commons more or less connected with science, we can well understand their silence in the modern council of the nation which so little resembles the Witanagemote of former times.

In his pleading for more State recognition of science the President points out the present activity of Germany and France, and especially of the United States:

". . . Both France and Germany make energetic efforts to advance Science with the aid of their national resources. More remarkable is it to see a young nation like the United States reserving 150,000,000 acres of national lands for the promotion of scientific education. In some respects this young country is in advance of all European nations in joining Science to its administrative offices. Its scientific publications, like the great palæontological work embodying the researches of Prof. Marsh and his associates in the Geological Survey, are an example to other Governments. The Minister of Agriculture is surrounded with a staff of botanists and chemists. The Home Secretary is aided by a special Scientific Commission to investigate the habits, migrations, and food of fishes, and the latter has at its disposal two specially constructed steamers of large tonnage. The United States and Great Britain promote fisheries on distinct systems. In this country we are perpetually issuing expensive Commissions to visit the coasts in order to ascertain the experiences of fishermen. I have acted as Chairman of one of these Royal Commissions, and found that the fishermen, having only a knowledge of a small area, gave the most contradictory and unsatisfactory evidence. In America the questions are put to Nature, and not to fishermen. Exact and searching investigations are made into the life-history of the fishes, into the temperature of the sea in which they live and spawn, into the nature of their food, and into the habits of their natural enemies. For this purpose the Government give the cooperation of the Navy, and provide the Commission with a special corps of skilled naturalists, some of whom go out with the steamships, and others work in the biological laboratories at Wood's Holl, Massachusetts, or at Washington. . . . The practical results flowing from these scientific investigations have been important. The inland waters and rivers have been stocked with fish of the best and most suitable kinds. Even the great ocean which washes the coasts of the United States is beginning to be affected by the knowledge thus acquired, and a sensible result is already produced upon the most important of its fisheries. The United Kingdom largely depends upon its fisheries, but as yet our own Government have scarcely realised the value of such scientific investigations as those pursued with success by the United States."

He quotes with approval a passage from Washington's farewell to his countrymen: "Promote as an object of primary importance institutions for the general diffusion of knowledge. In proportion as the structure of a Government gives force to public opinion it is essential that public opinion should be enlightened." He next points out that it was not till 1870 that England established a system of education at all, and that now, while all great countries, except our own, have Ministers of Education, we have only Ministers who are managers of primary schools.

Passing on to the State need of abstract knowledge, we read as follows :—

"Ali, the son-in-law of Mahomet, the fourth successor to the Caliphate, urged upon his followers that men of science and their disciples give security to human progress. Ali loved to say, 'Eminence in science is the highest of honours;' and 'He dies not who gives life to learning.' In addressing you upon texts such as these my purpose was to show how unwise it is for England to lag in the onward march of science when most other European Powers are using the resources of their States to promote higher education and to advance the boundaries of knowledge. English Governments alone fail to grasp the fact that the competition of the world has become a competition in intellect."

We have seen how Sir Lyon Playfair twits the heads of the Education Department with being merely managers of primary schools. The President of the Chemical Section, Prof. Armstrong, also shows reason why their functions must be expanded if science is ever to get on here. He holds that without State action the difficulties which at present prevent the existing teaching institutions from exercising their full share of influence upon the advancement of our national prosperity are all but insuperable. He foresees the objection that such an interference would deprive teaching-centres of their individuality, but he denies that this must necessarily follow, and we know no one who has a better right to express an opinion on such a subject.

Some part indeed of Prof. Armstrong's address is terrible reading. The present chemical education and chemical examinations in this country are, according to him, to a large extent shams, and worse. The students who come to the centres of higher instruction are scarcely reasoning beings—they have never been brought to reason; and at those centres the instruction has been of too technical a character, while hardly anywhere is there an atmosphere of research. We commend this part of Prof. Armstrong's address strongly to our readers. He points out, among many other matters, the vital importance of the research atmosphere, and he frankly states the difficulties felt by earnest men. On this point, indeed, we think him a little too sensitive. Many of the remarks so often made now touching the absence of research in our chemical laboratories apply not to such men as him, but to those whose trading spirit and proclivities are well known—men who discredit the profession to which they belong. Still, it is well that the difficulties should be fairly recorded, especially in juxtaposition with a statement that absence of research must always indicate the absence of teaching worthy of the name.

A complete revision of the present system, both of teaching and examining in chemistry, is, therefore, according to Prof. Armstrong, one of the most pressing of our present needs.

Are the other sciences better off? Certainly not mathematics if Prof. Chrystal has a right to speak for that branch:

"All men practically engaged in teaching who have learned enough, in spite of the defects of their own early training, to enable them to take a broad view of the matter, are agreed as to the canker which turns everything that is good in our educational practice to evil. It is the absurd prominence of written competitive examinations that works all this mischief."

But some may think that in the setting of problems mathematics teachers have an advantage over others in preventing unintelligent cramming. This is not Prof. Chrystal's opinion :

"The history of this matter of problems, as they are called, illustrates in a singularly instructive way the weak point of our English system of education. They originated, I fancy, in the Cambridge Mathematical Tripos Examination, as a reaction against the abuses of cramming bookwork, and they have spread into almost every branch of science teaching—witness test-tubing in chemistry. At first they may have been a good thing; at all events the tradition at Cambridge was strong in my day, that he that could work the most problems in three or two and a half hours was the ablest man, and, be he ever so ignorant of his subject in its width and breadth, could afford to despise those less gifted with this particular kind of superficial sharpness. But, in the end, came all to the same: we were prepared for problem-working in exactly the same way as for bookwork. We were directed to work through old problem papers, and study the style and peculiarities of the day and of the examiner. The day and the examiner had, in truth, much to do with it, and fashion reigned in problems as in everything else. The only difference I could ever see between problems and bookwork was the greater predominance of the inspiriting element of luck in the former. This advantage was more than compensated for by the peculiarly disjointed and, from a truly scientific point of view, worthless nature of the training which was employed to cultivate this species of mental athletics. The result, so far as problems worked in examinations go, is, after all, very miserable, as the reiterated complaints of examiners show; the effect on the examinee is a well-known enervation of mind, an almost incurable superficiality, which might be called Problematic Paralysis—a disease which unfits a man to follow an argument extending beyond the length of a printed octavo page."

As to the crying present need, Profs. Chrystal and Armstrong are at one. We want a higher ideal of education in general and of scientific education in particular :

"Science cannot live among the people, and scientific education cannot be more than a wordy rehearsal of dead text-books, unless we have living contact with the working minds of living men. It takes the hand of God to make a great mind, but contact with a great mind will make a little mind greater. The most valuable instruction in any art or science is to sit at the feet of a master, and the next best to have contact with another who has himself been so instructed. No agency that I have ever seen at work can compare for efficiency with an intelligent teacher, who has thoroughly made his subject his own. It is by providing such, and not by sowing the dragon's teeth of examinations, that we can hope to raise up an intelligent generation of scientifically educated men, who shall help our race to keep its place in the struggle of nations. In the future we must look more to men and to ideas, and trust less to mere systems. Systems have had their trial. In particular, systems of examination have been tested and found wanting in nearly every civilised country on the face of the earth."

What we have written will show what food for thought in the matter of our present needs has been provided at Aberdeen for those gathered together for the advancement of science. Surely the three addresses to which we have specially referred in the present article suggest a gap in the organisation of the Association. Why should there not be a section to deal specially with the question of Education and Research?

THE "DECOMPOSITION" OF DIDYMIUM

UNDER the above title the *Chemical News* has recently reprinted from the *Chemiker Zeitung* a notice of an important piece of work recently communicated to the Vienna Academy by Dr. C. A. von Welsbach. The work appears to have resulted in the discovery that the "dyad or triad element" didymium with an "atomic weight" of 48 or 96, or 147, according to the text-books employed, and which since its separation by Mosander in 1841 has been investigated by Marignac, Hermann, Watts, Bunsen, Deville, and Erk, not to mention many others, is no element at all, but is built up of two substances which can be separated from each other by an ordinary chemical process. The "decomposition" was in fact effected by means of the double ammonium or sodium nitrates in presence of lanthanum salt.

The colours of the salts of the two substances are quite different. The salts of that which approaches lanthanum in its chemical characteristics are of a leek-green, those of the other substance are rose or amethyst red, and it is this substance which exists in greatest quantity in didymium. Dr. von Welsbach proposes for these two new substances the names of "praseodymium" and "neodymium."

It will be readily seen that from the chemical point of view alone these results are of very high interest, but there is another from which they assume a very great importance.

The "element" didymium after it was separated by the chemist had been handed over to the physicists. Gladstone, we believe, was among the first to note the characteristic absorption spectrum of the salts. In this work he was followed by Bahr and Bunsen, Erk and others. Thalèn determined its spark spectrum, and in our spectroscopic literature didymium has taken its place by the side of hydrogen and iron as a characteristic spectrum-giving element.

Now one of the arguments which has been used in support of the view put forward some time ago of the dissociation of the chemical elements at solar temperatures is that at one "heat level" in the sun's atmosphere (a term coined because the sun's atmosphere must get hotter as we go down, and we have means of determining which vapours ascend from hotter regions and which descend from cooler ones) we get some lines of the spectrum of a substance, let us say iron, and at another we get others; so that to get the complete spectrum of iron, as we see it when we use iron in our laboratories, we have to add together the two sets of lines seen in the spectra of parts of the sun known to be at different temperatures.

To make our statements more precise we may say that the lines of iron seen bright in the spectra of solar prominences and those seen widened in the spectra of solar spots are so different that it may be said that there is hardly a line common to both. So much so that, as was said years ago, if we did not know iron here, and the fact that its spectrum contains both sets of lines, we should say that the prominences *quâ* iron contained one substance, and the spots *quâ* iron contained another.

These facts were explained by the hypothesis that there were in the so-called element iron at least two different substances or molecular groupings, one of which alone could withstand the higher temperature of the prominences. The reason that *both* sets of lines and many others are seen in the spectrum of iron in the high-tension spark is that the temperature of the spark is sufficient to carry the solid metal through the series of simplifications, whether many or few, which lie between the limits formed by the solid state and the temperature of the prominences.

To this it has been objected that if these things exist in iron they should be isolated and put in bottles. To this it has been replied that the bottles themselves must be incandescent, or the "things" will unite again as they have done before to form iron as we know it.

Now the real importance of Dr. von Welsbach's work is that what has not yet been done for iron—to prove beyond all cavil the above hypothesis—he has done for didymium. He has got into two bottles, which we may mentally label "spot bottle," "prominence bottle," two substances from the "element" didymium, each of which has a characteristic spectrum consisting of different parts of the spectrum of didymium just as the spots and prominences have spectra *quâ* iron, which are different parts of the spectrum of iron. Further, by mixing the substances in these two bottles together in proper proportions he can produce a third, which gives the mapped spectrum of didymium exactly as in the general spectrum of the sun, in which we get, added together, the absorptions of the hotter and cooler regions represented by prominences and spots, we have *quâ* iron, something not unlike the arc spectrum of that substance.

There is no doubt that the interest of both chemists and physicists will be keenly excited by Von Welsbach's work, and that it will be critically examined and repeated. If it be confirmed we may hope that some day similar work will be undertaken here. The way is open, and has been cleared in a remarkable way. Formerly it was imagined that very high temperatures and new chemical methods were the sole agents to which appeal could be made in such a case; it may turn out that there are reagents to hand if chemists will turn their attention to them.

It is further clear that the "elements" with high atomic weight should be the first to be attacked. Those who consider the spectrum of cerium, for instance, which in the blue and violet portion is richer in lines than the spectrum of the sun itself, to be produced by the vibration of "the chemical atom" or "the chemical molecule," no matter which, will find themselves in a hopeless minority, now that the simpler explanation of a mixed origin has apparently received confirmation in the case of another substance.

But although we have chiefly confined ourselves to the spectroscopic bearing of the work, it is not too much to say of it that, if this separation be in the sense as indicated, it is the most important work in mineral chemistry we have had for many years. By patient work the group of cerium, didymium, &c., metals has yielded several new metallic oxides, differing considerably from didymium, but having the same general reactions, being members of the same group in fact. The difference in the ordinary chemical reactions of cerium, lanthanum, didymium, scandium, terbium, ytterbium, and probably samarium is generally very slight, and they can only be separated by long-continued operations, nearly always cases of fractional separation. The close relationship of these metallic oxides has been long recognised, and the group has been considered peculiar in this respect, and in consequence an immense amount of labour has been expended upon it, more than has ever been expended on groups of other metallic oxides. Indeed, the notion that heat is the agent of chemical resolution seems to have gained such a hold that apparently for the last two, or three, decades, with the exception of the cerite metals, it is the only reagent the action of which has been taken as definitive in establishing a thing to be an element. We are not aware that any records of patient work on chromium exist, attempts to isolate any other substance from chromium oxide other than our ordinary chromium. The general properties of this, or these, oxides surely invite to further investigation. And in the case of nickel and cobalt, which appear almost to be isomers, there is a fine field for investigation which might be as profitably cultivated perhaps as an almost infinite series of carbon compounds.

OUR BOOK SHELF

Annuaire géologique univ... et Guide du Géologie autour de la Terre. Par le Dr. Dagincourt. (Paris: Comptoir géologique de Paris, 1885.)

THIS is the first annual issue of a geological guide edited by the Secretary to the Geological Society of France, which cannot fail to be of the greatest use as a book of reference to those concerned with geology all over the world. *Multum in parvo* would be a very suitable motto for the book, for the amount of information which it contains in a small space is really marvellous. The editor does not profess to have carried out the whole of the programme which he has set before himself in the present issue; but it was decided to bring out the volume this year on account of the meeting of the Geological Congress at Berlin, and also in order that he may be able in the ensuing issue to profit by private and public criticism. The best criticism of it will be a bare statement of its contents. It first describes the history, various meetings and utility of the Congress of Geologists, with the proceedings at the meetings in Paris and Bologna. It then takes the continents in alphabetical order, and the countries in them in the same way, and supplies a mass of geological information of all kinds with regard to each. Taking as an example the first country under the head Europe, which is Germany (Allemagne), we find a list of books on the bibliography of German geology, of general (as distinguished from special and detailed) geological maps, and of the leading works on certain districts; these are succeeded by a general sketch of the geological features of Germany, and of the occurrence of the various geological systems; then a detailed account of the organisation for the production of geological maps in the various countries and provinces composing the German Empire; then a sketch of the institutions in which geology is taught, the various universities with their professors, laboratories, collections, museums, &c., the professors at the various polytechnic and agronomical schools, the public and private geological collections, with in some cases, brief descriptions of the principal features (these occupy a considerable space), then the various geological societies, with their organisations; next the periodical publications, their prices, size, general nature of the contents, divided into five classes—(1) those specially geological, (2) those containing from time to time geological papers, (3) geographical periodicals containing geological papers, (4) those devoted to mining, (5) collections of geological and palæontological memoirs. These lists are succeeded by others which form a very important feature of the work—viz. the names, addresses, and special fields of all the geologists in the German empire; and finally the titles of all the books and papers which have appeared during the past year on mineralogy, petrography, geology, and palæontology, arranged in alphabetical order. This description of the volume under the head "Allemagne," will give an accurate idea of the scope and arrangement of the book, for although circumstances have prevented the scheme being carried out with the same degree of thoroughness for every part of the globe, the volume will year by year approach nearer to, doubtless even improve upon, this standard. In the case of Great Britain, for instance, the issue for 1886 will contain a thorough study of our geology, and its teaching in our universities and other public institutions. Its ultimate completeness must naturally depend much on the assistance which the editor receives from geologists all over the world in supplying information, making the necessary alterations required by time, offering suggestions and adding corrections; and the volume is so useful and full in design that we have little doubt Dr. Dagincourt's fellow-geologists will willingly help him to carry it out in all its details. We observe that Tasmania has by an error been put amongst Asiatic countries instead of in Australasia.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Meteoric Cycle and Stonehenge

WE are now passing through the hundredth meteoric cycle of nineteen years, which commenced with A.D. 1882, and will terminate with A.D. 1900. These cycles began with the year of our Saviour's birth, and our prayer books contain tables showing for many successive years on what days Easter days and our movable festivals will occur. At the end of every such cycle the new and full moons happen within an hour and a half of the same time of the year as they did at the beginning.

With these cycles is commonly associated the name of Meton, an astronomer of Athens, who wrote a book on the subject, by which the Greeks regulated the recurrence of their festivals. He flourished 432 years B.C. But the knowledge of these cycles existed in England centuries before the time of Meton, as I will presently show, and it is probable that the four very ancient erections supposed to have been temples of the sun near Penzance, had reference to this cycle of nineteen years, as they each consisted originally of nineteen stones placed upright and rising from 3 to 6 feet above the ground in rude circles varying in diameter from 65 to 80 feet. These temples are still existing, although some of their stones have fallen, and they are miles from each other, but are all called in the printed maps, as well as immemorially, by one and the same name, viz. "*Nine*

Maidens," which is simply an abbreviation for *Nineteen Maidens*.

The following quotation from Diodorus Siculus (Book II. chap. iii. Booth's Trans., page 139), who flourished about forty-four years B.C., will be an historical confirmation of what I have above stated:—

"Amongst those who have written old stories much like fables, Hecatæus (born 549 years B.C.) and some others say that there is an island in the ocean over against Gaul (as big as Sicily) under the Arctic pole, where the Hyperboreans inhabit, so called because they lie beyond the breezes of the north wind; that the soil there is very rich and fruitful, and the climate temperate, inasmuch as there are two crops in the year."

This description does not apply to the whole of the island referred to, but represents Mount's Bay, its most south-western extremity, and we may therefore conclude that those from whom Hecatæus and the others derived their information were the Phœnician traders who for centuries previously frequented Mount's Bay for tin and fish, and who imagined all Britain to possess the same rich soil and mild climate as Mount's Bay where still "there are two crops in the year." But to proceed with the quotation:—

"They say that Latona was born there, that they worship Apollo above all other gods, and the inhabitants demean themselves as if they were Apollo's priests, who has there a stately grove and a renowned temple of a round form, and that there is a city likewise consecrated to this god. The sovereignty of this city and the care of the temple (they say) belong to the Boreades."

This city and this "renowned temple of a round form" are doubtless those of Old Sarum and Stonehenge, the inner oval of which, immediately around the altar, consists of precisely nineteen stones (see the plate in Dr. Stukeley's "Stonehenge," page 20). But the four temples of the sun above described of nineteen stones each, placed upright "in a round form" to represent the cycle of nineteen years, are not mentioned by Diodorus, as they were probably deemed not worthy of notice after alluding to the renowned temple of Stonehenge. The passage concludes as follows:—

"They say, moreover, that Apollo once in nineteen years comes into the island, in which space of time the stars perform their courses, and return to the same point, and therefore the Greeks call the revolution of nineteen years 'the great year.'"

Plymouth, August R. EDMONDS

Nebula in Andromeda

LAST night the nebula in Andromeda was observed here. The stellar-like nucleus was distinctly seen. It appeared to be of a reddish-yellow colour as contrasted with that of the nebula. We think that a change has certainly taken place, no such stellar-like centre having previously been seen in the nucleus. The stellar point was examined with a small prism held between the eye-piece and the eye. A continuous spectrum was seen. Dr. Boeddicher and I were both convinced that there were considerable inequalities in its light, and independently formed the impression that there was at times a bright band or line in the green. The colour of the stellar point appeared much the same as that of Aldebaran. ROSSE

Observatory, Birr Castle, September 8

Sunsets

IN July of this year I spent a short time in the Schwarzwald of Baden. For more than a week the sky was cloudless day and night, yet the heat was not oppressive. The sunsets were beautiful beyond description, and the after-glows magnificent. One evening in particular will always remain impressed upon my memory. It was that of July 26, and the place was a few miles from the town of Neustadt, nearly in the centre of the forest. Wonderful effects began to appear so soon as the sun touched the crest of the western hills. But these were as nothing compared with what followed. The moment the luminary had disappeared behind the hills long streamers began to radiate high up into the heavens, and for a time, as the daylight diminished, they increased both in length and intensity, rivalling any description or figures of the Arctic auroras that I have ever seen; at the same time the most vivid and ever-changing glow lit up the whole western heavens. The scene lasted more than an hour, and its effect was heightened by, and perhaps partly due to, a nearly full moon, which rose from behind a slight dip or pass in the hills on the eastern side of the valley. The inhabitants of the Schwarzwald are indubitably phlegmatic, and not easily moved to excitement; but this display of celestial pyrotechnics was too much for them, and at a small roadside inn the carters and others who were enjoying their beer inside turned out *en masse* to witness it. I am not a strong admirer of Turner's pictures, but, in comparing nature with art, one idea came uppermost—the scene was "Turneresque."

Lewisham, S.E., September 3 R. MCLACHLAN

Pulsation in the Veins

MR. HIPPISLEY will find a very simple way of showing pulsation in the veins, as well as in the arteries, by fixing a long bristle or thread of sealing-wax over the vessel by means of a little tallow. The end of the lever will vibrate and produce all the movements of the sphygmograph. This method was adopted by Mr. Wilkinson King nearly fifty years ago, and the instrument styled by him the sphygmometer. In his paper in the Guy's Hospital Reports for 1837, "On the Safety Valve Function of the Right Ventricle of the Heart," will be found much valuable matter and discussion about venous pulsation.

August 29 S. W.

Red Hail

VU l'intérêt que peut offrir la coloration de la grêle, j'espère que vous voudrez bien insérer ces quelques lignes dans votre journal: "La grêle colorée en rouge, observée par Mr. Mullan et dont il est question dans le No. 812 de ce journal, n'est pas un fait isolé. On a observé un cas analogue en 1880, le $\frac{2}{14}$ juin, en Russie. Les grêlons de cette chute-là étaient intéressants sous plus d'un rapport. Leur forme se ramenait à trois types: parallélipipède, cylindre, sphéroïde très-aplati et muni de cavité aux bouts de la petite axe. Certains de ces grêlons étaient percés de part en part, le long de la petite axe, ce qui leur donnait l'apparence des anneaux. Certains des grêlons étaient colorés en rouge-pâle, d'autres avaient la couleur bleu-pâle, mais pour la plupart les grêlons étaient gris ou blanc. L'observateur, M. Lagounowitch, crut avoir remarqué que la couleur était liée à la forme des grêlons. Je cite ces faits et j'en propose l'explication dans ma brochure, 'Sur l'Origine de la Grêle.'"

THÉODORE SCHWEDOFF,
Professeur de Physique à l'Université d'Odessa

Odessa, le $\frac{15}{27}$ août, 1885

On the Terminology of the Mathematical Theory of Electricity

MR. SUTHERLAND'S letter on terminology (NATURE, vol. xxxii. p. 391) leads me to suggest to Mr. Scott the employment of the term *low-pression* for depression in his weather forecasts sent to the newspapers. It is nearly as easily pronounced and written, and will not have such a tendency to mislead the general public as to there being a depressing of the air where it really ascends. HENRY MUIRHEAD

Cambuslang

THE BRITISH ASSOCIATION

Aberdeen, Monday

THIS place has evidently been astir for days in anticipation of the present meeting. Already are the directions necessary for visitors finding their way to the various sections put up in conspicuous places in Union Street and the neighbourhood of Marischal College. The accommodation in the fine building for reception rooms, committee rooms, reading, sectional, and other rooms, seems, so far as can be judged at present, everything that could be desired. It is evident that the Local Committee have been working in earnest to make the second Aberdeen meeting a success, and their efforts have been heartily supported by the citizens and country people. Up to Saturday 1000*l.* worth of tickets had been sold to local people alone, and many more will be sold between this and Wednesday. Of old members of the Association 750 have already written that they intend to be present and it is confidently anticipated that quite 2500 people will take out tickets for the meeting. This great influx of strangers has tasked the available accommodation in Aberdeen, and, as might be expected, the charges in hotels and lodging-houses are somewhat exorbitant.

Of foreigners who are to be present one of the most distinguished is Prof. O. C. Marsh, the well-known American palæontologist, who, it is expected, will take part in the proceedings of both C and D. Others are the Abbé Renard of Brussels, Dr. Max Schuster of Vienna, Dr. von Dechen of Bonn, and Prof. Radlkofer of Munich. It is expected that Mr. Im Thurn, the naturalist, who recently ascended Mount Roraima in British Guiana, will be able to be here, and tell personally of his ascent and its important results.

Of the excursions, that to Balmoral on Saturday is evidently the favourite, and there will be considerable competition to be included among the 150. The Earl of Crawford has for the same day invited sixty members to visit Dunecht, where the observatory will be inspected, and where the archæologists will be shown the "Barnekin of Dunecht." The Earl of Crawford also contributed several very valuable and interesting objects to a fine exhibition of antiquities, old books and manuscripts, that is being arranged. Among the expeditions arranged for Thursday the 17th, is one specially for geologists, to Portsoy; and for the same day the Rev. W. Gordon invites a party of naturalists to Braemar.

Among the local establishments which will be open to the inspection of visitors are several of the great granite works for which Aberdeen is so famous.

Another exhibition of special interest, arranged by the Scottish Geographical Society, will consist of Scottish maps, including some 150 different maps, atlases, guides, and special topographical works.

If one may judge from the present appearance of the weather, the meteorological conditions promise to be favourable, and, if so, the meeting will be sure to be successful, so far as pleasuring is concerned, while the discussions that have been arranged for the Sections A and B are likely to give it considerable scientific importance.

Inaugural Address by the Right Hon. Sir Lyon Playfair, K.C.B., M.P., F.R.S., President

I. *Visit to Canada.*—Our last meeting at Montreal was a notable event in the life of the British Association, and even marked a distinct epoch in the history of civilisation. It was by no mere accident that the constitution of the Association enabled it to embrace all parts of the British Empire. Science is truly catholic, and is bounded only by the universe. In relation to our vast empire, science, as well as literature and art, are the common possession of all its varying people. The United Kingdom is limited to 120,800 square miles, inhabited by 35 millions of people; but the empire as a whole has 8½ millions of square miles, with a population of 305 millions. To federate such vast possessions and so teeming a population into a political unit is a work only to be accomplished by the labours and persistent efforts of perhaps several generations of statesmen. The federation of its science is a subject of less dimensions well within the range of experiment. No part of the British Empire was more suited than Canada to try whether her science could be federated with our science. Canada has lately federated distinct provinces, with conflicting interests arising from difference of races, nationalities, and religions. Political federation is not new in the history of the world, though it generally arises as a consequence of war. It was war that taught the Netherlands to federate in 1619. It was war which united the States in America; federated Switzerland, Germany, and Austria, and unified Italy. But Canada formed a great national life out of petty provincial existences in a time of profound peace. This evolution gave an immense impulse to her national resources. The Dominion still requires consolidation in its vast extent, and applied science is rapidly effecting it. Canada, with its great expanse of territory, nearly as large as the United States, is being knit together by the iron bands of railways from the Gulf of St. Lawrence to the Pacific Ocean, so that the fertile lands of Ontario, Manitoba, Columbia, and the North-Western territories will soon be available to the world. Still practical science has much to accomplish. England and France, with only one-fifth the fertile area of Canada, support 80 millions of people, while Canada has a population not exceeding 5 millions.

A less far-seeing people than the Canadians might have invited the applied science which they so much require. But they knew that without science there are no applications. They no doubt felt with Emerson—

> "And what if Trade sow cities
> Like shells along the shore,
> And thatch with towns the prairie broad
> With railways ironed o'er;
> They are but sailing foam-bells
> Along Thought's causing stream,
> And take their shape and sun-colour
> From him that sends the dream."

So it was with a far-reaching foresight that the Canadian Government invited the British Association for the Advancement of Science to meet in Montreal. The inhabitants of Canada received us with open arms, and the science of the Dominion and that of the United Kingdom were welded. We found in Canada, as we had every reason to expect, men of manly and self-reliant character, who loved not less than we did the old home from which they had come. Among them is the same healthiness of political and moral life, with the same love of truth which distinguishes the English people. Our great men are their great men: our Shakspeare, Milton, and Burns belong to them as much as to ourselves; our Newton, Dalton, Faraday, and Darwin are their men of science as much as they are ours. Thus a common possession and mutual sympathy made the meeting in Canada a successful effort to stimulate the progress of science, while it established, at the same time, the principle that all people of British origin—and I would fain include our cousins in the United States—possess a common interest in the intellectual glories of their race, and ought, in science at least, to constitute part and parcel of a common empire, whose heart may beat in the small islands of the northern seas, but whose blood circulates in all her limbs, carrying warmth to them and bringing back vigour to us. Nothing can be more cheering to our Association than to know that many of the young communities of English-speaking people all over the globe—in India, China, Japan, the Straits, Ceylon, Australia, New Zealand, the Cape—have founded scientific societies in order to promote the growth of scientific research. No doubt science, which is only a form of truth, is one in all lands, but still its unity of purpose and fulfilment received an important practical expression by our visit to Canada. This community of science will be continued by the fact that we have invited Sir William Dawson, of Montreal, to be our next President at Birmingham.

II. *Science and the State.*—I cannot address you in Aberdeen without recollecting that when we last met in this city our President was a great prince. The just verdict of time is that, high as was his royal rank, he has a far nobler claim to our regard as a lover of humanity in its widest sense, and especially as a lover of those arts and sciences which do so much to adorn it. On September 14, 1859, I sat on this platform and listened to the eloquent address and wise counsel of the Prince Consort. At one time a member of his household, it was my privilege to co-operate with this illustrious prince in many questions relating to the advancement of science. I naturally, therefore, turned to his presidential address to see whether I might not now continue those counsels which he then gave with all the breadth and comprehensiveness of his masterly speeches. I found, as I expected, a text for my own discourse in some pregnant remarks which he made upon the relation of science to the State. They are as follows:—"We may be justified in hoping . . . that the Legislature and the State will more and more recognise the claims of science to their attention, so that it may no longer require the begging-box, but speak to the State like a favoured child to its parent, sure of his paternal solicitude for its welfare; that the State will recognise in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand."

This opinion, in its broadest sense, means that the relations of science to the State should be made more intimate because the advance of science is needful to the public weal.

The importance of promoting science as a duty of statecraft was well enough known to the ancients, especially to the Greeks and Arabs, but it ceased to be recognised in the dark ages, and was lost to sight during the revival of letters in the fifteenth and sixteenth centuries. Germany and France, which are now in such active competition in promoting science, have only publicly acknowledged its national importance in recent times. Even in the last century, though France had its Lavoisier and Germany its Leibnitz, their Governments did not know the value of science. When the former was condemned to death in the Reign of Terror, a petition was presented to the rulers that his life might be spared for a few weeks in order that he might complete some important experiments, but the reply was, "The Republic has no need of savants." Earlier in the century the much-praised Frederick William of Prussia shouted with a loud voice, during a graduation ceremony in the University of Frankfort, "An ounce of mother-wit is worth a ton of university wisdom." Both France and Germany are now ashamed of these utterances of their rulers, and make energetic efforts to advance science with the aid of their national resources. More remarkable is it to see a young nation like the United States reserving 150,000,000 acres of national lands for the promotion of scientific education. In some respects this young country is in advance of all European nations in joining science to its administrative offices. Its scientific publications, like the great palæontological work embodying the researches of Prof. Marsh and his associates in the Geological Survey, are an example to other Governments. The Minister of Agriculture is surrounded with a staff of botanists and chemists. The Home Secretary is aided by a special Scientific Commission to investigate the habits, migrations, and food of fishes, and the latter has at its disposal two specially-constructed steamers of large tonnage. The United States and Great Britain promote fisheries on distinct systems. In this country we are perpetually issuing expensive Commissions to visit the coasts in order to ascertain the experiences of fishermen. I have acted as chairman of one of these Royal Commissions, and found that the fishermen, having only a knowledge of a small area, gave the most contradictory and unsatisfactory evidence. In America the questions are put to Nature, and not to fishermen. Exact and searching investigations are made into the life-history of the fishes, into the temperature of the sea in which they live and spawn, into the nature of their food, and into the habits of their natural enemies. For this purpose the Government give the co-operation of the navy, and provide the Commission with a special corps of skilled naturalists, some of whom go out with the steamships and others work in the biological laboratories at Wood's Holl, Massachusetts, or at Washington. The different universities send their best naturalists to aid in these investigations, which are under the direction of Mr. Baird, of the Smithsonian Institution. The annual cost of the Federal Commission is about 40,000*l.*, while the separate States spend about 20,000*l.* in local efforts. The practical results flowing from these scientific investigations have been important. The inland waters and rivers have been stocked with fish of the best and most suitable kinds. Even the great ocean which washes the coasts of the United States is beginning to be affected by the knowledge thus acquired, and a sensible result is already produced upon the most important of its fisheries. The United Kingdom largely depends upon its fisheries, but as yet our own Government have scarcely realised the value of such scientific investigations as those pursued with success by the United States. Less systematically, but with great benefit to science, our own Government has used the surveying expeditions, and sometimes has equipped special expeditions to promote natural history and solar physics. Some of the latter, like the voyage of the *Challenger*, have added largely to the store of knowledge; while the former, though not primarily intended for scientific research, have had an indirect result of infinite value by becoming training-schools for such investigators as Edward Forbes, Darwin, Hooker, Huxley, Wyville Thomson, and others.

In the United Kingdom we are just beginning to understand the wisdom of Washington's farewell address to his countrymen when he said: "Promote as an object of primary importance institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened." It was only in 1870 that our Parliament established a system of national primary education. Secondary education is chaotic, and remains unconnected with the State, while the higher education of the universities is only brought at distant intervals under the view of the State. All great countries except England have Ministers of Education, but this country has only Ministers who are the managers of primary schools. We are inferior even to smaller countries in the absence of organised State supervision of education. Greece, Portugal, Egypt, and Japan have distinct Ministers of Education, and so also among our Colonies have Victoria and New Zealand. Gradually England is gathering materials for the establishment of an efficient Education Minister. The Department of Science and Art is doing excellent work in diffusing a taste for elementary science among the working classes. There are now about 78,000 persons who annually come under the influence of its science classes, while a small number of about 200, many of them teachers, receive thorough instruction in science at the excellent school in South Kensington, of which Prof. Huxley is the Dean. I do not dwell on the work of this Government department, because my object is chiefly to point out how it is that science lags in its progress in the United Kingdom owing to the deficient interest taken in it by the middle and upper classes. The working classes are being roused from their indifference. They show this by their selection of scientific men as candidates at the next election. Among these are Profs. Stuart, Roscoe, Maskelyne, and Rücker. It has its significance that such a humble representative of science as myself received invitations from working-class constituencies in more than a dozen of the leading manufacturing towns. In the next Parliament I do not doubt that a Minister of Education will be created as a nucleus around which the various educational materials may crystallise in a definite form.

III. *Science and Secondary Education.*—Various Royal Commissions have made inquiries and issued recommendations in regard to our public and endowed schools. The Commissions of 1861, 1864, 1868, and 1873 have expressed the strongest disapproval of the condition of our schools, and, so far as science is concerned, their state is much the same as when the Duke of Devonshire's Commission in 1873 reported in the following words:—"Considering the increasing importance of science to the material interests of the country, we cannot but regard its almost total exclusion from the training of the upper and middle classes as little less than a national misfortune." No doubt there are exceptional cases and some brilliant examples of improvement since these words were written, but generally throughout the country teaching in science is a name rather than a reality. The Technical Commission which reported last year can only point to three schools in Great Britain in which science is fully and adequately taught. While the Commission gives us the consolation that England is still in advance as an industrial nation, it warns us that foreign nations, which were not long ago far behind, are now making more rapid progress than this country, and will soon pass it in the race of competition unless we give increased attention to science in public education. A few of the large towns, notably Manchester, Bradford, Huddersfield, and Birmingham, are doing so. The working classes are now receiving better instruction in science than the middle classes. The competition of actual life asserts its own conditions, for the children of the latter find increasing difficulty in obtaining employment. The cause of this lies in the fact that the schools for the middle classes have not yet adapted themselves to the needs of modern life. It is true that many of the endowed schools have been put under new schemes, but as there is no public supervision or inspection of them, we have no knowledge as to whether they have prospered or slipped back. Many corporate schools have arisen, some of them, like Clifton, Cheltenham, and Marlborough Colleges, doing excellent educational work, though as regards all of them the public have no rights and cannot enforce guarantees for efficiency. A return just issued, on the motion of Sir John Lubbock, shows a lamentable deficiency in science teaching in a great proportion of the endowed schools. While twelve to sixteen hours a week are devoted to classics, two to three hours are considered ample for science in a large proportion of the schools. In Scotland there are only six schools in the Return which give more than two hours to science weekly, while in many schools its teaching is wholly omitted. Every other part of the kingdom stands in a better position than Scotland in relation to the science of its endowed schools. The old traditions of education stick as firmly to schools as a limpet does to a rock; though I do the limpet injustice, for it does make excursions to seek pastures new. Are we to give up in despair because an exclusive system of classical education has resisted the assaults of such cultivated authors as Milton, Montaigne, Cowley, and Locke? There was once an enlightened Emperor of China, Chi Hwangti, who knew that his country was kept back by its exclusive devotion to the classics of Confucius and Mencius. He invited 500 of the teachers to bring their copies of these authors to Pekin, and after giving a great banquet in their honour, he buried alive the professors along with their manuscripts in a deep pit. But Confucius and Mencius still reign supreme. I advocate milder measures, and depend for their adoption on the force of public opinion. The needs of modern life will force schools to adapt themselves to a scientific age. Grammar-schools believe themselves to be immortal. Those curious immortals—the Struldburgs—described by Swift, ultimately regretted their immortality, because they found themselves out of touch, sympathy, and fitness with the centuries in which they lived.

As there is no use clamouring for an instrument of more compass and power until we have made up our minds as to the tune, Prof. Huxley, in his evidence before a Parliamentary Committee in 1884, has given a time-table for grammar-schools. He demands that out of their forty hours for public and private study, ten should be given to modern languages and history, eight to arithmetic and mathematics, six to science, and two to geography, thus leaving fourteen hours to the dead languages. No time-table would, however, be suitable to all schools. The great public schools of England will continue to be the gymnasia for the upper classes, and should devote much of their time to classical and literary culture. Even now they introduce into their curriculum subjects unknown to them when the Royal Commission of 1868 reported, though they still accept science with timidity. Unfortunately the other grammar-schools which educate the middle classes look to the higher public schools as a type to which they should conform, although their functions are so different. It is in the interest of the higher public schools that this difference should be recognised, so that, while they give an all-round education and expand their curriculum by a freer recognition of the value of science as an educational power in developing the faculties of the upper classes, the schools for the middle classes should adapt themselves to the needs of their existence, and not keep up a slavish imitation of schools with a different function. The old classical grammar-schools may view these remarks as a direct attack upon them, and so it is in one sense, but it is like the stroke of Ithuriel's spear, which heals while it wounds.

The stock argument against the introduction of modern subjects into grammar schools is that it is better to teach Latin and Greek thoroughly rather than various subjects less completely. But is it true that thoroughness in teaching dead languages is the result of an exclusive system? In 1868 the Royal Commission stated that even in the few great public schools thoroughness was only given to 30 per cent. of the scholars, at the sacrifice of 70 per cent. who got little benefit from the system. Since then the curriculum has been widened and the teaching has improved. I question the soundness of the principle that it is better to limit the attention of the pupils mainly to Latin and Greek, highly as I value their educational power to a certain order of minds. As in biology the bodily development of animals is from the general to the special, so is it in the mental development of man. In the school a boy shauld be aided to discover the class of knowledge that is best suited for his mental capacities, so that, in the upper forms of the school and in the university, knowledge may be specialised in order to cultivate the powers of the man to their fullest extent. Shakspeare's educational formula may not be altogether true, but it contains a broad basis of truth—

> "No profit goes, where is no pleasure ta'en;—
> In brief, sir, study what you most affect."

The comparative failure of the modern side of school education arises from constituting it out of the boys who are looked upon as classical asses. Milton pointed out that in all schools there are boys to whom the dead languages are "like thorns and thistles," which form a poor nourishment even for asses. If teachers looked upon these classical asses as beings who might receive mental nurture according to their nature, much higher results would follow the bifurcation of our schools. Saul went out to look for asses and he found a kingdom. Surely this fact is more encouraging than the example of Gideon, who "took thorns of the wilderness and briars, and with these he *taught* the men of Succoth."[1] The adaptation of public schools to a scientific age does not involve a contest as to whether science or classics shall prevail, for both are indispensable to true education. The real question is whether schools will undertake the duty of moulding the minds of boys according to their mental varieties. Classics, from their structural perfection and power of awakening dormant faculties, have claims to precedence in education, but they have none to a practical monopoly. It is by claiming the latter that teachers sacrifice mental receptivity to a Procrustean uniformity.

[1] Judges, viii. 16.

The universities are changing their traditions more rapidly than the schools. The *via antiqua* which leads to them is still broad, though a *via moderna*, with branching avenues, is also open to their honours and emoluments. Physical science, which was once neglected, is now encouraged at the universities. As to the 70 per cent. of boys who leave schools for life-work without going through the universities, are there no growing signs of discontent which must force a change? The Civil Service, the learned professions, as well as the army and navy, are now barred by examinations. Do the boys of our public schools easily leap over the bars, although some of them have lately been lowered so as to suit the schools? So difficult are these bars to scholars that crammers take them in hand before they attempt the leap; and this occurs in spite of the large value attached to the dead languages and the small value placed on modern subjects. Thus, in the Indian Civil Service examinations, 800 marks as a maximum are assigned to Latin, 600 to Greek, 500 to chemistry, and 300 to each of the other physical sciences. But if we take the average working of the system for the last four years we find that while 68 per cent. of the maximum were given to candidates in Greek and Latin, only 45 per cent. were accorded to candidates in chemistry, and but 30 per cent. to the other physical sciences. Schools sending up boys for competition naturally shun subjects which are dealt with so hardly and so heavily handicapped by the State.

Passing from learned or public professions to commerce, how is it that in our great commercial centres, foreigners—German, Swiss, Dutch, and even Greeks—push aside our English youth and take the places of profit which belong to them by national inheritance? How is it that in our colonies, like those in South Africa, German enterprise is pushing aside English incapacity? How is it that we find whole branches of manufactures, when they depend on scientific knowledge, passing away from this country, in which they originated, in order to engraft themselves abroad, although their decaying roots remain at home?[1] The answer to these questions is that our systems of education are still too narrow for the increasing struggle of life.

Faraday, who had no narrow views in regard to education, deplored the future of our youth in the competition of the world, because, as he said with sadness, "our schoolboys, when they come out of school, are ignorant of their ignorance at the end of all that education."

The opponents of science education allege that it is not adapted for mental development, because scientific facts are often disjointed and exercise only the memory. Those who argue thus do not know what science is. No doubt an ignorant or half-informed teacher may present science as an accumulation of unconnected facts. At all times and in all subjects there are teachers without æsthetical or philosophical capacity—men who can only see carbonate of lime in a statue by Phidias or Praxiteles; who cannot survey zoology on account of its millions of species, or botany because of its 130,000 distinct plants; men who can look at trees without getting a conception of a forest, and cannot distinguish a stately edifice from its bricks. To teach in that fashion is like going to the tree of science with its glorious fruit in order to pick up a handful of the dry fallen leaves from the ground. It is, however, true that as science teaching has had less lengthened experience than that of literature, its methods of instruction are not so matured. Scientific and literary teaching have different methods; for while the teacher of literature rests on authority and on books for his guidance, the teacher of science discards authority and depends on facts at first hand, and on the book of Nature for their interpretation. Natural science more and more resolves itself into the teaching of the laboratory. In this way it can be used as a powerful means of quickening observation, and of creating a faculty of induction after the manner of Zadig, the Babylonian described by Voltaire. Thus facts become surrounded by scientific conceptions, and are subordinated to order and law.

It is not those who desire to unite literature with science who degrade education; the degradation is the consequence of the refusal. A violent reaction—too violent to be wise—has lately

[1] See Dr. Perkins's address to the Soc. Chem. Industry, NATURE August 6, 1855, p. 333

taken place against classical education in France, where their own vernacular occupies the position of dead languages, while Latin and science are given the same time in the curriculum. In England manufacturers cry out for technical education, in which classicul culture shall be excluded. In the schools of the middle classes science rather than technics is needed, because, when the seeds of science are sown, technics as its fruit will appear at the appointed time. Epictetus was wise when he told us to observe that, though sheep eat grass, it is not grass but wool that grows on their backs. Should, however, our grammar-schools persist in their refusal to adapt themselves to the needs of a scientific age, England must follow the example of other European nations and found new modern schools in competition with them. For, as Huxley has put it, we cannot continue in this age "of full modern artillery to turn out our boys to do battle in it, equipped only with the sword and shield of an ancient gladiator." In a scientific and keenly competitive age an exclusive education in the dead languages is a perplexing anomaly. The flowers of literature should be cultivated and gathered, though it is not wise to send men into our fields of industry to gather the harvest when they have been taught only to cull the poppies and to push aside the wheat.

IV. *Science and the Universities.*—The State has always felt bound to alter and improve universities, even when their endowments are so large as to render it unnecessary to support them by public funds. When universities are poor, Parliament gives aid to them from imperial taxation. In this country that aid has been given with a very sparing hand. Thus the universities and colleges of Ireland have received about 30,000*l.* annually, and the same sum has been granted to the four universities of Scotland. Compared with imperial aid to foreign universities such sums are small. A single German university like Strassburg or Leipsic receives about 40,000*l.* annually, or 10,000*l.* more than the whole colleges of Ireland or of Scotland. Strassburg, for instance, has had her university and its library rebuilt at a cost of 711,000*l.*, and receives an annual subscription of 43,000*l.* In rebuilding the University of Strassburg eight laboratories have been provided, so as to equip it fully with the modern requirements for teaching and research.[1] Prussia, the most economical nation in the world, spends 391,000*l.* yearly out of taxation on her universities.

The recent action of France is still more remarkable. After the Franco-German war the Institute of France discussed the important question: "Pourquoi la France n'a pas trouvé d'hommes supérieurs au moment du péril?" The general answer was, Because France had allowed university education to sink to a low ebb. Before the great Revolution France had twenty-three autonomous universities in the provinces. Napoleon desired to found one great university at Paris, and he crushed out the others with the hand of a despot, and remodelled the last with the instincts of a drill-sergeant. The central university sank so low than in 1868 it is said that only 8000*l.* were spent for true academic purposes. Startled by the intellectual sterility shown in the war, France has made gigantic efforts to retrieve her position, and has rebuilt the provincial colleges at a cost of 3,280,000*l.*, while her annual budget for their support now reaches half a million of pounds. In order to open these provincial colleges to the best talent of France, more than 500 scholarships have been founded at an annual cost of 30,000*l.* France now recognises that it is not by the number of men under arms that she can compete with her great neighbour Germany, so she has determined to equal her in intellect. You will understand why it is that Germany was obliged, even if she had not been willing, to spend such large sums in order to equip the university of her conquered province, Alsace-Lorraine. France and Germany are fully aware that science is the source of wealth and power, and that the only way of advancing it is to encourage universities to make researches and to spread existing knowledge through the community. Other European nations are advancing on the same lines. Switzerland is a remarkable illustration of how a country can compensate itself for its natural di-advantages by a scientific education of its people. Switzerland contains neither coal nor the ordinary raw materials of industry, and is separated from other countries which might supply them by mountain barriers. Yet, by a singularly good system of graded schools, and by the great technical college of Zurich, she has become a prosperous manufacturing country. In Great Britain we have nothing comparable to this technical college, either in magnitude or efficiency. Belgium is reorganising its universities, and the State has freed the localities from the charge of buildings, and will in future equip the universities with efficient teaching resources out of public taxation. Holland, with a population of 4,000,000 and a small revenue of 9,000,000*l.*, spends 136,000*l.* on her four universities. Contrast this liberality of foreign countries in the promotion of higher instruction with the action of our own country. Scotland, like Holland, has four universities, and is not very different from it in population, but it only receives 30,000*l.* from the State. By a special clause in the Scotch Universities Bill the Government asked Parliament to declare that under no circumstances should the Parliamentary grant be ever increased above 40,000*l.* According to the views of the British Treasury there is a finality in science and in expanding knowledge.

The wealthy universities of Oxford and Cambridge are gradually constructing laboratories for science. The merchant princes of Manchester have equipped their new Victoria University with similar laboratories. Edinburgh and Glasgow Universities have also done so, partly at the cost of Government and largely by private subscriptions. The poorer universities of Aberdeen and St. Andrews are still inefficiently provided with the modern appliances for teaching science.

London has one small Government college and two chartered colleges, but is wholly destitute of a teaching university. It would excite great astonishment at the Treasury if we were to make the modest request that the great metropolis, with a population of 4,000,000, should be put into as efficient academical position as the town of Strassburg, with 104,000 inhabitants, by receiving, as that town does, 43,000*l.* annually for academic instruction, and 700,000*l.* for university buildings. Still, the amazing anomaly that London has no teaching university must ere long cease.

It is a comforting fact that, in spite of the indifference of Parliament, the large towns of the kingdom are showing their sense of the need of higher education. Manchester has already its university. Nottingham, Birmingham, Leeds, and Bristol have colleges more or less complete. Liverpool converts a disused lunatic asylum into a college for sane people. Cardiff rents an infirmary for a collegiate building. Dundee, by private benefaction, rears a Baxter College with larger ambitions. All these are healthy signs that the public are determined to have advanced science teaching, but the resources of the institutions are altogether inadequate to the end in view. Even in the few cases where the laboratories are efficient for teaching purposes, they are inefficient as laboratories for research. Under these circumstances the Royal Commission on Science advocated special Government laboratories for research. Such laboratories, supported by public money, are as legitimate subjects for expenditure as galleries for pictures or sculpture; but I think that they would not be successful, and would injure science if they failed. It would be safer in the meantime if the State assisted universities or well-established colleges to found laboratories of research under their own care. Even such a proposal shocks our Chancellor of the Exchequer, who tells us that this country is burdened with public debt, and has ironclads to build and arsenals to provide. Nevertheless our wealth is proportionally much greater than that of foreign States which are competing with so much vigour in the promotion of higher education. They deem such expenditure to be true economy, and do not allow their huge standing armies to be an apology for keeping their people backwards in the march of knowledge. France, which in the last ten years has been spending a million annually on university education, had a war indemnity to pay, and competes successfully with this country in ironclads. Either all foreign States are strangely deceived in their belief that the competition of the world has become a competition of intellect, or we are marvellously unobservant of the change which is passing over Europe in the higher education of the people. Preparations for war will not ensure to us the blessings and security of an enlightened peace. Protective expenditure may be wise, though productive expenditure is wiser.

> "Were half the powers which fill the world with terror,
> Were half the wealth bestowed on camps and courts,
> Given to redeem the human mind from error—
> There were no need of arsenals and forts."

Universities are not mere storehouses of knowledge; they are

[1] The cost of these laboratories has been as follows:—Chemical Institute, 35,000*l.*; Physical Institute, 28,000*l.*; Botanical Institute, 26,000*l.*; Observatory, 25,000*l.*; Anatomy, 42,000*l.*; Clinical Surgery, 26,000*l.*; Physiological Chemistry, 16,000*l.*; Physiological Institute, 13,900*l.*

also conservatories for its cultivation. In Mexico there is a species of ant which sets apart some of its individuals to act as honey-jars by monstrously extending their abdomens to store the precious fluid till it is wanted by the community. Professors in a university have a higher function, because they ought to make new honey as well as to store it. The widening of the bounds of knowledge, literary or scientific, is the crowning glory of university life. Germany unites the functions of teaching and research in the universities, while France keeps them in separate institutions. The former system is best adapted to our habits, but its condition for success is that our science chairs should be greatly increased so that teachers should not be wholly absorbed in the duties of instruction. Germany subdivides the sciences into various chairs, and gives to the professors special laboratories. It also makes it a condition for the higher honours of a university that the candidates shall give proofs of their ability to make original researches. Under such a system, teaching and investigation are not incompatible. In the evidence before the Science Commission many opinions were given that scientific men engaged in research should not be burdened with the duties of education, and there is much to be said in support of this view when a single professor for the whole range of a physical science is its only representative in a university. But I hope that such a system will not long continue, for if it do we must occupy a very inferior position as a nation in the intellectual competition of Europe. Research and education in limited branches of higher knowledge are not incompatible. It is true that Galileo complained of the burden imposed upon him by his numerous astronomical pupils, though few other philosophers have echoed this complaint. Newton, who produced order in worlds, and Dalton, who brought atoms under the reign of order and number, rejoiced in their pupils. Lalande spread astronomers as Liebig spread chemists, and Johannes Müller biologists, all over the world. Laplace, La Grange, Dulong, Gay Lussac, Berthollet, and Dumas were professors as well as discoverers in France. In England our discoverers have generally been teachers. In fact, I recollect only three notable examples of men who were not—Boyle, Cavendish, and Joule. It was so in ancient as well as in modern times, for Plato and Aristotle taught and philosophised. If you do not make the investigator a schoolmaster, as Dalton was, and as practically our professors are at the present time, with the duty of teaching all branches of their sciences, the mere elementary truths as well as the highest generalisations being compressed into a course, it is well that they should be brought into contact with the world in which they live, so as to know its wants and aspirations. They could then quicken the pregnant minds around them, and extend to others their own power and love of research. Goethe had a fine perception of this when he wrote—

> Wer in der Weltgeschichte lebt,
> Wer in die Zeiten schaut, und strebt,
> Nur der ist werth, zu sprechen und zu dichten.

Our universities are still far from the attainment of a proper combination of their resources between teaching and research. Even Oxford and Cambridge, which have done so much in recent years in the equipment of laboratories and in adding to their scientific staff, are still far behind a second-class German university. The professional faculties of the English universities are growing, and will diffuse a greater taste for science among their students, though they may absorb the time of the limited professoriate so as to prevent it advancing the boundaries of knowledge. Professional faculties are absolutely essential to the existence of universities in poor countries like Scotland and Ireland. This has been the case from the early days of the Bologna University up to the present time. Originally universities arose not by mere bulls of popes, but as a response to the strong desire of the professional classes to dignify their crafts by real knowledge. If their education had been limited to mere technical schools like the Medical School of Salerno which flourished in the eleventh century, length but not breadth would have been given to education. So the universities wisely joined culture to the professional sciences. Poor countries like Scotland and Ireland must have their academic systems based on the professional faculties, although wealthy universities like Oxford and Cambridge may continue to have them as mere supplements to a more general education. A greater liberality of support on the part of the State in the establishment of chairs of science, for the sake of science and not merely for the teaching of the professions, would enable the poorer universities to take their part in the advancement of knowledge.

I have already alluded to the foundation of new colleges in different parts of the kingdom. Owens College has worthily developed into the Victoria University. Formerly she depended for degrees on the University of London. No longer will she be like a moon reflecting cold and sickly rays from a distant luminary, for in future she will be a sun, a centre of intelligence, warming and illuminating the regions around her. The other colleges which have formed themselves in large manufacturing districts are remarkable expressions from them that science must be promoted. Including the colleges of a high class, such as University College and King's College in London, and the three Queen's Colleges in Ireland, the aggregate attendance of students in colleges without university rank is between nine and ten thousand, while that of the universities is fifteen thousand. No doubt some of the provincial colleges require considerable improvement in their teaching methods; sometimes they unwisely aim at a full university curriculum when it would be better for them to act as faculties. Still, they are all growing in the spirit of self-help, and some of them are destined, like Owens College, to develop into universities. This is not a subject of alarm to lovers of education, while it is one of hope and encouragement to the great centres of industry. There are too few autonomous universities in England in proportion to its population. While Scotland, with a population of 3¾ millions, has four universities with 6500 students, England, with 26 millions of people, has only the same number of teaching universities with 6000 students. Unless English colleges have such ambition, they may be turned into mere mills to grind out material for examinations and competitions. Higher colleges should always hold before their students that knowledge, for its own sake, is the only object worthy of reverence. Beyond college life there is a land of research flowing with milk and honey for those who know how to cultivate it. Colleges should at least show a Pisgah view of this Land of Promise, which stretches far beyond the Jordan of examinations and competitions.

V. *Science and Industry.*—In the popular mind the value of science is measured by its applications to the useful purposes of life. It is no doubt true that science wears a beautiful aspect when she confers practical benefits upon man. But truer relations of science to industry are implied in Greek mythology. Vulcan, the god of industry, wooed science, in the form of Minerva, with a passionate love, but the chaste goddess never married, although she conferred upon mankind nearly as many arts as Prometheus, who, like other inventors, saw civilisation progressing by their use while he lay groaning in want on Mount Caucasus. The rapid development of industry in modern days depends on the applications of scientific knowledge, while its slower growth in former times was due to experiments being made by trial and error in order to gratify the needs of man. Then an experiment was less a questioning of Nature than an exercise on the mind of the experimentalist. For a true questioning of Nature only arises when intellectual conceptions of the causes of phenomena attach themselves to ascertained facts as well as to their natural environments. Much real science had at one time accumulated in Egypt, Greece, Rome, and Arabia, though it became obscured by the intellectual darkness which spread over Europe like a pall for many centuries. The mental results of Greek science, filtered through the Romans and Arabians, gradually fertilised the soil of Europe. Even in ages which are deemed to be dark and unprolific, substantial though slow progress was made. By the end of the fifteenth century the mathematics of the Alexandrian school had become the possession of Western Europe; Arabic numerals, algebra, trigonometry, decimal reckoning, and an improved calendar having been added to its stock of knowledge. The old discoveries of Democritus and Archimedes in physics, and of Hipparchus and Ptolemy in astronomy, were producing their natural developments, though with great slowness. Many manufactures, growing chiefly by experience, and occasionally lightened up by glimmerings of science throughout the prevailing darkness, had arisen before the sixteenth century. A knowledge of the properties of bodies, though scarcely of their relations to each other, came through the labours of the alchemists, who had a mighty impulse to work; for by the philosopher's stone, often not larger than half a rape's seed, they hoped to attain the three sensuous conditions of human enjoyment—gold, health, and immortality. By the end of the fifteenth century many important manufactures were founded by empirical experiment, with only the uncertain guidance of science. Among these were the compass, printing, paper, gunpowder, guns, watches, forks, knitting-needles, horseshoes, bells, wood-cutting and copper-engraving, wire-drawing, steel, table glass, spectacles, microscopes, glass mirrors backed by amalgams of tin and lead, windmills, crushing and saw mills. These important manufactures arose from an increased knowledge of facts, around which scientific conceptions were slowly concreting. Aristotle defines this as science when he says, "Art begins when, from a great number of experiences, one general conception is formed which will embrace all similar cases." Such conceptions are formed only when culture developes the human mind and compels it to give a rational account of the world in which man lives, and of the objects in and around it, as well as of the phenomena which govern their action and evolution. Though the accumulation of facts is indispensable to the growth of science, a thousand facts are of less value to human progress than is a single one when it is scientifically comprehended, for it then becomes generalised in all similar cases. Isolated facts may be viewed as the dust of science. The dust which floats in the atmosphere is to the common observer mere incoherent matter in a wrong place, while to the man of science it is all-important when the rays of heat and light act upon its floating particles. It is by them that clouds and rains are influenced; it is by their selective influence on the solar waves that the blue of the heavens and the beauteous colours of the sky glorify all Nature. So, also, ascertained though isolated facts, forming the dust of science, become the reflecting media of the light of knowledge, and cause all Nature to assume a new aspect. It is with the light of knowledge that we are enabled to question Nature through direct experiment. The hypothesis or theory which induces us to put the experimental question may be right or wrong; still, *prudens questio dimidium scientiæ est*—it is half way to knowledge when you know what you have to inquire. Davy described hypothesis as the mere scaffolding of science, useful to build up true knowledge, but capable of being put up or taken down at pleasure. Undoubtedly a theory is only temporary, and the reason is, as Bacon has said, that the man of science "loveth truth more than his theory." The changing theories which the world despises are the leaves of the tree of science drawing nutriment to the parent stems, and enabling it to put forth new branches and to produce fruit; and though the leaves fall and decay, the very products of decay nourish the roots of the tree and reappear in the new leaves or theories which succeed.

When the questioning of Nature by intelligent experiment has raised a system of science, then those men who desire to apply it to industrial inventions proceed by the same methods to make rapid progress in the arts. They also must have means to compel Nature to reveal her secrets. Æneas succeeded in his great enterprise by plucking a golden branch from the tree of science. Armed with this even dread Charon dared not refuse a passage across the Styx; and the gate of the Elysian fields was unbarred when he hung the branch on its portal. Then new aspects of Nature were revealed—

"Another sun and stars they know
That shine like ours, but shine below."

It is by carrying such a golden branch from the tree of science that inventors are able to advance the arts. In illustration of how slowly at first and how rapidly afterwards science and its applications arise, I will take only two out of thousands of examples which lie ready to my hand. One of the most familiar instances is air, for that surely should have been soon understood if man's unaided senses are sufficient for knowledge. Air has been under the notice of mankind ever since the first man drew his first breath. It meets him at every turn; it fans him with gentle breezes, and it buffets him with storms. And yet it is certain that this familiar object—air—is very imperfectly understood up to the present time. We now know by recent researches that air can be liquefied by pressure and cold; but as a child still looks upon air as nothing, so did man in his early state. A vessel filled with air was deemed to be empty. But man, as soon as he began to speculate, felt the importance of air, and deemed it to be a soul of the world upon which the respiration of man and the god-like quality of fire depended. Yet a really intelligent conception of these two essential conditions to man's existence—respiration and combustion—was not formed till about a century ago (1775). No doubt long before that time there had been abundant speculations regarding air. Anaximenes, 548 years before Christ, and Diogenes of Apollonia, a century later, studied the properties of air so far as their senses would allow them; so, in fact, did Aristotle. Actual scientific experiments were made on air about the year 1100 by a remarkable Saracen, Alhazen, who ascertained important truths which enabled Galileo, Torricelli, Otto de Guericke, and others at a later period to discover laws leading to important practical applications. Still there was no intelligent conception as to the composition of air until Priestley in 1774 repeated, with the light of science, an empirical observation which Eck de Sulbach had made 300 years before upon the union of mercury with an ingredient of air and the decomposition of this compound by heat. This experiment now proved that the active element in air is oxygen. From that date our knowledge, derived from an intelligent questioning of air by direct experiments, has gone on by leaps and bounds. The air, which mainly consists of nitrogen and oxygen, is now known to contain carbonic acid, ammonia, nitric acid, ozone, besides hosts of living organisms which have a vast influence for good or evil in the economy of the world. These micro-organisms, the latest contribution to our knowledge of air, perform great analytical functions in organic nature, and are the means of converting much of its potential energy into actual energy. Through their action on dead matter the mutual dependence of plants and animals is secured, so that the air becomes at once the grave of organic death and the cradle of organic life. No doubt the ancients suspected this without being able to prove the dependence. Euripides seems to have seen it deductively when he describes the results of decay:—

"Then that which springs from earth, to earth returns,
And that which draws its being from the sky
Rises again up to the skyey height."

The consequences of the progressive discoveries have added largely to our knowledge of life, and have given a marvellous development to the industrial arts. Combustion and respiration govern a wide range of processes. The economical use of fuel, the growth of plants, the food of animals, the processes of husbandry, the maintenance of public health, the origin and cure of disease, the production of alcoholic drinks, the processes of making vinegar and saltpetre—all these and many other kinds of knowledge have been brought under the dominion of law. No doubt animals respired, fuel burned, plants grew, sugar fermented, before we knew how they depended upon air. But as the knowledge was empirical it could not be intelligently directed. Now all these processes are ranged in order under a wise economy of Nature, and can be directed to the utilities of life; for it is true, as Swedenborg says, that human "ends always ascend as Nature descends." There is scarcely a large industry in the world which has not received a mighty impulse by the better knowledge of air acquired within a hundred years. If I had time I could show still more strikingly the industrial advantages which have followed from Cavendish's discovery of the composition of water. I wish that I could have done this, because it was Addision who foolishly said, and Paley who as unwisely approved the remark, "that mankind required to know no more about water than the temperature at which it froze and boiled, and the mode of making steam."

When we examine the order of progress in the arts, even before they are illumined by science, their improvements seem to be the resultants of three conditions:

(1) The substitution of natural forces for brute animal power, as when Hercules used the waters of the Alpheus to cleanse the Augean stables; or when a Kamchadal of Eastern Asia, who has been three years hollowing out a canoe, finds that he can do it in a few hours by fire.

(2) The economy of time, as when a calendering machine produces the same gloss to miles of calico that an African savage gives to a few inches by rubbing it with the shell of a snail; or the economy of production, as when steel pens, sold when first introduced at one shilling apiece, are now sold at a penny per dozen; or when steel rails, lately costing 45*l*. per ton, can now be sold at 5*l*.

(3) Methods of utilising waste products, or of endowing them with properties which render them of increased value to industry, as when waste scrap iron and the galls on the oak are converted into ink; or the badly-smelling waste of gasworks is transformed into fragrant essences, brilliant dyes, and fertilising manure; or when the effete matter of animals or old bones is changed into lucifer-matches.

All three results are often combined when a single end is obtained—at all events, economy of time and production invariably follows when natural forces substitute brute animal force. In industrial progress the sweat of the brow is lessened by the conceptions of the brain. How exultant is the old Greek poet, Antipater,[1] when women are relieved of the drudgery of turning the grindstones for the daily supply of corn. "Woman! you who have hitherto had to grind corn, let your arms rest for the future. It is no longer for you that the birds announce by their songs the dawn of the morning. Ceres has ordered the *water-nymphs* to move the heavy millstones and perform your labour." Penelope had twelve slaves to grind corn for her small household. During the most prosperous time of Athens it was estimated that there were twenty slaves to each free citizen. Slaves are mere machines, and machines neither invent nor discover. The bondmen of the Jews, the helots of Sparta, the captive slaves of Rome, the serfs of Europe, and uneducated labourers of the present day who are the slaves of ignorance, have added nothing to human progress. But as natural forces substitute and become cheaper than slave labour, liberty follows advancing civilisation. Machines require educated superintendence. One shoe factory in Boston by its machine does the work of thirty thousand shoemakers in Paris who have still to go through the weary drudgery of mechanical labour. The steam power of the world, during the last twenty years, has risen from 11½ million to 29 million horse-power, or 152 per cent.

Let me take a single example of how even a petty manufacture improved by the teachings of science affects the comforts and enlarges the resources of mankind. When I was a boy the only way of obtaining a light was by the tinder-box, with its quadruple materials, flint and steel, burnt rags or tinder, and a sulphur match. If everything went well, if the box could be found and the air was dry, a light could be obtained in two minutes; but very often the time occupied was much longer, and the process became a great trial to the serenity of temper. The consequence of this was that a fire or a burning lamp was kept alight through the day. Old Gerard, in his herbal, tells us how certain fungi were used to carry fire from one part of the country to the other. The tinder-box long held its position as a great discovery in the arts. The *Pyxidicula igniaria* of the Romans appears to have been much the same implement, though a little ruder, than the flint and steel which Philip the Good put into the collar of the Golden Fleece in 1429 as a representation of high knowledge in the progress of the arts. It continued to prevail till 1833, when phosphorus matches were introduced, though I have been amused to find that there are a few venerable ancients in London who still stick to the tinder box and for whom a few shops keep a small supply. Phosphorus was no new discovery, for it had been obtained by an Arabian called Bechel in the eighth century. However it was forgotten, and was rediscovered by Brandt, who made it out of very stinking materials in 1669. Other discoveries had, however, to be made before it could be used for lucifer matches. The science of combustion was only developed on the discovery of oxygen a century later. Time had to elapse before chemical analysis showed the kind of bodies which could be added to phosphorus so as to make it ignite readily. So it was not till 1833 that matches became a partial success. Intolerably bad they then were, dangerously inflammable, horribly poisonous to the makers, and injurious to the lungs of the consumers. It required another discovery, by Schrötter in 1845, to change poisonous waxy into innocuous red-brick phosphorus in order that these defects might be remedied, and to give us the safety-match of the present day. Now what have these successive discoveries in science done for the nation, in this single manufacture, by an economy of time? If before 1833 we had made the same demands for light that we now do, when we daily consume eight matches per head of the population, the tinder-box could have supplied the demand under the most favourable conditions by an expenditure of one quarter of an hour. The lucifer-match supplies a light in fifteen seconds on each occasion, or in two minutes for the whole day. Putting these differences into a year the venerable ancient who still sticks to his tinder-box would require to spend ninety hours yearly in the production of light, while the user of lucifer-matches spends twelve hours; so that the latter has an economy of seventy-eight hours yearly, or about ten working days. Measured by cost of production at one shilling and sixpence daily, the economy of time represented in money to our population is twenty-six millions of pounds annually. This is a curious instance of the manner in which science leads to economy of time and wealth even in a small manufacture. In larger industries the economy of time and labour produced by the application of scientific discoveries is beyond all measurement. Thus the discovery of latent heat by Black led to the inventions of Watt; while that of the mechanical equivalent of heat by Joule has been the basis of the progressive improvements in the steam-engine which enables power to be obtained by a consumption of fuel less than one-fourth the amount used twenty years ago. It may be that the engines of Watt and Stephenson will yield in their turn to more economical motors; still they have already expanded the wealth, resources, and even the territories of England more than all the battles fought by her soldiers or all the treaties negotiated by her diplomatists.

[1] "Analecta Veterum Græcorum," Epig. 39, vol. ii. p. 119.

The coal which has hitherto been the chief source of power probably represents the product of five or six million years during which the sun shone upon the plants of the Carboniferous period, and stored up its energy in this convenient form. But we are using this conserved force wastefully and prodigally; for although horse power in steam-engines has so largely increased since 1864, two men only now produce what three men did at that date. It is only three hundred years since we became a manufacturing country. According to Prof. Dewar, in less than two hundred years more the coal of this country will be wholly exhausted, and in half that time will be difficult to procure. Our not very distant descendants will have to face the problem —What will be the condition of England without coal? The answer to that question depends upon the intellectual development of the nation at that time. The value of the intellectual factor of production is continually increasing; while the values of raw material and fuel are lessening factors. It may be that when the dreaded time of exhausted fuel has arrived, its importation from other coal-fields, such as those of New South Wales, will be so easy and cheap, that the increased technical education of our operatives may largely over-balance the disadvantages of increased cost in fuel. But this supposes that future Governments in England will have more enlightened views as to the value of science than past Governments have possessed.

Industrial applications are but the overflowings of science welling over from the fulness of its measure. Few would ask now, as was constantly done a few years ago, "What is the use of an abstract discovery in science?" Faraday once answered this question by another, "What is the use of a baby?" Yet around that baby centre all the hopes and sentiments of his parents, and even the interests of the State, which interferes in its upbringing so as to ensure it being a capable citizen. The processes of mind which produce a discovery or an invention are rarely associated in the same person, for while the discoverer seeks to explain causes and the relations of phenomena, the inventor aims at producing new effects, or at least of obtaining them in a novel and efficient way. In this the inventor may sometimes succeed without much knowledge of science, though his labours are infinitely more productive when he understands the causes of the effects which he desires to produce.

A nation in its industrial progress, when the competition of the world is keen, cannot stand still. Three conditions only are possible for it. It may go forward, retrograde, or perish. Its extinction as a great nation follows its neglect of higher education, for, as described in the proverb of Solomon, "They that hate instruction love death." In sociology, as in biology, there are three states. The first of balance, when things grow neither better nor worse; the second that of elaboration or evolution, as we see it when animals adapt themselves to their environments; and third, that of degeneration, when they rapidly lose the ground they have made. For a nation, a state of balance is only possible in the early stage of its existence, but it is impossible when its environments are constantly changing.

The possession of the raw materials of industry and the existence of a surplus population are important factors for the growth of manufactures in the early history of a nation, but afterwards they are bound up with another factor—the application of intellect to their development. England could not be called a manufacturing nation till the Elizabethan age. No doubt coal, iron, and wood were in abundance, though, in the reign of the Plantagenets, they produced little prosperity. Wool was sent to Flanders to be manufactured, for England then stood to Holland as Australia now does to Yorkshire. The political crimes of Spain, from the reign of Ferdinand and Isabella to that of Philip III., destroyed it as a great manufacturing nation, and indirectly led to England taking its position. Spain, through the activity and science of the Arabian intellect, had acquired many important industries. The Moors and the Moriscoes, who had been in Spain for a period as long as from the Norman Conquest of this country to the present date, were banished, and with them departed the intellect of Spain. Then the invasion of the Low Countries by Philip II. drove the Flemish manufacturers to England, while the French persecution of the Huguenots added new manufacturing experience, and with them came the industries of cotton, wool, and silk. Cotton mixed with linen and wool became freely used, but it was only from 1738 to the end of the century that the inventions of Wyatt, Arkwright, Hargreaves, Crompton, and Cartwright started the wonderful modern development. The raw cotton was imported from India or America, but that fact as regards cost was a small factor in comparison with the intellect required to convert it into a utility. Science has in the last hundred years altered altogether the old conditions of industrial competition. She has taught the rigid metals to convey and record our thoughts even to the most distant lands, and, within less limits, to reproduce our speech. This marvellous application of electricity has diminished the cares and responsibilities of Governments, while it has at the same time altered the whole practice of commerce. To England steam and electricity have been of incalculable advantage. The ocean, which once made the country insular and isolated, is now the very life-blood of England, and of the greater England beyond the seas. As in the human body the blood bathes all its parts, and through its travelling corpuscles carries force to all its members, so in the body politic of England and its pelasgic extensions, steam has become the circulatory and electricity the nervous system. The colonies, being young countries, value their raw materials as their chief sources of wealth. When they become older they will discover that it is not in these, but in the culture of scientific intellect, that their future prosperity depends. Older nations recognise this as the law of progress more than we do; or, as Jules Simon tersely puts it—"That nation which most educates her people will become the greatest nation, if not to-day, certainly to-morrow." Higher education is the condition of higher prosperity, and the nation which neglects to develope the intellectual factor of production must degenerate, for it cannot stand still. If we felt compelled to adopt the test of science given by Comte, that its value must be measured by fecundity, it might be prudent to claim industrial inventions as the immediate fruit of the tree of science, though only fruit which the prolific tree has shed. But the test is untrue in the sense indicated, or rather the fruit, according to the simile of Bacon, is like the golden apples which Aphrodite gave to the suitor of Atalanta, who lagged in his course by stooping to pick them up, and so lost the race. The true cultivators of the tree of science must seek their own reward by seeing it flourish, and let others devote their attention to the possible practical advantages which may result from their labours.

There is, however, one intimate connection between science and industry which I hope will be more intimate as scientific education becomes more prevalent in our schools and universities. Abstract science depends on the support of men of leisure, either themselves possessing or having provided for them the means of living without entering into the pursuits of active industry. The pursuit of science requires a superfluity of wealth in a community beyond the needs of ordinary life. Such superfluity is also necessary for art, though a picture or a statue is a saleable commodity, while an abstract discovery in science has no immediate, or, as regards the discoverer, proximate commercial value. In Greece, when philosophical and scientific speculation was at its highest point, and when education was conducted in its own vernacular and not through dead languages, science, industry, and commerce were actively prosperous. Corinth carried on the manufactures of Birmingham and Sheffield, while Athens combined those of Leeds, Staffordshire, and London, for it had woollen manufactories, potteries, gold and silver work, as well as shipbuilding. Their philosophers were the sons of burghers, and sometimes carried on the trades of their fathers. Thales was a travelling oil merchant, who brought back science as well as oil from Egypt. Solon and his great descendant Plato, as well as Zeno, were men of commerce. Socrates was a stonemason; Thucydides a gold-miner; Aristotle kept a druggist's shop until Alexander endowed him with the wealth of Asia. All but Socrates had a superfluity of wealth, and he was supported by that of others. Now, if our universities and schools created that love of science which a broad education would surely inspire, our men of riches and leisure who advance the boundaries of scientific knowledge could not be counted on the fingers as they now are, when we think of Boyle, Cavendish, Napier, Lyell, Murchison, and Darwin, but would be as numerous as our statesmen and orators. Statesmen, without a following of the people who share their views and back their work, would be feeble indeed. But while England has never lacked leaders in science, they have two few followers to risk a rapid march. We might create an army to support our generals in science, as Germany has done, and as France is now doing, if education in this country would only mould itself to the needs of a scientific age. It is with this feeling that Horace Mann wrote: "The action of the mind is like the action of fire: one billet of wood will hardly burn alone, though as dry as the sun and north-west wind can make it, and though placed in a current of air; ten such billets will burn well together, but a hundred will create a heat fifty times as intense as ten—will make a current of air to fan their own flame, and consume even greenness itself."

VI. *Abstract Science the Condition for Progress.*—The subject of my address has been the relations of science to the public weal. That is a very old subject to select for the year 1885. I began it by quoting the words of an illustrious prince, the consort of our Queen, who addressed us on the same subject from this platform twenty-six years ago. But he was not the first prince who saw how closely science is bound up with the welfare of States. Ali, the son-in-law of Mahomet, the fourth successor to the Caliphate, urged upon his followers that men of science and their disciples give security to human progress. Ali loved to say, "Eminence in science is the highest of honours," and "He dies not who gives life to learning." In addressing you upon texts such as these my purpose was to show how unwise it is for England to lag in the onward march of science when most other European Powers are using the resources of their States to promote higher education and to advance the boundaries of knowledge. English Governments alone fail to grasp the fact that the competition of the world has become a competition in intellect. Much of this indifference is due to our systems of education. I have ill fulfilled my purpose if, in claiming for science a larger share in public education, I have in any way depreciated literature, art, or philosophy, for every subject which adds to culture aids in human development. I only contend that in public education there should be a free play to the scientific faculty, so that the youths who possess it should learn the richness of their possession during the educative process. The same faculties which make a man great in any walk of life—strong love of truth, high imagination tempered by judgment, a vivid memory which can co-ordinate other facts with those under immediate consideration—all these are qualities which the poet, the philosopher, the man of literature, and the man of science equally require and should cultivate through all parts of their education as well as in their future careers. My contention is that science should not be practically shut out from the view of a youth while his education is in progress, for the public weal requires that a large number of scientific men should belong to the community. This is necessary because science has impressed its character upon the age in which we live, and, as science is not stationary, but progressive, men are required to advance its boundaries, acting as pioneers in the onward march of States. Human progress is so identified with scientific thought, both in its conception and realisation, that it seems as if they were alternative terms in the history of civilisation. In literature, and even in art, a standard of excellence has been attained which we are content to imitate because we have been unable to surpass. But there is no such standard in science. Formerly, when the dark cloud was being dissipated which had obscured the learning of Greece and Rome, the diffusion of literature or the discovery of lost authors had a marked influence on advancing civilisation. Now, a Chrysoloras might teach Greek in the Italian universities without hastening sensibly the onward march of Italy; a Poggio might discover copies of Lucretius and Quintilian without exercising a tithe of the influence on modern life that an invention by Stephenson or Wheatstone would produce. Nevertheless, the divorce of culture and science, which the present state of education in this country tends to produce, is deeply to be deplored, because a cultured intelligence adds greatly to the development of the scientific faculty. My argument is that no amount of learning without science suffices in the present state of the world to put us in a position which will enable England to keep ahead or even on a level with foreign nations as regards knowledge and its applications to the utilities of life. Take the example of any man of learning, and see how soon the direct consequences resulting from it disappear in the life of a nation, while the discoveries of a man of science remain productive amid all the shocks of empire. As I am in Aberdeen I remember that the learned Dutchman Erasmus was introduced to England by the encouragement which he received from Hector Boece, the Principal of King's College in this University. Yet even in the case of Erasmus—who taught Greek at Cambridge and did so much for the revival of classical literature as well as in the promotion of spiritual freedom—how little has civilisation to ascribe to him in comparison with the discoveries of two other Cambridge men, Newton and Cavendish. The discoveries of Newton will influence the destinies of mankind to the end of the world. When he established the laws by which the motions of the great masses of matter in the universe are governed, he conferred an incalculable benefit upon the intellectual development of the human race. No great discovery flashes upon the world at once, and therefore Pope's lines on Newton are only a poetic fancy :—

> "Nature and Nature's laws lay hid in night,
> God said, 'Let Newton be,' and all was light."

No doubt the road upon which he travelled had been long in preparation by other men. The exact observations of Tycho Brahe, coupled with the discoveries of Copernicus, Kepler, and Galileo had already broken down the authority of Aristotle and weakened that of the Church. But though the conceptions of the universe were thus broadened, mankind had not yet rid themselves of the idea that the powers of the universe were still regulated by spirits or special providences. Even Kepler moved the planets by spirits, and it took some time to knock these celestial steersmen on the head. Descartes, who really did so much by his writings to force the conclusion that the planetary movements should be dealt with as an ordinary problem in mechanics, looked upon the universe as a machine, the wheels of which were kept in motion by the unceasing exercise of a divine power. Yet such theories were only an attempt to regulate the universe by celestial intelligences like our own, and by standards within our reach. It required the discovery of an all-pervading law, universal throughout all space, to enlarge the thoughts of men, and one which, while it widened the conceptions of the universe, reduced the earth and solar system to true dimensions. It is by the investigation of the finite on all sides that we obtain a higher conception of the infinite—

> "Willst du ins Unendliche schreiten,
> Geh nur im Endlichen nach allen Seiten."

Ecclesiastical authority had been already undermined by earnest inquirers, such as Wycliffe and Huss, before Luther shook the pillars of the Vatican. They were removers of abuses, but were confined within the circles of their own beliefs. Newton's discovery cast men's minds into an entirely new mould, and levelled many barriers to human progress. This intellectual result was vastly more important than the practical advantages of the discovery. It is true that navigation and commerce mightily benefited by our better knowledge of the motions of the heavenly bodies. Still these benefits to humanity are incomparably less in the history of progress than the expansion of the human intellect which followed the withdrawal of the cramps that confined it. Truth was now able to discard authority, and marched forward without hindrance. Before this point was reached Bruno had been burned, Galileo had abjured, and both Copernicus and Descartes had kept back their writings for fear of offending the Church.

The recent acceptance of evolution in biology has had a like effect in producing a far profounder intellectual change in human thought than any mere impulse of industrial development. Already its application to sociology and education is recognised, but that is of less import to human progress than the broadening of our views of Nature.

Abstract discovery in science is then the true foundation upon which the superstructure of modern civilisation is built; and the man who would take part in it should study science, and, if he can, advance it for its own sake and not for its applications. Ignorance may walk in the path lighted by advancing knowledge, but she is unable to follow when science passes her, for, like the foolish virgin, she has no oil in her lamp.

An established truth in science is like the constitution of an atom in matter—something so fixed in the order of things that it has become independent of further dangers in the struggle for existence. The sum of such truths forms the intellectual treasure which descends to each generation in hereditary succession. Though the discoverer of a new truth is a benefactor to humanity, he can give little to futurity in comparison with the wealth of knowledge which he inherited from the past. We, in our generation, should appreciate and use our great possessions—

> "For me your tributary stores combine.
> Creation's heir; the world, the world is mine."

SECTION A.

MATHEMATICAL AND PHYSICAL SCIENCE.

Opening Address by Prof. G. Chrystal, M.A., F.R.S.E., President of the Section.

When a man finds himself unexpectedly in some unusual situation his first impulse is to look around and see how others have done in like circumstances. I have accordingly run through the addresses of my predecessors in the honourable office of president of Section A, which is fated this year to be filled somewhat unworthily. This examination has, I am bound to say, comforted me not a little. I have found precedents for all kinds of addresses, long and short, even apparently for none at all. The variety of subjects is also suggestive of great latitude. I have found reviews of the progress of mathematical and physical science, discussions of special scientific subjects, dissertations on the promotion of scientific research, and on the teaching and diffusion of science, all chosen in their turn for the subjects of this opening address.

Following some of the most eminent of my forerunners, I propose to be brief; following the last of them, Prof. Henrici, I shall take for my subject, so far as I have one, the Diffusion of Scientific Knowledge. Apart from the fact that Prof. Henrici's address greatly interested me, and that I find many of his conclusions in agreement with the results of my own experience, and that, therefore, I wish to second him with all my power, I have other reasons for this choice, For more than half the year I am employed with absolute continuity in teaching mathematics, and it has happened for the last eight years or so that the other half has been mainly occupied in a variety of ways with science-teaching generally. This is the thing concerning which I have had most experience, and I hold it to be the most respectful course towards my audience to speak to them on the subject that I know best.

Ever since I began to study science I have been deeply interested in the question of how it could best be taught. I believe my meditations in that direction were awakened by some unsuccessful boyish efforts to apply to the satisfaction of a ploughman, who was my friend and confidant, certain principles of natural philosophy to explain the action of his plough. Wisely and unwisely I have always been ardent about the improvement of scientific teaching. I was so long before I dreamt that I should one day be called upon to put my ideas through the cold ordeal of practice. It would not be becoming that I should speak at any time, more particularly to-day, regarding the success of my own efforts, or even regarding my alternate fits of hopefulness and despair. It is enough to say that, in such a cause,

> "'Tis better to have loved and lost,
> Than never to have loved at all."

The British Association, by its title, exists for the advancement of science. Now, I hold that one of the essential conditions for that advancement is the existence of a scientific public—a public, like the Athenians of old, eager to hear and tell of some new truth ; eager to discuss and eager to criticise ; ready to appreciate what is novel ; to receive it if sound, to reject it if unsound. It is to such a public that the British Association appeals, and certainly in the past it has not found its public wanting in generosity. What I should wish to see is less of mere friendly onlooking and more participation in the dance.

I am not speaking now merely of a professional public, such as is so prominent in Germany for instance, made up of teachers and others professionally concerned with science. I refer mainly to that amateur but truly expert public which has always been so honourable a feature of English science, as examples of which I may mention Boyle and Cavendish in former days, and Joule and Spottiswoode in our own. It is quite true that much of that scientific public came in days of yore from the leisured class, whose ratio to the rest of the nation will not improbably decrease in the course of our social development. I think, however, that the loss we may thus sustain will be more than compensated by the continual increase of those who have received higher education of some kind or other, and whose daily occupations give them an interest, direct or indirect, in one or more branches of science.

It may not be amiss to insist for a little on the advantages to science of a great body of men unofficially engaged in scientific research, in writing regarding science, or even in merely turning scientific matter over in their minds. It will not have escaped the notice of those among you who have studied the history of science, that few scientific ideas spring up suddenly without previous trace or history. It is perfectly true that in many cases some mind of unwonted breadth and firmness is required to formulate the new doctrine, and carry it to manifold fruition; but a close examination always shows that the sprite was in the air before the Prospero came to catch him. It is very striking to notice, in the history of Algebra for instance, long periods in which great improvements were effected in the science, which cannot be traced to any individual, but seem to have been due merely to the working of the minds of scientific men generally upon the matter, one giving it this little turn, another that, in the main always for the better. Like every other thing that has the virtue of truth in it, science grows as it goes, not like the idle gossiping tale by the casual accretion of heterogeneous matter, but by the chemical combination of pure element with pure element in reasonable proportion.

I know of no greater advantage for science than the existence of an army of independent workers sufficiently enlightened for self-criticism, who shall test the results and theories of their day. Great and indispensable as are the uses of professional schools of scientific workmen, they are open to one great and insidious danger. The temptation there to swear by the word of the master is often irresistible. Not to speak of its being often the readiest avenue to fame and profit, it is the perfectly natural consequence of the contact of smaller mind with greater.

There are few things where the want of an enlightened scientific public strikes an expert more than the matter of scientific text-books. If the British public were educated as it ought to be, publishers would not be able to palm off upon them in this guise the ill-paid work of fifth-rate workmen so often as they do; nor would the scientific articles and reviews in popular journals and magazines so often be written by men so palpably ignorant of their subject.

We all have a great respect for the integrity of our British legislators, whatever doubts may haunt us occasionally as to their capacity in practical affairs. The ignorance of many of them regarding some of the most elementary facts that bear on every-day life is very surprising. Scientifically speaking, uneducated themselves, they seem to think that they will catch the echo of a fact or the solution of an arithmetical problem by putting their ears to the sounding-shell of uneducated public opinion. When I observe the process which many such people employ for arriving at what they consider truth, I often think of a story I once heard of an eccentric German student of chemistry. This gentleman was idle, but, like all his nation, systematic. When he had a precipitate to weigh, instead of resorting to his balance, he would go the round of the laboratory, hold up the test-tube before each of his fellow-students in turn, and ask him to guess the weight. He then set down all the replies, took the average, and entered the result in his analysis.

I will not take up your time in insisting upon the necessity of the diffusion of science among that large portion of the public who are, or ought to be, appliers of scientific knowledge to practical life. That part of my theme is so obvious, and has been of late so much dwelt upon, that I may pass it by, and draw your attention to another place in which the shoe pinches. All of you who have taken any practical interest in the organisation of our educational institutions must be aware of the great difficulty in securing the services of non-professional men of sufficient scientific knowledge to act on School Boards, and undertake the direction of our higher schools. It is no secret among those who carefully watch the course of the times in these matters that our present organisation is utterly insufficient; that it has not solved, and shows every day less likelihood of solving, the problems of higher education. This arises, to a great extent, from the fact that a scientifically educated public of the extent presupposed by the organisation really does not at present exist.

If the existence of a great scientific public be as important as I think I have shown it to be, it must be worth while to devote a few moments to the consideration of the means we adopt to produce it both in the rising and in the risen generation.

It would naturally be expected that we should look carefully to the scientific education of our youth, to see that the best men and the best means that could be had were devoted to it; that we should endeavour to make for them a broad straight road to the newest and best of our scientific ideas; that we should exercise them when young on the best work of the greatest masters; familiarise them early with the great men and the great feats of science, both of the past and of the present; that we should avoid retarding their progress by making the details and illustrations or particular rules and methods end in themselves. Granting that it is impossible to bring every learner within reach of the fullest scientific knowledge of his time, it would surely be reasonable to take care that the little way we lead him should not be along some devious by-path, but towards some eminence from which he might at least *see* the promised land. The end of all scientific training of the great public I take to be, to enable each member of it to look reason and nature in the face, and judge for himself what, considering the circumstances of his day, may be known, and not be deceived regarding what must to him remain unknown. If this be so, surely the ideal of scientific education which I have sketched is the right one: yet it is most certainly not the ideal of our present system of instruction. To attain conviction on that head it is sufficient to examine the text-books and examination papers of the day.

Let us confine ourselves for the present to the most elementary of all the exact sciences, viz., geometry and algebra. These two, although among the oldest, are, as Professor Cayley very justly reminded the Association last year, perhaps the most progressive and promising of all the sciences. Great names of antiquity are associated with them, and in modern times an army of men of genius have aided their advance. Moreover, it cannot be said that this advance concerns the higher parts of these sciences alone. On the contrary, the discoveries of Gauss, Lobatschewsky, and Riemann, and of Poncelet, Möbius, Steiner, Chasles, and Von Standt, in geometry, and the labours of De Morgan, Hamilton, and Grassman, not to mention many others, in algebra, have thrown a flood of light on the elements of both these subjects. What traces of all this do we find in our school books? To be sure *antiquity* is stamped upon our geometry, for we use the text-book of Euclid, which is some two thousand years old; but where can we point to the influence of *modern* progress in our geometrical teaching? For our teaching of algebra, I am afraid, we can claim neither the sanction of antiquity nor the light of modern times. Whether we look at the elementary, or at what is called the higher teaching of this subject, the result is unsatisfactory. With respect to the former, my experience justifies the criticism of Professor Henrici; and I have no doubt that the remedy he suggests would be effectual. In the higher teaching, which interests me most, I have to complain of the utter neglect of the all-important notion of algebraic form. I found, when I first tried to teach University students co-ordinate geometry, that I had to go back and teach them algebra over again. The fundamental idea of an integral function of a certain degree, having a certain form and so many coefficients, was to them as much an unknown quantity as the proverbial x. I found that their notion of higher algebra was the solution of harder and harder equations. The curious thing is that many examination candidates, who show great facility in reducing exceptional equations to quadratics, appear not to have the remotest idea beforehand of the number of solutions to be expected; and that they will very often produce for you by some fallacious mechanical process a solution which is none at all. In short, the logic of the subject, which, both educationally and scientifically speaking, is the most important part of it, is wholly neglected. The whole training consists in example grinding. What should have been merely the help to attain the end has become the end itself. The result is that algebra, as we teach it, is neither an art nor a science, but an ill-digested farrago of rules, whose object is the solution of examination problems.

The history of this matter of problems, as they are called, illustrates in a singularly instructive way the weak point of our English system of education. They originated, I fancy, in the Cambridge Mathematical Tripos Examination, as a reaction against the abuses of cramming bookwork, and they have spread into almost every branch of science teaching—witness test-tubing in chemistry. At first they may have been a good thing; at all events the tradition at Cambridge was strong in my day, that he that could work the most problems in three or two and a half hours was the ablest man, and, be he ever so ignorant of his subject in its width and breadth, could afford to despise those less gifted with this particular kind of superficial sharpness. But, in the end, came all to the same: we were prepared for problem-working in exactly the same way as for bookwork. We were directed to work through old problem papers, and study the style and peculiarities of the day and of the examiner. The day and the examiner had, in truth, much to do with it, and fashion reigned in problems as in everything else. The only difference I could ever see between problems and bookwork was the greater predominance of the inspiriting element of luck in the former. This advantage was more than compensated for by the peculiarly disjointed and, from a truly scientific point of view, worthless nature of the training which was employed to cultivate this species of mental athletics. The result, so far as problems worked in examinations go, is, after all, very miserable, as the reiterated complaints of examiners show; the effect on the examinee is a well-known enervation of mind, an almost incurable superficiality, which might be called Problematic Paralysis —a disease which unfits a man to follow an argument extending beyond the length of a printed octavo page. Another lamentable feature of the matter is that an enormous amount of valuable time is yearly wasted in this country in the production of these scientific trifles. Against the occasional working and propounding of problems as an aid to the comprehension of a subject, and to the starting of a new idea, no one objects, and it has always been noted as a praiseworthy feature of English methods, but the abuse to which it has run is most pernicious.

All men practically engaged in teaching who have learned enough, in spite of the defects of their own early training, to enable them to take a broad view of the matter, are agreed as to the canker which turns everything that is good in our educational practice to evil. It is the absurd prominence of written competitive examinations that works all this mischief. The end of all education nowadays is to fit the pupil to be examined; the end of every examination not to be an educational instrument, but to be an *examination* which a creditable number of men, however badly taught, shall pass. We reap, but we omit to sow. Consequently our examinations, to be what is called fair —that is, beyond criticism in the newspapers—must contain nothing that is not to be found in the most miserable text-book that any one can cite bearing on the subject. One of my students, for example, who was plucked in his M.A. examination, and justly so if ever man was, by the unanimous verdict of three examiners, wrote me an indignant letter because he believed, or was assured, that the paper set by the examiners could not have been answered out of Todhunter's Elementary Algebra. I have nothing to say, of course, against that or any other text-book, but who put it into the poor young man's head that the burden lay with me to prove that the examination in question ought to contain nothing but what is to be found in Todhunter's Elementary Algebra? The course of this kind of reasoning is plain enough, and is often developed in the newspapers with that charming simplicity which is peculiar to honest people who are, at the same time, very ignorant and very unthinking. First, it follows that lectures should contain nothing but what is to be found in every text-book; secondly, lectures are therefore useless, since it is all in the text-book; thirdly, the examination should allude to nothing that is not in the text-books, because that would be unfair; fourthly, which is the coach or crammer's deduction, there should be nothing in the text-book that is not likely to be set in the examination. The problem for the writer of a text-book has come now, in fact, to be this—to write a book so neatly trimmed and compacted that no coach, on looking through it, can mark a single passage which the candidate for a minimum pass can safely omit. Some of these text-books I have seen, where the scientific matter has been, like the lady's waist in the nursery song, compressed "so gent and sma'," that the thickness of it barely, if at all, surpasses what is devoted to the publisher's advertisements. We shall return, I verily believe, to the Compendium of Martianus Capella. The result of all this is that science, in the hands of specialists, soars higher and higher into the light of day, while educators and the educated are left more and more to wander in primeval darkness.

When our system sets such mean ends before the teacher, and encourages such unworthy conceptions of education, is it to be wondered at that the cry arises that pupils degenerate beneath even the contemptible standards of our examinations? These can hardly be made low enough to suit the popular taste. It is no merit of the system we pursue, but due simply to the better educated among our teachers—men, many of them, who work for little reward and less praise—that we have not come to a worse pass already. Some even of the much-abused crammers have conceptions of a teacher's duty far higher than the system-mongers of the day, whom it is their special business to outwit; and it is but fair to allow to such of these also as deserve it part of the credit of stemming the torrent of degeneration. We place our masters in positions such that their very bread depends upon their doing what many of them know and will acknowledge to be *wrong*. Their excuse is, "We do so and so because of the examination."

The cure for all this evil is simply to give effect to a higher ideal of education in general, and of scientific education in particular. Science cannot live among the people, and scientific education cannot be more than a wordy rehearsal of dead text-books, unless we have living contact with the working minds of living men. It takes the hand of God to make a great mind, but contact with a great mind will make a little mind greater. The most valuable instruction in any art or science is to sit at the feet of a master, and the next best to have contact with another who has himself been so instructed. No agency that I have ever seen at work can compare for efficiency with an intelligent teacher, who has thoroughly made his subject his own. It is by providing such, and not by sowing the dragon's teeth of examinations, that we can hope to raise up an intelligent generation of scientifically educated men, who shall help our race to keep its place in the struggle of nations. In the future we must look more to men and to ideas, and trust less to mere systems. Systems have had their trial. In particular, systems of examination have been tested and found wanting in nearly every civilised country on the face of the earth. Backward as we are here, we are stirring. The University of London, after rendering a great service to the country by forcing the older universities to give up the absurd practice of restricting their advantages to persons professing a particular shade of religious belief, has for many years pursued its career as a mere examining body. It has done so with rare advantages in the way of Government aid, efficient organisation, and an unsurpassed staff of examiners. Yet it has been a failure as an instrument for promoting the higher education—foredoomed to be so, because, as I have said, you must sow before you can reap. At the present time, with great wisdom, the managers of that institution have set about the task of really fitting it out for the great end that it professes to pursue. If they succeed in so doing, they will confer upon the higher education one of the greatest benefits it has yet received. They have an opportunity before them of dethroning the iron tyrant Examination which is truly enviable. This movement is only one of the signs of the times. Among the younger generation I find few or none that have any belief in the "learn when you can and we will examine you" theory; and small wonder, for they have tasted the bitterness of its fruit. *Laissez faire* as a method in the higher education no longer holds its place, except in the minds of inexperienced elderly people, who cling, not unnaturally, to the views and fashions which were young when they were so.

All the same, the task of reformation is not an easy one. Examinations have a strong hold upon us, for various reasons, some good, some bad, but all powerful. In the first place, they came in as an outlet from the system of patronage, which, with many obvious advantages, some of which are now sorely missed, had become unsuited to our social conditions. There is a certain advantage in examinations from the organiser's point of view, which any one who, like myself, has to deal with large quantities of pretty raw material, will readily understand. Again, there is an orderly bustle about the system that pleases the business-loving eye of the Briton. Yearly the printed sheets go forth in every corner of the land. The candidates meet and, in the solemn silence of the examination hall, the inspector, the local magnate, or the professor, sits, while for two or three busy hours the pens go scratching over the paper. A feeling of thankfulness comes over the important actor in this well-ordered scene, that the younger generation have such advantages that their fathers never knew. It is only when the answers are dissected in the examiner's study that the rottenness is revealed underlying the fair outward skin. But then the examiner must go by his standards; he must consider what is done elsewhere, and what is to be reasonably expected. Accordingly he takes his report and quickly writes so many per cent. passed. Then the chorus of reporting examiners lift up their voices in wonderful concordance; and all, perhaps even the examiners, are comforted. There is something attractive about the whole thing that I can only compare to the pleasure with which one listens to the hum of a busy factory or to the roaring of the forge and ringing of the anvil. But what avails the hum of the factory if the product be shoddy, and what the roar of the forge and the ring of the anvil if the metal we work be base?

In conclusion, let us consider for a moment what might be done for the risen generation, who are too old to go formally to school, and yet not too old to learn. In their education such bodies as the British Association might be very helpful. Indeed, in the past, the British Association has been very helpful in many ways. It can point to an admirable series of reports on the progress of science, for which every one who, like myself, has used them, is very grateful. It is much to be desired that these reports should be continued, and extended to many branches of science which they have not yet covered.

The Association has at present, I believe, a committee of inquiry into science-teaching generally. This is typical of a kind of activity which the Association might very profitably extend. This Association, with its long list of members bristling with the names of experts in every science, not drawn from any clique or particular centre, but indiscriminately from the whole land, might take upon itself to look into the question of scientific text-books and treatises. Even if it did not set up a censorship of the scientific press, which might be an experiment of doubtful wisdom, although some kind of interference seems really wanted now and then, it might set itself to the highly useful work of filling the gaps in our scientific literature. There is nothing from which the English student suffers so much as the want of good scientific manuals. The fact is that the expense of getting up such books in this country is so great, and the demand for them, though steady, yet so limited, that it will not pay publishers to issue them, let alone remunerate authors to write them. In my student-days the scarcity was even greater than it is now, and in fact then no one could hope to get even a reasonable acquaintance with the higher branches of exact science unless he had some familiarity with French or German at the very least—a familiarity which was rare among my fellow-students either in England or in Scotland. Might not the British Association now and then request some one fitted for the task to write a treatise on such and such a subject, and offer him reasonable remuneration for the time, labour, and skill required?

Another field in which the Association might profitably extend its labours appears to me to be the furnishing of reports, from time to time, on the teaching of science in other countries, and the drawing up of programmes of instruction for the guidance of schoolmasters and of those who are reading for their own instruction. There is no need to impose these programmes on any one. I would leave as much freedom to the teacher as I would to the private student. The programme drawn up by the Society for the Improvement of Geometrical Teaching, for example, has been very useful to me as a teacher, although I do not follow it or any other system exclusively. The great thing is not to fall asleep over any programme or system. For the matter of that, Euclid would do very well in the earlier stages of school instruction at least, provided he were modernised, and judiciously discarded at that part of the student's career where a lighter vehicle and more rapid progress becomes necessary. In such programmes as I contemplate the bearing of recent discovery on the elements of the various sciences could be pointed out, and the general public kept in this way from that gross ignorance into which they are at present allowed to fall.

The British Association has of late, I believe, given its attention to the encouragement of local scientific activity. There can be no doubt that much could be done in this way that is not done at present. The concentration of scientific activity in metropolitan centres is beginning to have a depressing effect in Great Britain. This is seen in the singularly unequal way in which Government aid is distributed over the country. Large sums are spent—sometimes we outsiders think not to the best purpose—through certain channels, simply because these channels happen to have a convenient opening in some Government office in London, or in some place in that important city which has easy access to the ruling powers; while applications on behalf of other objects not less worthy are met with a refusal which is sometimes barely courteous. The result is that local effort languishes, and men of energy, finding that nothing can be done apart from certain centres, naturally gravitate thither, leaving provincial desolation to become more desolate.

I think our great scientific societies—the Royal Societies of London and Edinburgh and the Royal Irish Academy—might do more than they do at present to prevent this languishing of local science, which is so prejudicial to the growth of a scientific public. Besides their all-important publishing function, these bodies have for a considerable time back been constituted into a species of examining and degree-conferring bodies for grown-up men. That is to say, their membership has been conferred upon a principle of *exclusion*. Instead of any one being *admitted* who is willing to do his best, by paying his subscription or otherwise, to advance science, every one is *excluded* who does not come up to the standard of a certain examining body. So far is this carried in the case of the Royal Society of London, that there is an actual competitive examination, on the result of which a certain number of successful candidates are annually chosen. Now, against this proceeding by itself I have nothing to say, except that it appears to belong to the pupillary age both of men and nations. It is not the honouring of the select few that I think evil, but the exclusion of the unhonoured many. The original intention in founding these societies was to promote the advancement of science. How that is done by excluding any one, be it the least gifted among us, who is honestly willing to contribute his mite towards the great end, fairly passes my comprehension. If it is thought necessary, for the proper cultivation of the scientific spirit among us, that the degree-conferring function should be continued, let there by all means be an inner court of the temple, a place for titular immortals; but let there be also a court of the Gentiles, where those whose fate or whose choice it is to serve science unadorned may find a modest reception. I believe that the adoption of this suggestion would enormously extend the usefulness of our great scientific societies, and give to their voice a weight which it never had before. At all events, if the trammels of tradition, or some better reason with which I am unacquainted, should prevent them from broadening their basis in the way I indicate, nothing prevents the British Association, with its more liberal constitution, from considering what may be done for the scientific plebeian.

There is one other function of the British Association in connection with which I wish to venture another suggestion. During the annual meeting, scientific men have an opportunity of making each other's acquaintance. Great men exchange ideas with great men; and, most important of all, young and little men have a chance, rarely otherwise afforded, of taking a nearer view of the great. What I would suggest for consideration is, whether it might not be possible to form an organisation which would in a certain sense carry this advantage through the whole year. I have already alluded more than once to the difficulties that the scientific public—and here I include professional men generally, in fact all but the leaders of science—have in keeping pace with recent advances. Would it not be possible to have an arrangement enabling at least every large centre of the higher education to have periodically the benefit of communion with and instruction from the high priests of the various branches of science? How glad we, the teachers of science in Edinburgh for example, would be to have a course of lectures once every three or four years from Professors Cayley, Sylvester, Stokes, Adams, Lord Rayleigh. In this way effect would be given to the principle which cannot be too much insisted upon, that the power of the spoken word far exceeds that of the written letter. Not only should we learn from the mouths of the prophets themselves the highest truths of science, but the present generation would thus come to know face to face, as living men, those whose work will be the glory of their time and a light for future ages. From the want of a proper circulating medium, the influence of great scientific men very often does not develop until they and the secrets of their insight have gone from among us. The object of what I propose is to make these men more of a living power in their own lifetime.

SECTION B

CHEMICAL SCIENCE

OPENING ADDRESS BY PROF. HENRY E. ARMSTRONG, PH.D., F.R.S., SEC. C.S., PRESIDENT OF THE SECTION

IN the Chemical Section of the British Association for the Advancement of Science the advancement of chemistry throughout the British Empire must be a subject of commanding interest. Signs of such advancement are not wanting:—the rapid establishment of science colleges in one after another of our large towns; the establishment of the Society of Chemical Industry, which now, only in the fifth year of its existence, numbers over 2,000 members; the granting of a Royal charter to the Institute of Chemistry; the changes introduced at the London University in the regulations for the D.Sc. degree; the report of the Royal Commission on Technical Education, in which the value to chemical manufacturers of advanced chemical knowledge is so fully recognised; the important conference on education held at the Health Exhibition last year; the recent agitation to found a teaching university in London with adequate provision for research—surely all these are signs that the value of higher education must and will, ere long, be generally recognised.

The neglect of chemical research in our British schools has often been forcibly commented upon—of late, especially, by an eminent past-President of this section, Dr. Perkin, whose opinion is of peculiar value, as he is not only world renowned as a chemist, but also as a manufacturer: indeed, as the founder of two distinct important chemical industries. There can be no doubt of the fact and of the dire consequences to our country of such neglect: how is it, then, that such pronounced complaints have been so coldly received; that hitherto they have produced comparatively so little effect; and that such slight encouragement is being given to those who, notwithstanding the many difficulties in their way, have steadfastly devoted themselves to research work? I question whether the value of such work has yet been brought home to teachers generally, let alone the public: the "*cui bono?*" cry is almost invariably met by pointing to some discovery of great pecuniary value as the outcome of research. This argument educationalists very properly refuse to recognise. Too little has been said as to the cause of the neglect so bitterly and properly complained of. Hence it is that I propose again to take up what many may regard as a somewhat threadbare theme.

Every one will agree with Prof. Sir Henry Roscoe, who in his address last year to this Section said "that those who are to become either scientific or industrial chemists should receive as sound and extensive a foundation in the theory and practice of chemical science as their time and abilities will allow, rather than they should be *forced prematurely*"—the italics are mine—"into the preparation of a new series of homologous compounds, or the investigation of some special reaction, or of some possible new colouring matter, though such work might doubtless lead to publication." We must also cordially agree with him that the aim should be, as he tells us his has been, "to prepare a young man by a careful and fairly complete general training to fill with intelligence and success a post either as teacher or industrial chemist, rather than to turn out mere specialists, who, placed under other conditions than those to which they have been accustomed, are unable to get out of the narrow groove in which they have been trained." If it were necessary to show that Sir Henry Roscoe is a believer in research in its proper place, ample proof would be afforded by his statement, "that, far from underrating the educational advantages of working at original subjects, he considers this sort of training of the highest and best kind, but only useful when founded upon a sound and general basis."

But I venture to think that something has to be added in order to completely define the position of those who deplore the slight amount of original work which is being done in British laboratories. We maintain that no one can really "*fill with intelligence and success* a post either as teacher or industrial chemist" who has not been trained in the methods of research; and that, owing to the neglect of research, the majority of students are of necessity trained in a narrow groove. The true teacher and the industrial chemist are daily called upon to exercise precisely those faculties which are developed in the course of original investigation, and which it is barely possible—many would say, perhaps with justice, it is impossible—to sufficiently cultivate in any other manner. In a works the *chemist* is scarcely required as long as all goes well. The quality of the materials used or produced can be controlled by purely routine processes of analysis by the works analyst, or by well-trained laboratory boys. But things never do go well for any long period of time: difficulties are always arising; obscure points have to be investigated; and, if the manufacturer understand his business, improvements have to be effected—which cannot be done unless the conditions under which he is working be understood, as well as the character of the changes which are taking place. Investigation is therefore necessary at every step. No amount of instruction, such as is ordinarily given, in the mere theory and practice of chemical science will confer the habits of mind, the acuteness of vision and resourcefulness required of an efficient chemist in a works, any more than the mere placing of the best tools in a workman's hands will make him a skilful operator.

Such being our position, we maintain that it is essential to make research an integral portion of the student's course in every college which pretends to *educate chemists*. It will not suffice occasionally to set a promising student to investigate, but a number of students, as well as the staff, must always be engaged in original work: in fact, *an atmosphere of research must pervade the college*. It cannot be too clearly recognised that it is this which characterises and distinguishes the German schools at the present time. The student does not learn so much from the one special piece of work with which he is occupied, but a number of his fellow-students being also similarly engaged, the spirit of inquiry is rife throughout the laboratory: original literature is freely consulted, and they thus become acquainted with the methods of the old masters; vigorous discussions take place, not only in the laboratory, but also at that most useful institution, the "Kneipe"; the appearance of each new number of the scientific periodicals is keenly welcomed;—in fact, a proper spirit of inquisitiveness is awakened and maintained, until it gradually becomes a habit. Probably there is less actual routine teaching done by the staff in the German schools than in our own. I am proud to own my indebtedness to one of them, and I can without hesitation say that I never truly realised what constituted the *science* of chemistry until I came under its influence.

But to realise the state which I have pictured—*to create an atmosphere of research in our science colleges in order that it may be possible for our students to obtain complete training in chemistry*, several things are required. In the first place, it will be necessary that the students come to them better prepared than they are at present: as a rule they are so ill-prepared that it is very difficult, if not impossible, in the time at disposal to give such preliminary instruction as is indispensable before higher work can be attempted. Their mathematical knowledge is so ill-digested that it is more often than not necessary to begin by teaching simple proportion, and they look aghast at a logarithm table. They cannot draw; so far have we advanced in our civilisation that the subject is more often than not an "extra" in our schools. They understand a little French; but German, which may almost be called the language of modern science, is indeed an unknown tongue to them. I do not complain of their want of knowledge of science subjects, but of the unscientific manner in which they have been trained at school, and especially of the manner in which their intellectual faculties have become deadened from want of exercise, instead of developed and sharpened. Too many have never acquired the habit of working steadily and seriously; they have not learnt to appreciate the holiness of work,[1] so that they render the office of teacher akin to that of slave-driver instead of to that of friend. What is perhaps worst is their marked inability, often amounting to downright refusal, either to take proper notice of what happens in an experiment or to draw any logical conclusion from an observation. Man is said to be a reasoning being, but my experience as an examiner and teacher would lead me to believe that this fact is altogether lost sight of by the average schoolmaster, who appears to confine himself almost exclusively to the teaching of hard dry facts, and makes no attempt to cultivate those very faculties which are supposed to characterise the human race; or he is so ill-prepared for his work that he fails to understand his duty. These are harsh words, but the evil is of such magnitude that it cannot be too plainly stated; those who, like myself, are brought full face to it fail in their duty if, when opportunity occurs, they do not take occasion to call attention to its existence.

Probably the only remedy—certainly the most effectual, and that which can be most easily applied—is the introduction of a *rational system* of practical science teaching into all our schools, whatever their grade; one effect would be that all the school subjects would of necessity soon be taught in a more scientific manner. I am not one of those who would eschew the teaching of classics, and I do not wish to see science teaching introduced into schools generally, in order that the students who come to me may already have gained some knowledge of science: under existing circumstances I prefer that they shall not; but I desire its introduction because the faculty of observing and of reasoning from observation, and also from experiment, is most readily

[1] In my experience, the behaviour of ordinary day male students is, in this respect, particularly striking in comparison with that of female and evening students: the evening students, who come with a desire to learn, and the female students are invariably most attentive, and make the fullest use of the opportunities afforded them.

developed by the study of experimental science: this faculty, which is of such enormous practical value throughout life, being, I believe—as I have said elsewhere—left uncultivated after the most careful mathematical and literary training. No one has stated this more clearly than Charles Kingsley. We are told that, speaking to the boys at Wellington College, he said: "The first thing for a boy to learn, after obedience and morality, is a habit of observation—a habit of using his eyes. It matters little what you use them on, provided you do use them. They say knowledge is power, and so it is—but only the knowledge which you get by observation. Many a man is very learned in books, and has read for years and years, and yet he is useless. He knows *about* all sorts of things, but he can't *do* them." This is precisely our complaint—the average schoolboy may know a good deal *about* things, but he can't *do* them. The ordinary school system of training does not, in fact, develop the "wits," to use a popular and expressive term for the observing and reasoning faculties; but it is certain that the wits require training. It is because the teaching of experimental science tends to develop the wits that those among us who know its power are so anxious for its introduction. This cannot be too clearly stated, the popular view—to judge from newspaper discussions—being apparently that science is to be classed with "extras": that it is good for those who can afford it, but can be dispensed with by those who cannot. This undoubtedly is true of the "science" which is taught the specialist, and I fear even of much of the "science" which is at present taught in schools: let us hope that ere long other views will prevail when the object which it is sought to gain by teaching science is made clear.

While blaming the schoolmaster for his neglect, it must not be forgotten that the teaching of sciences in schools meets with comparatively little encouragement at the hands of our examining bodies and the universities. Again, examinations are too often entrusted to those who have no educational experience, and with most unfortunate results: in no case, probably, is inexperience so inexcusable as in an examiner. Too often, also, the examinations are in the hands of pure specialists, who take too formal a view of their duty, and expect from boys and girls at school as much as from their own students, who are older and devote more time to the work. Such examiners are prone to discourage science by marking too severely; and as their questions govern the teaching, instruction is given in schools without due reference to educational requirements, and in a purely technical style: this, I fear, is the effect of some of the universities' local examinations.

I have it on good authority, that the recent changes in the scheme of the examinations for admission at Sandhurst have forced one large school, well known for the attention paid in it to the teaching of science, to cease to give instruction in science to those of its pupils who propose to compete at these examinations, at once on their deciding to do so. Then, not only are the science scholarships at the universities few in proportion, but the great majority of students pass through their university career without being called upon to gain the slightest knowledge of physical science: yet, more often than not, the teachers are chosen from these. A large proportion become clergymen, and considering the demands upon them and the unbounded opportunities which they have of imparting useful information, there cannot be a doubt that to no other class of the community is a knowledge of natural science likely to be of more value.[1] Let us hope that the time is near when our universities will no longer be open to this reproach.[2] Whatever steps they may elect to take, it is before all things important that it be not forgotten that their main purpose must be to influence the schools, so that experimental science may be used as an educational weapon at the most appropriate time, and not when the faculties to be fashioned by it have become atrophied through neglect, as I fear is too often the case, ere the university is reached.

We must carefully guard against being satisfied with the mere introduction of one or more science subjects into the school curriculum: some of those who strenuously advocate the introduction of science teaching perhaps do not sufficiently bear this in mind. Chemistry, physics, &c., may be—and I fear are, more often than not—taught in such a way that it were better had no attempt whatever been made to teach them. I hold that it is of no use merely to set lads to prepare oxygen, &c., or to make experiments which please them in proportion as they more nearly resemble fireworks; and it is not the duty of the schoolmaster to train his boys as though they were to become chemists, any more than it is his duty to fit them to enter any other particular profession or trade: the whole of the science teaching in a school should be subservient to the one object of developing certain faculties. Unfortunately, two great difficulties stand in the way at present—viz. the want of suitable books and of a rational system of teaching science from the point of view here advocated; and the requirements of the universities and other examining bodies. Both books and examinations are of too special a character: they may suit the specialist, but do not meet educational requirements. I have already somewhat fully expressed my views on this subject in a paper read at the Educational Conference in London last year. Although much more might be said, I will now only call attention to the important service which we may render in removing these difficulties.

The reform most urgently needed, in which, as members of the community, not merely as chemists, we are all most interested, is the introduction of some system which will insure a proper training for teachers. Engineers, lawyers, medical men, pharmacists, have severally associated themselves to found institutions which require those who desire to join the profession to obtain a certain qualification; even chemists are seeking to do this through the Institute of Chemistry. But schoolmasters, although members of what is probably the most responsible, onerous, useful, and honourable of any of the professions, have as yet neither made, nor shown any inclination to make, a united effort to insure that all those who join their profession shall be properly qualified. Surely the time has come when the subject must receive full public attention; the country cannot much longer remain content that the education of all but those of its sons and daughters who come within the province of the School Board should be carried on without any guarantee that it is being properly conducted.

Glaring as are the faults in the existing school system, and although it rests with the universities and other teaching and examining bodies—if the public do not intervene—to prescribe a proper course of instruction for potential schoolmasters and to enforce a rational system of training all the mental faculties, we science teachers may meanwhile do much by introducing more perfect methods into our own system of teaching. The students attending our courses belong to various classes: some will become chemists, and require the highest and most complete training; others will be teachers in colleges or schools; many will occupy themselves as consulting chemists or analysts; many others will have to take charge of manufacturing operations in which a knowledge of chemistry is of more or less direct importance and value; not a few will become medical men; and a large proportion, let us hope, will be those who have no direct use for chemistry, although the knowledge will be of great service to them in many ways: among such we may include architects and builders, engineers, farmers, and even country gentlemen. Have we sufficiently considered the several requirements of all these various classes? I submit, with all due deference, that we have not! Our attention has been too exclusively directed to the training up of the future analyst; the instruction has been of too technical a character.

I know it is rank heresy to say so, but I maintain that in future far less time must be devoted to the teaching of ordinary qualitative and quantitative analysis, and that *technical instruction* as now given in these subjects must find its place later in the course. Our main object in the first instance must be to fully develop the intellectual faculties of our students; to encourage their aspirations by inculcating broad and liberal views of our science, not an infinite number of petty details. We must not merely teach them the principles and main facts of our science, but we must show them how the knowledge of those facts and principles has been gained; and they must be so drilled as to have complete command of their knowledge. The great

[1] "I sometimes dream," said Kingsley, "of a day when it will be considered necessary that every candidate for ordination should be required to have passed creditably in at least one branch of physical science, if it be only to teach him the method of sound scientific thought."

[2] I learnt with the most lively satisfaction, but a few days ago, that Dr. Percival, the late head-master of Clifton College, speaking at a meeting of Convocation at Oxford last term, said: "If twenty years ago this university had said: from this time forward the elements of natural science shall take their place in responsions side by side with the elements of mathematics, and shall be equally obligatory, you would long ago have effected a revolution in school education." This remark elicited some warm expressions of approval. Dr. Percival has, I am sure, the approval of all science teachers, and he will earn their gratitude, and deserve that of the public at large, if he can succeed in inducing his university to take action in accordance with his enlightened views.

majority will not be required to perform *ordinary* analyses, either qualitative or quantitative; it will be sufficient for them to have gained such an amount of practical experience that they thoroughly understand the principles of analysis; that they shall have learnt to appreciate the sacredness of accuracy; and that they shall have acquired sufficient manipulative skill to be able when occasion requires to carry into execution the analytical process which their text-books tell them is applicable, and even, if necessary, to modify the process to suit circumstances.

Chemistry is no longer a purely descriptive science. The study of carbon compounds and Mendeljeff's generalisation have produced a complete revolution! The faults in our present system are precisely those which have characterised the teaching of geography and history, and which are now becoming so generally recognised and condemned; in fact, no better statement of the manner in which I conceive chemistry should be taught could be given them by broadly applying to the teaching of chemistry what was said by Professor Seeley at the International Conference on education last year, in an important paper on the teaching of history.

The necessity for some change must, I venture to think, be patent to all thoughtful teachers, and especially to those who are called upon to fulfil the painful duties of an examiner. The railway book-stalls have made us acquainted with "Confessions" of all sorts, but if the "Confessions of an Examiner" were to be written they would be far more heartrending than any. The examiner in chemistry, let him go where he will, scarcely dare to ask a question to which the answer cannot be directly read out from a text-book. He will be told "that such and such a compound is formed by the action of so and so upon so and so," but he will usually find blank ignorance of the phrase "by the action of," and as to the mode of performing the operation. The examiner would, however, be bound to agree with the teacher that it is almost impossible to induce students to seek information outside the lecture-room, and except in the ordinary cram text-books, and that it is hopeless to expect them to devote attention to anything unless it will pay in a subsequent examination—in fact that the old university spirit of acquiring knowledge for its own sake is almost unknown among our science students. Herein lies one of the teacher's most serious difficulties, as he is more often than not bound to teach in a particular way, or to teach certain subjects, in entire opposition to his own views, in order to qualify his students to pass a particular examination; for example, many of our colleges now distinctly state that their courses are intended to qualify students to pass the examinations of the London University, and hence they are governed by the requirements of that university, which vary more or less as the examiners are periodically changed. The examiner, on the other hand, is often placed in a difficult position: it is clear to him that the system under which the students he is called upon to examine have been taught is a bad one; yet he feels that he has no right to set questions such as he honestly believes should direct the teaching into proper channels, because he knows that the teacher is immovable, and it is not fair to make the examinees the victims of a system for which they are not responsible. Hence, perforce, the teacher goes on teaching badly and the examiner examining badly. Difficulties of this kind are bound to make themselves felt at a transition period like the present, and will only disappear if we recognise the grave responsibility which rests upon ourselves and improve our methods of teaching and our text-books: these, in too many instances, are unsuited to modern requirements, and are being made worse by stereotyping, and the practice which is gradually creeping in of merely changing the date on the title page and the numeral before the word "edition," thus engendering the belief that the information is given up to date.

Both in teaching and examining two important changes ought forthwith to be made: our students ought at the very beginning of their career to become familiar with the use of the balance; and the imaginary distinction between so-called inorganic and organic compounds should be altogether abandoned. I do not mean that students should be taught quantitative analysis as ordinarily understood, but that instead of endeavouring to make clear to them by explanation only the meaning of terms such as equivalent, for example, we should set them to perform a few simple quantitative exercises in determining equivalents, &c. It can easily be done, and terms which otherwise long remain mythical acquire a real meaning in the student's mind. That the elements of the chemistry of carbon compounds do not find a place at a very early period in the course of instruction is one of those riddles connected with our system which it is impossible to answer. Attention was once pithily directed to the fact in my hearing by a scientific friend—not a chemist—who said he had often felt astonished that, although he had learnt a good deal of chemistry, the chemistry of the breakfast-table was practically a sealed book to him, common salt being the one object of which he felt he knew something.

I may here urge that there is one great error which we *must* avoid in the future, that of overworking our students, in the sense of obliging them to pay attention to too many subjects at a time. This is done more or less, I believe, in all our science schools, and medical students are peculiarly unfortunate in this respect. It is to some extent necessitated by the deficient preliminary education of our students; but I believe that I am justified in stating that it is also partly, perhaps mainly, due to the fact that the curriculum is too often imposed by lecturers who are directly interested in the attendance of students at their lectures. This is one of the great difficulties in the way of higher education, and the continuance of the evil is probably in a measure due to inappreciation of what constitutes higher education and culture: neither consist in a smattering of knowledge of a variety of subjects such as is too often required at present.

The more general appreciation of the value of science undoubtedly depends to a considerable extent on improvements such as I have indicated being introduced. When such is the case, we may hope that a large number of students will enter our chemical schools, not with the intention of becoming chemists, but because it will be recognised that the training there given is of a high educational value, and that a knowledge of chemistry is of distinct service in very many avocations.

We may also hope that it will be possible ere long to teach chemistry properly to medical students. Seeing that the practice of medical men largely consists in pouring chemicals into that delicately organised vessel, the human body, and that the chemical changes which thereupon take place, or which normally and abnormally occur in it, are certainly not more simple than those which take place in ordinary inert vessels in our laboratories, the necessity for the medical man to have a knowledge of chemistry—and that no slight one—would appear to ordinary minds to stand to reason; that such is not generally acknowledged to be the case can only be accounted for by the fact that they never yet have been taught *chemistry*, and that the apology for chemistry which has been forced upon them has been found to be of next to no value. No proof is required that the student has ever performed a single quantitative exercise; and I have no hesitation in saying that the examinations in so-called practical chemistry, even at the London University, are beneath contempt: after more than a dozen years' experience as a teacher under the system, I can affirm that the knowledge gained is of no permanent value, and the educational discipline *nil*. Here the reform must be effected by the examining boards: it is for them to insist upon a satisfactory preliminary training, and they must so order their demands as to enforce a proper system of practical teaching; and if chemistry is to be of real service to medical men, more time must be devoted to its study. Physiological chemistry is taught nowhere in our country, either at the universities or at any of our great medical schools; let us hope that the publication of works like those of Gamgee and Lauder Brunton may have some effect in calling attention to this grievous neglect of so important a subject.

Having dealt with the educational aspect of the question, let me now briefly refer to some other difficulties which seriously hinder research. It has been more or less openly stated that the teachers in our chemical schools might themselves do far more. Is this the case? I do not think so; I believe it is not the staff, in most cases, who are primarily in fault. Under our peculiar system of placing the government of science schools in the hands of those who have little, if any, experience as educationalists, and little knowledge of or sympathy with science, the appointments are sometimes made without the slightest reference to capability of inciting and conducting original investigation, and without any proof having been given either of a desire to promote higher education in the only possible way—by research; nevertheless experience shows that, as a rule, fair use is made by teachers of their opportunities. The opportunities afforded us are indeed few. In the first place, the amount of actual routine teaching we are called upon to perform is very considerable, many of us having to conduct evening as well as day classes; and the work is often of the most harassing description, owing to the want of interest displayed by the students. The assistance provided is also too often inadequate, and much which should be done by assistants is therefore thrown upon the principals. Higher work under these conditions is practically out of the question, not so much because it is impossible to snatch at intervals a few hours per week, but because the attention is so much taken up in the preparation of lectures and laboratory and tutorial teaching that it is impossible to secure that freedom of mind and concentrated attention which are essential to the successful prosecution of research. Bad, however, as is often the position of the principals, that of the junior staff is usually far worse. During official hours they are entirely occupied in tutorial work, and what little energy remains must more often than not be devoted to coaching or literary work, to supplement the too modest income which the salary attached to their official position affords. Under these circumstances, it is remarkable that so much enthusiasm should prevail among them on the subject of research. The tradition which prevails in the German schools, that the junior staff are bound to find some time for original work, is almost unknown in this country, and too often difficulties are raised, rather than facilities afforded, when the desire is manifested: we do not, in fact, sufficiently honour the assistant as the potential professor. It has also often struck me as remarkable, and it must have struck others who understand the German system, that in this practical country we have not adopted that cheap luxury—the Privat-Docent, who costs nothing and exercises a most important function in promoting higher education. The explanation of this and many other anomalies lies in the fact that very few among us realise what a university is: a clear exposition of the Scotch and German systems would be of great value in these days of new universities and university colleges.

I believe that in most, if not all, of the German chemical schools a private research assistant is placed at the disposal of the professor. Will this ever be the case here? The want material assistance is not only felt in this respect, however: few of our chemical schools are really efficiently equipped; most of them are seriously in want of larger and more expensive apparatus, of suitable specimens, &c.; the annual grant barely suffices for the purchase of the ordinary chemicals and the payment of unavoidable current expenses, so that, as a rule, nothing remains to meet the expenses of research work—*i.e.*, of higher education. In point of fact, nearly all of those who are engaged in research are doing so at their own expense; important assistance, for which we cannot be too thankful, is indeed received from the various research funds, but the proportion which the grants bear to the total sum expended is not large. I am sure we all recognise that each one of us is bound, according to his abilities and the opportunities he has, to add to the stock of knowledge, and that the keenest intellectual pleasure is derived therefrom; but it must not be forgotten that the results we obtain are very rarely of immediate practical value, and that as a rule *we* reap no pecuniary advantage. I venture to think, in act, that it is remarkable that so much, not that so little, is done, and that reproach rests very lightly apon the profession in this matter. Whether our national pride will prevent our being much longer beholden to foreigners for by far the greater number of new facts in chemistry is a difficult question to answer, and must rest with the public!

The occasions on which we teachers of science subjects are able to bear witness in public are of necessity few. Deeply sensible, not only of the honour, but also of the responsibility of my position as President ot this Section, I felt that it was my duty to avail myself of this opportunity. Being a teacher who is interested in teaching; being convinced of the existence of most serious faults in our educational system; feeling that the present is a most critical period: I have not hesitated to speak very freely. Some of the difficulties to which I have referred might soon disappear if science teachers generally would agree to consider them together, and I believe that it would be a very great advantage if an association for the discussion of educational questions were formed of the staffs of our science colleges throughout the country. The special difficulties which surround our science colleges, and prevent them from exercising their full share of influence upon the advancement of our national prosperity might also be removed at no distant date; but I see only one way of accomplishing this, and I fear it will hardly find favour: it is by their all becoming vested in the State. In this country we like to do things in our own way, and the objection will at once be raised that this would deprive all the colleges of their individuality, and would tend to crush originality and to stereotype teaching. If I thought so I should never make the suggestion. But it would not, provided that complete academic freedom were secured to the staff, and each college were left to adjust itself to local requirements; efficiency would be maintained by the competition of the various colleges. Local enterprise, which has hitherto been trusted to, is clearly breaking down under the tremendous strain of modern educational requirements: some change must ere long be made.

(*To be continued.*)

SECTION C

GEOLOGY

Opening Address by Prof. J. W. Judd, F.R.S., Sec. G.S., President of the Section.

As this city is the only place within the limits of the Scottish Highlands where our Association holds its annual gatherings, it is fitting that the attention of those who meet in this section should, on the present occasion, be specially directed to the grand problems of Highland geology. Six-and-twenty years have passed since the members of this section assembled here, under the presidency of my dear friend, my revered master, Charles Lyell. Few now present can have actually listened to the stormy discussions of that memorable occasion, but all are familiar with the nature of the problems which in the year 1859 were here so keenly debated. It is true that the fires of these controversies have now almost died out, and from their ashes have arisen the new problems which confront us to-day; but it will not, I think, be without profit to direct your attention for a few minutes to those two subjects which constituted the "burning questions" of that day—the age of the Crystalline Rocks of the Highlands, and the geological position of the Reptiliferous Sandstone of Elgin.

With respect to the first of these questions, there are especial reasons why I should briefly review the discussions which have taken place in connection with it. It was in the meetings of this section of the British Association that the successive stages of the controversy were gradually developed. It was at a former meeting of the Association in this city that James Nicol submitted to the scientific world that splendid solution of a difficult problem, which is now universally admitted to have been the correct one. This university was, during the last twenty-seven years of his active, useful, and honoured life, the scene and centre of the labours of that profound but modest thinker to whom we owe so much. Lest it should seem presumption on my part to speak on the question, I may add that for some years before his death it was my good fortune to enjoy the friendship and confidence of the late Prof. Nicol, with whom I had several opportunities of discussing the great questions at issue between himself and Murchison. Seeing, as I do to-day, his own great claims too often forgotten or ignored, I feel that, should I, on this occasion, hold my peace—"the very stones would cry out." It will indeed be an unfortunate day for our republic of science when the palm of recognition—withheld from him whom modesty and self-respect restrain from clamorous self-assertion—is permitted to be snatched away by the bold and noisy advertiser of his own claims.

Nearly seventy years ago, John Macculloch—that distinguished pioneer in Scottish geology—was able to prove that in our Western Highlands there exists a grand formation, made up of red sandstones and quartzite, both exhibiting unmistakable evidence of a sedimentary origin. He also pointed out that, associated with these red sandstones and quartzites, are beds of limestone, which are often altogether destitute of crystalline characters, and are sometimes bituminous, while they occasionally contain fossils.

Macculloch strongly insisted that this great system of strata, which covers large areas in Sutherland and Ross, extending also into some of the Western Isles, is distinct alike from the Old- and the New-Red Sandstone; he asserted that it belongs to a far older period than either of those formations, and, employing the phraseology of the early geologists, he gave to it the name of the "*Primary* Red Sandstone" (*Trans.* Geol. Soc. ser. 1, vol. ii. p. 450, &c. "Western Isles of Scotland" (1819), vol. ii. p. 89, &c. "System of Geology" (1831).

Macculloch showed clearly that the strata of his "Primary Red Sandstone Formation" are often found resting unconformably upon the gneissose and schistose rocks of the Highlands;

but that in other places they appear to be overlain conformably by, and even to alternate with, crystalline schists and gneisses. He was further able to state that the quartzites of his "Primary Red Sandstone Formation" contain organic remains, some of which he correctly identified as the burrows of marine worms, while others he recognised as *Orthoceratites* ("Western Isles of Scotland" (1819), vol. ii. pp. 512, 513). It is almost painful to have to add that his want of appreciation of the value of palæontological evidence, a weakness which Macculloch shared with so many of the early Scottish geologists, prevented any attempt on his part at the correlation of this "Primary Red Sandstone" with the rocks of other districts; and thus for more than forty years this important discovery remained almost entirely fruitless.

The next step in the history of our knowledge of these Highland strata which we have to record, was unfortunately a retrograde one. Sedgwick and Murchison, who visited the district in 1827, maintained that Macculloch had fallen into grievous error, and that his "Primary Red Sandstone Formation" was in fact no other than an outlying part of the Old Red Sandstone (*Trans.* Geol. Soc. ser. 2, vol. iii. p. 155).

This view was strongly protested against by Hay Cunningham, who, writing in 1839, after a careful survey of Sutherland, demonstrated the justice of Macculloch's conclusions, and even went beyond that geologist in showing the very intimate connection between the quartzite and limestone. He clearly illustrated by numerous sections the unconformity of the "Primary Red Sandstone Formation," consisting of red sandstone, quartzite, and limestone, upon the gneissose rocks, and the apparently conformable superposition to it of other schists and gneisses ("On the Geognosy of Sutherlandshire," by R. J. H. Cunningham, M.W.S.; *Transactions* of the Highland and Agricultural Society of Scotland, vol. xiii. (1839).

Such was the state of geological opinion when, in the winter of 1854, the attention of geologists was recalled to this ancient formation of Macculloch by the discovery in it of fossils by one who fully recognised their value and importance—Mr. Charles Peach. These fossils, though imperfect, were sufficient to prove that the strata containing them must be of *Palæozoic* age.

Three of the leaders of geological science at that day appear to have been deeply impressed with the importance of this discovery of Mr. Peach's; but for a time, at least, the fruits of that discovery were missed, through the unfortunate retrograde teachings of Sedgwick and Murchison in 1827.

Hugh Miller, whose splendid researches in the Old Red Sandstone had made him ready to welcome any extension of its boundaries, suggested that the fossils of Durness might belong to the marine Devonian.

Roderick Murchison, who in his younger days had worthily conquered a kingdom in Siluria, and by successive annexations in his later years had sought to convert this kingdom into an empire—one which should embrace all the Lower Palæozoic rocks of the globe—was not unwilling to claim his native Highlands as part of this ever-growing realm.

James Nicol, who had been the first to discover graptolites in the rocks of the Scottish Borderland, and had thus demonstrated their Silurian age, was so struck by the resemblance of some of the slaty rocks of the Highlands to the fossiliferous shales of his native district, that, ten years before Peach made his important discovery, he had suggested the probability of the Highland schists and gneisses being simply the Borderland shales and greywackes in an altered state ("Guide to the Geology of Scotland" [1844]). Hence Nicol, equally with Murchison, was prepared to accept the Silurian age of the Durness limestone, and of the rocks associated with it.

Murchison, still full of his old enthusiasm for discovery, determined to lose no time in putting to the test the truth of the suggestion made by his old friend Nicol and himself; and accordingly, shortly before the meeting of the British Association, which was fixed to take place in the year 1855 at Glasgow, we find the two friends making their way into the wild district of North-west Sutherland.

Unfortunately the time was too short and the weather too unpropitious for the task they had set before themselves.

When this Geological Section assembled at Glasgow, Murchison declared his conviction that the limestone of Durness, which had yielded the fossils to Mr. Peach, was of Silurian—that is, as he employed the term—of Lower Palæozoic age. But he, at the same time, maintained the truth of his old views, that the red sandstones of Applecross and Gareloch are in reality nothing but Old Red Sandstone ("Brit. Ass. Rep." 1855); *Trans.* of Sec. p. 87), and in this latter contention he received the warm support of Sedgwick, who was also present at the meeting (Geikie's "Memoir of Sir Roderick Murchison" (1875), vol. ii. p. 207).

Nicol, on the other hand, appears to have been greatly dissatisfied with the results of this hasty and inauspicious journey to Sutherland. While, however, withholding his judgment as to the age of the several rock-masses, he insisted, in opposition to the views of Murchison and Sedgwick, that the whole of the vast series of Red Sandstones in Applecross and Torridon is, as Macculloch showed, inferior to the quartzite and limestone (see Nicol's "Geology of the North of Scotland" (1866), Appendix, p. 96).

In the summer of the next year, 1856, Nicol, so soon as he was released from his teaching work in this university, hastened back to the Western Highlands to try and resolve some of the doubts which troubled him concerning the age and succession of the strata. This summer's labour was productive of great and important discoveries. In the first place, he was able to completely confirm the conclusions of Macculloch and Hay Cunningham, that *all* the Red Sandstone of the Western Islands, with the exception of some small patches of "New Red," belong to an old formation underlying the quartzite and limestone. But his researches also enabled him to show that Macculloch's "Primary Red Sandstone" in reality consists of *two* formations, the lower—to which he subsequently gave the name of the "Torridon Sandstone"—lying unconformably on the gneiss, and the upper (consisting of quarzite and limestone, containing fossils) resting everywhere unconformably upon, and overlapping, the sandstones.[1] It is a very noteworthy circumstance that while Nicol admitted the accuracy of the descriptions of Macculloch and Hay Cunningham which seemed to point to a conformable superposition of beds of gneiss to the quartzite and limestone, the results of this first summer's work had already raised serious misgivings in his mind as to the correctness of this conclusion, for he wrote as follows:—"The fact of the overlying gneiss having been metamorphosed *in situ*, and not pushed up over the quartzite, is one requiring further investigation" (*Quart. Journ. Geol. Soc.* vol. xiii., 1857, p. 35). It is not surprising, however, to find that Nicol was so staggered by the magnitude of the faults which would be required to bring about such a result, that for more than a year he hesitated to accept this, which we now know to be the true, explanation of the phenomena.

There was a suggestion—and it was nothing more than a suggestion—made by Nicol at this time, which has often been very unfairly quoted to his disadvantage. Convinced that Macculloch was right as to the infraposition of the Torridon Sandstone to the quartzite and limestone, and strongly inclined to accept Murchison's confident assertion that this Torridon Sandstone was simply the "Old Red," Nicol pointed out that the only possible way of harmonising these two views was to suppose that the quartzites and limestones were of Carboniferous age; and he showed that the imperfect fossils which had been up to that time obtained at Durness were not sufficient to negative such a supposition (*Quart. Jour. Geol. Soc.* vol. xiii., 1857, p. 36).

But during the summers of 1857 and 1858, Nicol continued his labours in the Western Highlands, with the result of clearing away many of his difficulties and perplexities. Murchison, too, had revisited the district, and seen that his idea of the "Old-Red" age of the Torridon Sandstone would have to be finally abandoned, and that Macculloch's views, as amended by Nicol, concerning the relations of the Highland rock-masses must be accepted. Salter, too, examining more perfect specimens of fossils which had in the meanwhile been obtained from the Durness limestone by the indefatigable Mr. Charles Peach, showed that they were certainly of *lower* Palæozoic age (Silurian of Murchison).

The position taken up by Murchison, and on which he made his final stand, was simply arrived at by combining the stratigraphical conclusions of Macculloch and Nicol with the palæontological results of Peach and Salter.

Murchison attended the meetings of this Association at Dublin in 1857, and at Leeds in 1858, on both occasions making use of the opportunity for explaining in detail his ideas concerning the age and succession of the Highland rocks. On the latter

[1] Colonel Sir Henry James is said to have made similar observations during the same season, the summer of 1856, and to have communicated them to Sir Roderick Murchison by letter. But there can be no doubt that Nicol's discovery was made quite independently, and he was the first to publish it.

occasion, he challenged his old friend Nicol to meet him at the forthcoming meeting at Aberdeen to discuss the question, and the challenge was accepted.

When Murchison arrived at this city, in September 1859, he brought with him a redoubtable champion in the person of Prof. (now Sir Andrew) Ramsay, the director of the Geological Survey, who had been conducted to Assynt and shown the section there. It may perhaps serve as a caution against hasty generalisations, drawn from a single section imperfectly examined, to remember that so excellent a field-geologist as Ramsay undoubtedly was not only failed to see the weakness of Murchison's position, but threw all the weight of his great authority into the scale against Nicol in this memorable controversy.

Nicol, however, laid before this meeting a paper which, afterwards published in detail in the *Journal* of the Geological Society,[1] must be admitted to have really established the main facts concerning the geology of the Highlands as accepted by all geologists at the present day; though his views, as is not uncommonly the case with great and original discoveries, were met for a long time with nothing but bitter opposition or cold neglect. Permit me to state, as briefly as possible, the conclusions which Nicol, as the result of three years of patient work in the Western Highlands, was able to announce in this place, just twenty-six years ago.

1. He maintained with Macculloch and Hay Cunningham, and in opposition to the views originally propounded by Sedgwick and Murchison, that there exists in the Western Highlands an enormously thick series of red sandstones, quartzites, and limestones, which rest unconformably upon the ancient gneisses and schists, and belong to a far older geological period than the Old Red Sandstone.

2. He showed that this series of strata really constitutes *two* distinct formations, and that the older of these, the Torridon Sandstone, consists of red sandstones and conglomerates, in which no organic remains could be detected.

3. The younger of these formations was shown by him to lie unconformably upon the Torridon Sandstone, and to consist of three members, which Nicol named the Quartzite, the Fucoid Beds, and the Limestone (*Quart. Journ. Geol. Soc.* vol. xvii., 1861, p. 92, &c.). It is this formation which has yielded the interesting fossils of Lower Palæozoic age.

4. The apparent repetition of beds of quartzite and limestone, which was insisted upon by Murchison, was shown to be due to faulting and overthrow, and thus the "Upper Quartzite" and the "Upper Limestone" of that author were proved to have no real existence (*Quart. Journ. Geol. Soc.* vol. xvii., 1861, pp. 98, 108, 109, &c.).

5. What so many authors had taken for a conformable upward succession of this older Palæozoic formation into overlying schist and gneiss, was asserted by Nicol to be an altogether fallacious appearance, due to the thrusting of the crystalline rocks over the sedimentary ones by great overthrow-faults.

6. The relations between these crystalline and sedimentary strata in the Scottish Highlands were shown to be precisely similar to those which are constantly produced by lateral pressure in all great mountain-chains, and consist of sharp foldings, inversions, and faulting on the very grandest scale. Examples of overthrow-faults, similar to those of the Scottish Highlands, were instanced by Nicol as occurring in the Alps (*Quart. Journ. Geol. Soc.* vol. xvii., 1861, pp. 108, 109, 110).

We cannot perhaps better illustrate the position maintained by Nicol in this remarkable paper than by quoting the following passage: "Until some rational theory is produced of the mode in which an overlying formation, hundreds of square miles in extent and thousands of feet in thickness, can have been metamorphosed, whilst the underlying formation of equal thickness and scarcely less in extent has escaped, we shall be justified in admitting inversions and extrusions" (*i.e.*, of older masses on younger, as he explains his meaning to be) "equal to those of the Alps" (*Quart. Journ. Geol. Soc.* vol. xvii., 1861, p. 110).

The only serious error into which Nicol fell—and after all it is a very inconsiderable one judged in comparison with his undoubtedly great achievements—was that of attaching too much importance to the influence of igneous intrusions in connection with the tremendous inversions and overthrow-faults to which he so clearly showed that these Highland rocks have been subjected. We now know that many of these supposed intrusive masses, though really of igneous origin in all probability, were of *older* date than the Palæozoic rocks in the midst of which they lie; and that they were brought into their present positions, not by intrusion in a liquid state, but by complicated faulting. It must be remembered that these "granulites," as Nicol very justly called them (*Quart. Journ. Geol. Soc.* vol. xvii., 1861, p. 89) for they present a wonderful analogy with the typical rocks of Saxony which are known by that name, have long been regarded by geologists as among the most difficult and perplexing of rocks to explain the origin of, though the recent researches of Dr. Lehmann have now done something towards the solution of the problem.

Calmly reviewing, in the light of our present knowledge, the grand work accomplished single-handed by Nicol, I have no hesitation in asserting that when this Association met here twenty-six years ago, he had already mastered the great Highland problem in all its essential details, and that his results were distinctly proclaimed during the meetings of this section.

If, then, Nicol had so fully solved this great problem of Highland geology twenty-six years ago, how is it, may not unreasonably be asked, that we have waited so long for the justice of these views to be admitted?

A variety of circumstances have contributed to bring about this unfortunate result. Murchison was at the time too old and infirm to examine in careful detail the wild districts where those rock-masses are exhibited. Hence Nicol's oft-repeated invitations to view the sections in his company remained unheeded, and we find the great geologist of Aberdeen writing in 1866 his concluding plaintive words in this memorable discussion: "I must express my most sincere regret that my illustrious opponent—from whom only the most thorough conviction that my views are well founded, and that the question was one on which it became a teacher of geology in Scotland to give no uncertain utterances, could have compelled me to differ—has never found it convenient to meet me again in the North. I am convinced that we agree in so many essential points, that a few hours together in the field would bring us nearer in opinion than whole volumes of controversy." ("Geology of the North of Scotland, p. 96.")

The phalanx of eminent geological authorities opposed to the views of Nicol, including Professors Harkness, Ramsay, Archibald Geikie, and Hull, for a long time carried all before them; but it is now admitted that each of these excellent observers was deceived by having seen only portions of the evidence, and that they based their conclusions on imperfect data. Nicol, though during the later years of his life he declined unavailing controversy, still continued to study the Highlands year by year, re-examining every joint in his armour and satisfying himself of its soundness.

In the year 1877 I had an opportunity of visiting for the first time the interesting sections of Assynt and Loch Broom, in company with Dr. Taylor Smith, F.G.S., and Mr. Richard D. Oldham, now of the Geological Survey of India. Although I entered upon this task with the strongest prepossessions in favour of the Murchisonian hypothesis, yet what I saw there during several weeks of work convinced me that the theory of an "Upper Quartzite" and an "Upper Limestone" was altogether untenable, and that, so far as these two sections were concerned, Nicol's interpretation was undoubtedly the correct one. I was greatly impressed with the proofs of enormous folding and faulting among these Highland rocks, and when, shortly afterwards, I had an opportunity of meeting Prof. Nicol in this place, and of hearing from his lips many details of his later work, I strongly urged him to republish his conclusions with the fuller illustrations and arguments which he was then so well able to supply. To all my pleadings he made but one reply: important as he knew these discoveries to be, yet in his advancing years he thought but little of the glory of them compared to their painful consequences to himself—the breach of the old friendly relations with one he, to the end, so greatly loved and honoured. He strongly deprecated at that time the reopening of a controversy associated for him with such bitter memories; but he expressed his full conviction that when sufficiently accurate topographical maps were in existence, and the whole district should be surveyed by competent geologists, the truth of all the essential parts of his teaching would be established.[1]

[1] *Quart. Journ. Geol. Soc.* vol. xvii., 1861, pp. 85-113. This paper was read on December 5, 1860; although its title is slightly different, the whole course of the argument is the same with that of the paper read here in the September of the previous year.

[1] In my two earlier papers "On the Secondary Rocks of Scotland," published in 1873 and 1874 respectively, I had employed the Murchisonian nomenclature for the older rocks of the Highlands whenever I had occasion

Most completely have these anticipations of Nicol been fulfilled. During the last seven years many of the sections of the Western Highlands have been visited by different geologists, Dr. Hicks leading the way, and not a few papers have been published embodying the results of these new studies of some of the disputed points. Such an able review of this recent work has been lately drawn up by my friend, Prof. Bonney, in his Anniversary Address to the Geological Society, that I need not go over the ground again, but will content myself by referring to that address and to two exhaustive papers read by Dr. Hicks before the Geologists' Association for full details concerning this later work. It will be seen that while new methods of study have enabled them to improve or correct Nicol's petrological nomenclature, the principal conclusions of nearly all these writers concerning the relations of the several rock-masses entirely support his views on the subject.

But very recently Nicol's work has been tested in the way which he himself so earnestly desired. Prof. Lapworth, who, like Nicol, was especially prepared for the task by long and patient study of the crumpled Silurian rocks of the Borderland, taking advantage of the newly published Ordnance maps of Sutherland, proceeded in the summer of 1882 to Eriboll, bent on the task of unravelling the complicated rocks and of mapping them upon the large scale of 6 inches to the mile. Prof. Lapworth's detailed maps and sections were exhibited to the Geological Society on May 9, 1883, during the reading of a paper by Dr. Callaway, in which the views of Nicol also received a considerable amount of valuable support.

In the same year, 1883, a detachment of the Geological Survey of Scotland, under the superintendence of Messrs. B. N. Peach and J. Horne, commenced the detailed mapping of the Durness-Eriboll district. How admirably these gentlemen have performed their task we all know, and I hope that some interesting information concerning their conclusions will be laid before the present meeting. In offering them—as I am sure that I am empowered by you to do—the hearty congratulations of the Geological Section of the British Association upon the auspicious commencement of this great undertaking, I cannot refrain from reminding you that, of the leaders in this important enterprise, one is the son of the discoverer of the Durness fossils, the veteran Mr. Charles Peach to whom we owe so much, while the other is a very active and efficient local secretary of this Section.

Nor should I do justice to my own sentiments on the subject if I failed to bear tribute to the judgment displayed by the present chief of the Geological Survey in his choice of a base from which to attack this difficult problem, to his loyalty in accepting results so entirely opposed to his published opinions, and to his promptitude in making his fellow-workers in geology acquainted with these important discoveries. Unfortunately called upon while still young, and with but little of that ripe experience which he has since gained, to grapple with the most intricate of problems—problems which the most practised of field-geologists might be forgiven for failing to solve—his own judgment yielded, though not without serious misgivings (see "Memoirs of Sir Roderick Murchison" (1875), vol. ii. p. 238) when opposed to the ardent confidence of a companion and friend whose reputation in the scientific world commanded his respect, and whose previous achievements had won his complete reliance. If, like your own Randolph at Bannockburn, he has "lost a rose from his chaplet" at the commencement of this great Highland campaign, we are well assured that the error will be worthily repaired in its subsequent stages.

The conclusions arrived at by Nicol, by Professor Lapworth, and by the officers of the Geological Survey, are, in all their main features, absolutely identical; and the Murchisonian theory of Highland succession is now, by universal consent, abandoned.

In the second of the great controversies to which we have alluded as having occupied the attention of this Geological Section in 1859—that concerning the age and relations of the Reptiliferous Sandstone of Elgin—the combatants were found ranged in quite a different order. Nicol is seen battling shoulder to shoulder with Murchison, Ramsay, and Harkness, in favour of the *Palæozoic* age of the beds in question; while Lyell, supported by Symonds of Pendock and Moore of Bath, is as stoutly maintaining their *Secondary* age.

The finding by Mr. Patrick Duff, in the year 1852, of the little fossil lizard called *Telerpeton*, and the determination of its true nature by Mantell and Owen, constitute a discovery comparable in importance and fruitfulness to Mr. Peach's detection of the fossiliferous character of the limestone of Durness; up to that time no doubt had ever been entertained as to the "Old Red" age of the yellow sandstone of Elgin. For bringing together the remarkable fossils of these rocks, geologists are indebted to the untiring labours of Dr. Gordon of Birnie—whom, full of years and honours, and the object of such universal respect and love as indeed make grey hairs a "crown of glory," we rejoice to have still in our midst. Studying Dr. Gordon's important collections, Professor Huxley was able, shortly before the previous meeting of the Association in this city, to announce that a crocodilian (*Stagonolepis*), and a second lizard of Triassic affinities (*Hyperodapedon*), existed at the period when these beds were deposited, so that even in 1859 the palæontological evidence in favour of the Mesozoic age of these rocks was admitted to be almost overwhelming.

But this evidence has been very greatly strengthened since that date; for Professor Huxley has shown that the genus *Hyperodapedon* is represented in the Trias of Warwickshire, of Devonshire, and of India. In the same reptiliferous sandstone, with its abundant footprints, the teeth of *Ceratodus*, a fish unknown in the Palæozoic rocks, have been found, together with the remains of a reptile which Professor Huxley permits me to state is, in his opinion, probably *Dinosaurian*. I am sure that you will all join with me in the hope that the health of the President of the Royal Society may soon be so far restored that he may be able to return to the examination of these fossil reptiles of Elgin, in the study of which some of the earliest of his great palæontological discoveries were achieved.

The manner in which the yellow sandstones, which have yielded these reptilian remains, are at many different points found associated with beds containing *Holoptychius* and other Old Red Sandstone fish, appeared to many geologists altogether inexplicable on any other hypothesis than that the strata are all of the same geological age.

In spite, however, of these appearances, and the interesting observations of Dr. Gordon and Dr. Joass on the rocks of the Tarbet peninsula, which seemed to support the hypothesis just referred to, I am able to announce that proof of the most clear and convincing character now exists of the distinction between the fish-bearing "Old Red" and the reptiliferous "New Red" of the neighbourhood of Elgin. In the year 1873 I showed that rocks, identical in character with the reptiliferous sandstone of Elgin, and the overlying calcareous and cherty rock of Stotfield, exist on the northern side of the Moray Firth, in the county of Sutherland, and that they there conformably underlie Rhætic and Liassic strata. Very recently Dr. Gordon has added a crowning discovery to his long list of previous ones, by detecting in the same quarry the rocks containing the reptilian and fish remains respectively. I find, however, that while the two series of beds present well-marked differences in their mineral characters, the yellow sandstones with fish remains clearly overlie the undoubted Upper Old Red, and are separated from it by a well-marked bed of conglomerate. In other quarries in the district, the manner in which these two series of strata have been thrown side by side by the action of great faults is very clearly exhibited. I hope that full details of the evidence on this interesting subject will be laid before you during the present meeting.

The facts relied upon by the Palæontologist and the Stratigraphist respectively are thus found to be no longer opposed to one another. By a complicated series of parallel faults, the Devonian and Triassic sandstones, which happen to have a general resemblance in their mineral characters, are found again and again thrown side by side with one another in the Elgin district, so that the error into which geologists fell before the discovery of the distinctive fossils of the two sets of rocks, was a very pardonable one.

A retrospect of these two controversies, now so happily laid at rest, is not, I think, without its uses for the student of Highland geology, for it may serve to furnish him with some useful warnings which are in great danger of being overlooked at the present time.

The discovery of a few fossil remains in strata where they were previously unknown, has completely revolutionised our ideas concerning the age of rock-masses of enormous extent and

to refer to them; but in the third of this series of papers, published in 1878 (*Quart. Journ. Geol. Soc.* vol. xxxiv. p. 660), I had no hesitation in abandoning this terminology for that of Nicol.

thickness. Resemblances in mineral character have been proved not only to have been, at their best, very unsafe guides indeed, but to have actually betrayed those who trusted in them into the most serious errors. But for the discoveries of Charles Peach on the one hand, and of Patrick Duff and Dr. Gordon on the other, geologists would probably still continue to class the sandstones of Torridon and Elgin respectively with the "Old Red."

But perhaps the consideration of greatest importance which is impressed upon us by this retrospect is, that in these Highland districts we must be always prepared to meet with rock-masses of very different geological ages, thrown into puzzling juxtaposition by the gigantic movements to which this part of the earth's crust has been subjected. He who enters on the study of Highland geology without being prepared to encounter at every step complicated foldings, vast dislocations, and stupendous inversions of the strata, can scarcely fail to be betrayed into the most disastrous and fatal errors.

The early history of Scotland is inextricably interwoven with that of Scandinavia. This proposition, true as it is of the insignificant periods of which human history takes cognizance, applies with even greater force to the vast epochs that fall within the ken of the geologist. To us the separation of Scotland and Scandinavia is an event of very recent date indeed; it is not only an accident, but an uncompleted accident! The Scottish Highlands, with the Hebrides and Donegal on the one hand, with Orkney and Shetland on the other, must be regarded—to use a technical phrase—as mere "outliers" of the Scandinavian Peninsula.

We must acknowledge, at the outset, that the study of the geological history of this Scandinavian peninsula and its outliers is a task bristling with difficulties. The problems presented to us in our Scottish Highlands are vast, complicated, and at times seemingly insoluble. But they are precisely the same problems that confront our brother geologists in Scandinavia. And if our tasks, our doubts, our perplexities are the same, we equally share in the advantages and triumphs of discovery.

The geologists of Scandinavia—and right worthy sons of Thor they are—have the advantage of possessing a territory almost limitless in its vastness, and seemingly infinite in its variety. But the very extent of their splendid country, with its sparse population and restricted means of communication, increases the difficulties of their task. "The harvest truly is plenteous, but the labourers are few!" With our smaller area, if we cannot expect so much variety, we may hope to gain something from the number of our students and the greater accessibility of our fields of labour.

Nor would I undervalue, in this connection, the importance of the union of this country with England. I allude, of course, not to events of yesterday, like the Accession of James VI. to the English throne and the Parliamentary Act of Union, but to operations that preceded these by many millions of years! It is no small advantage that a country like Scotland, in which the rock-formations are found hopelessly crushed and crumpled together, or broken into a thousand illfitting fragments that seem to defy all attempts to reduce them to order, should be united to one like England, where, by comparison, all is orderly and simple, the strata lying in regular sequence like well-arranged volumes in a library, and only await the touch of the geologist's hammer to display the wealth of their fossil contents.

The great Scandinavian *massif*, with its outlying fragments, constitutes the "basal-wreck"—to employ Darwin's expressive term—of a great Alpine chain. On other occasions I have endeavoured to show how much our study of the nature and products of volcanic action is facilitated by the existence of similar "basal-wrecks" of volcanic mountains, like those which exist in your beautiful Western Isles. In the same way, I believe we may learn more by the study of this dissected mountain-chain, concerning the operations by which these grand features of our globe have originated, than by the most prolonged examination of the superficial characters of the Alps or the Himalayas.

Here the scalpel of denudation has laid bare the innermost recesses of the mountain-masses, and what we can only guess at in the Alps and the Himalayas, here stands in our own Highlands clearly revealed to view.

It is a well ascertained fact that all the existing lofty mountain-chains have been formed at a very recent geological period. The reason of this it is not difficult to divine. In the higher regions of the atmosphere, the forces of denudation work so rapidly that within a very short period—geologically speaking—the vastest mountain-chain is razed to its very foundations—

> "They melt like mists, the solid lands,
> Like clouds they shape themselves, and go!"

It is not surprising then to find Powell and Gilbert, fresh from the study of the grand mountain-masses of the American Continent, giving expression to these thoughts in the following words: "All large mountains are young mountains, and, from the point of view of the uniformitarian, it is equally evident that all large mountains must be growing mountains; for if the process of growth is continuous, and if a high mountain melts with exceptional rapidity before the play of the elements, it is illogical to suppose that the uprising of any mountain, which to-day is lofty, has to-day ceased."

The Scandinavian Alps were a living and a growing mountain-chain in the far distant Palæozoic period. Now it is not only dead, but stretched on the dissecting table of the geologist—its outer integuments and softer tissues stripped away, and its very skeleton bared to our view—a splendid "subject" for the student of mountain anatomy.

One of the first to recognise this value of our Scottish Highlands to the student of Orographic Geology was the late Daniel Sharpe. He had made himself familiar with many of the characteristic details of Alpine architecture—so far as it was then understood—and was able to show that the foliated masses of our Highland districts exhibit precisely those relations which would be seen if the contorted and fan-like masses of the Alps were planed away by denudation. Nor in suggestions of this kind, as we have seen, was James Nicol far behind Sharpe; but at that time many of the most important features of mountain-structure were unrecognised or misinterpreted, and the conclusions of these geological pioneers were little more than guesses—though very valuable and suggestive guesses—after truth.

It is to our geological brethren over the Atlantic that we are especially indebted, not only for many important discoveries in the mechanics of mountain-formation, but for clearing away many of the clouds of error in which the subject had become involved. To Henry Darwin Rogers, who, after a career of valuable geological work in his native State of Pennsylvania, accepted the hospitality of this country, and spent the last decade of his useful life as Professor of Natural History and Geology in the sister university of Glasgow, must be assigned the foremost place in that school of orographic geologists which has grown up in America.

The first sketch of the important theory of mountain-building to which Rogers and his fellow-geologists were led by the study of the Appalachian chain, was published in 1842, but it was not till 1858 that the complete evidence on which this theory was founded could be published.

The conclusion at which Rogers arrived was, briefly expressed, as follows:—The Appalachian mountains were carved by denudation out of an enormously thick mass of stratified deposits, thrown into a series of parallel wave-like folds. To the westward of the mountain range "the crust-waves flatten out, recede from one another, and vanish into general horizontality;" but towards the heart of the mountain-mass the same flexed strata become greatly crowded together, their "axis-planes," become more and more inclined, till at last their folds, yielding at their apices to the tremendous lateral thrust, fractures twenty to eighty miles in length, and attended with a displacement of 20,000 feet or more, were produced.

Unfortunately Rogers accompanied these just views of mountain structure with certain crude speculations and untenable hypotheses concerning the methods by which they were produced. But in the minds of other American geologists, among whom may especially be mentioned Dana, Le Conte, and Vose—the fruitful ideas of Rogers have undergone development and expansion, while they have received abundant illustration through the labours of that active band of pioneers—the United States Geological Survey—including Clarence King, Powell, Emmons, Hague, Dutton, Gilbert, and many others.

Nor have the brilliant results attained by these investigators in the New World been without their effect on the geologists of Europe. Lory, Suess, Heim, Baltzer, and others have shown that the clue to the right understanding of the structure of the Alps, which had been so diligently sought and so long missed by Von Buch and De Beaumont, by Studer and Favre, was now placed in our hands by the researches of the American geologists.

In Northern Europe, Kjerulf, Dahll, Brögger, Reusch, and other geologists have ably illustrated the same peculiarities of structure in the denuded mountain-chain near the southern extremity of which we are now assembled; and in a recent valuable and suggestive essay "On the Secret of the Highlands" Professor Lapworth has shown how perfectly these structures are exemplified in the western district of Sutherland.

In offering a few remarks on some of the still unsolved problems of Highland geology I shall not hesitate to treat, as belonging to the same geological district, both Scandinavia and Scotland. Not only is the succession of geological deposits in the two areas almost completely identical, but the characters of the several formations and their relations to one another in the one country are almost the exact counterpart of what they are in the other.

The problems which await solution in Scotland are the same which confront our brethren in Scandinavia; their difficulties are our difficulties, their successes our successes; if they share the benefits of our discoveries, we equally partake with them in the fruits of their achievements. Important links in the chain of geological evidence, absolutely wanting in the one area, may perchance be found in the other. Every advance, therefore, which is made in the knowledge of the rocks of the one country, must necessarily re-act upon the opinions and theories which prevail among geologists in the other.

At the base, and forming the foundation of this greatly denuded mountain-chain, there exist enormous masses of highly foliated, crystalline rocks. These, in great part at least, underlie the oldest known, fossiliferous strata, and are therefore of pre-Cambrian or Archæan age. In spite of the labours of Kjerulf, Dahll, Brögger, Reusch, Tornebõhm, and many others in Scandinavia, and of Macculloch, Nicol, and their successors in this country, much still remains to be done in studying the petrographical characters and the geognostic relations of these widespread formations.

Some thirty years ago it was suggested by Sir Roderick Murchison that among these Archæan rocks there exists a "fundamental gneiss," a formation which is the counterpart and contemporary of the rocks in Canada, to which Sir William Logan gave the name of "Laurentian." Since that time other similar attempts have been made to identify portions of these Archæan rocks in the Highlands and Scandinavia with crystalline rock-masses in different parts of the New and Old World.

I confess that, speaking for myself, I am not sanguine as to the success of such endeavours. The miserable failures which we have seen to have attended similar attempts, in the case even of far less altered rocks, where identifications have been based on mineralogical resemblances only (and in connection with which definite palæontological or stratigraphical evidence has been subsequently obtained) ought surely to teach us caution in generalising from such uncertain data. It has been argued that, where palæontological evidence is wholly wanting, and stratigraphical relations are doubtful or obscure, then we may be allowed to avail ourselves of the only data remaining to us—those derived from mineralogical resemblances. But surely, in such cases, it is wiser to admit the insufficiency of the evidence, and to say "We do not know!" rather than to construct for ourselves a "fool's paradise," with a tree of pseudo-knowledge bearing the Dead-Sea fruit of a barren terminology! The impatient student may learn with the blind poet that

They also serve, who only stand and wait.

It is thought by some that the application of the microscope to the study of rock-masses may reveal peculiarities of structure that will serve as a substitute for palæontological evidence concerning the age of a rock when the latter is wanting. Greatly as I value the insight afforded to us by the microscope when it is applied to the study of the rocks, and highly as I esteem the opinions of some of those who hold these views, yet I fail to see that any such connection between the minute structure and the geological age of a rock has as yet been established.

Although the bold generalisation which sought to sweep all the crystalline rocks of our central Highlands into the great Silurian net has admittedly broken down, yet it by no means follows that the whole of these rock-masses are of Archæan age. Nicol always held that among the complicated foldings of the Highland rocks many portions of the older Palæozoic formations, in a highly altered condition, were included (see *Quart. Journ. Geol. Soc.* vol. xix. (1864), p. 184, and "Geology and Scenery of the North of Scotland," 1866). The same view has been persistently maintained by Dr. Hicks, to whose researches among the more ancient rock-masses of the British Isles geologists are so greatly indebted, and also by Prof. Lapworth.

To the settlement of this very important question we may feel sure that the effort of the officers of the Geological Survey will be especially directed. The geological surveyors of Scandinavia have been so fortunate as to detect, in rocks of an extremely altered character, a number of fossils sufficiently well preserved for generic and sometimes even for specific identification. Failing the occurrence of such a fortunate accident, I confess that it has always appeared to me that the disturbances to which these Highland rocks have been subjected are so extreme, and the difficulty of making out the original planes of bedding so great, that but little can be hoped for from general sections constructed to show the relations of the rocks of the Central and Southern Grampians to the fossiliferous deposits of the North-West of Sutherland.

Lying unconformably upon these Archæan crystalline rocks in our North-West Highlands we find great masses of arkose or felspathic grit, with some conglomerates, the whole of these well-stratified deposits attaining a thickness of several thousands of feet. These rocks, in their characters and their relations, so greatly resemble the "Sparagmite Formation" of Scandinavia. that it is impossible to refrain from drawing comparisons between them. The Scandinavian formation, however, includes calcareous and slaty deposits, which are wanting in its Scottish analogue. The "Sparagmites" of Scandinavia, as a whole, appear to underlie strata containing Cambrian (Primordial) fossils, but in the very highest portion of the "Upper Sparagmite Formation" of Southern Norway there have been found, according to Kjerulf, specimens of *Paradoxides*.

The Scottish formation has, on the other hand, yielded no undoubted organic remains. Murchison, on the ground of its unconformable infraposition to his Silurian strata, and its resemblance to certain beds in Wales which he called Cambrian, referred it in his later years to that system. Although an identification, based on such grounds, must be admitted to be of small value indeed, yet the discovery of "Primordial" fossils in the very similar rocks of Scandinavia may be admitted to lend it some slight support. In the present state of our knowledge, however, it is surely wiser to admit that the question of the age of these beds is still an open one, and to call it by the name suggested by Nicol—"The Torridon Sandstone." Kjerulf believes there is evidence that the Scandinavian Sparagmite, in places, passes horizontally into true gneiss, and similar appearances are not wanting in the case of our Torridon Sandstone.

(*To be continued.*)

NOTES FOR THE OPENING OF A DISCUSSION ON ELECTROLYSIS, TO BE HELD IN SECTION B, AT THE BRITISH ASSOCIATION IN ABERDEEN, SEPT., 1885, BY PROFESSOR OLIVER LODGE

I. *WHAT is an Electrolyte?* The question has two distinct meanings:

(*a*) Is a given substance an electrolyte at all; *i.e.* when alone.

(*b*) Is it the electrolyte in any particular case; *i.e.* when mixed with other substances.

In answering (*a*) remember that the fact of bad conductivity does not imply that what there is is non-electrolytic. An electrolyte is one whose conduction is wholly electrolytic. Distinction between metallic and electrolytic conduction. Obedience to Ohm's law shown by electrolytes.

Tests of Electrolytic conduction.
1. Visible decomposition.
2. Polarisation.
3. Non-agreement with Volta's series-law.
4. Transparency.

In answering (*b*) the fact of bad conductivity gives a decided negative, but substances which almost insulate when alone may conduct when mixed; *e.g.* $H_2O + HCl$.

To the question, What is the real conductor when a salt (or acid) is dissolved in water? there are four possible answers:

(1) The salt only,
(2) The water only,
(3) Both the salt and the water,
(4) A hydrate of the salt.

(1) is to be held by those who regard the water as unchanged by the addition of salt

(2) is to be held by those who suppose the water-molecules to be dissociated, or mechanically knocked asunder, by the massive salt-atoms

(3) and (4) are mere modifications of one another, not easily to be distinguished.

In deciding this question (*b*) we really decide what are the primary and what are the secondary products of electrolysis.

Discussion of experimental evidence bearing on the point.

Hittorf's and Buff's experiments on mixed Electrolytes.

Magnus and others on the effect of current-intensity. (With intense currents you are more likely to get the real ions liberated because secondary actions have hardly time to occur).

Direct experiment suggested by observing the place of appearance of free acid; and preliminary reply in favour of (3) or (4).

Valid objection suggested by Smee to regarding any of these experiments as crucial; but possible means of evading the objection.

Experiments of Hisinger, Berzelius and Davy on electrolytes in series sometimes throw light on the question, which are the real ions.

II. *Questions about the "migration of ions." Do ions in salt-solutions travel at different rates? And, in any case, at what rate do they travel?*

Distinction between fused and dissolved compounds.

There being simple experimental evidence that solutions often concentrate near anode and weaken near cathode, or perhaps occasionally *vice versâ*: what is the explanation?

Several possible hypotheses:

(1) Hittorf's that the salt is primarily decomposed and that its ions travel at different speeds.

(2) Hittorf's resort in exceptional cases, that per-salts are electrolysed into sub-salts and radical.

(3) Burgoin's, that a hydrate of the salt is electrolysed and that the water travels mostly with the cation.

(4) D'Almeida's, that a free acid envelop is formed around anode and is electrolysed in series with the salt.

(5) Quincke's, that opposite ions have charges differing in magnitude as well as in sign, and are therefore urged with different forces.

(6) Wiedemann's, that the entire salt molecules electrify themselves by contact with the water and are thus urged bodily either with or against the current.

(7) Kohlrausch's, that every ion has its own definite rate of propagation in a given fluid when urged by a given force; and that this rate is calculable from conductivity, concentration, and migration, data.

(8) Suggested, that opposite corresponding ions must always travel at equal opposite rates, but that in solutions the water may conduct more or less of the current.

Mode in which this hypothesis (8) can explain migration; and limitation to its explanation.

Easy calculation of total or resultant velocity of ions, but difficulty in apportioning the right fraction of this velocity to each ion in accordance with Kohlrausch's theory.

Reasons for supposing it necessary that opposite ions must travel at the same pace.

Wiedemann's, Quincke's, and Helmholtz's theories of electric *Endosmose*, and proof by Wiedemann that it is independent of "migration" phenomena.

Bearing of experiments with electrolytes in series on the question of relative migration velocities; and other suggested migration experiments.

III. *Quantitative Laws of Electrolysis.*

(*a*) Ohm's law of electrolytic conduction.
(*b*) Faraday's two laws,
(1) The voltametric law.
(2) The law of electro-chemical equivalence.

And (*c*) dependence of decomposition EMF on chemical combination-energy.

Nature of experimental evidence in favour of these laws.

Question whether Ohm's law will be exactly obeyed for violent currents. Very important consequences of the law, if exact for feeble currents.

Physical consequences of Faraday's two laws; to be asserted of all substances for which they are accurately true.

Law (1) asserts that no such electrolyte possesses a trace of metallic conduction; *i.e.* that electrolytic conduction and chemical decomposition are precisely correlative. In Helmholtz's words, "Through each section of an electrolytic conductor we have always equivalent electrical and chemical motion." Or again, in other words, with a spice of natural hypothesis (first due perhaps to Ampère), Electrolysis is a kind of electrical *convection* rather than conduction, each atom carrying a charge with it; and the charge conveyed by every atom of a given substance is the same.

Law (2) extends this last important statement to all electrolytes, and enables us to conclude that a definite quantity of electricity belongs to each unit of affinity of every atom of whatever kind, and that fractional portions of such atomic charges are, in electrolysis at least, unknown.

This last is a most astounding statement, for it suggests that electricity may be "atomic" as well as matter.

Calculation of magnitude of this atomic charge; enormous value of it in proportion to size of atoms (10^{-11} electrostatic units, probably, per monad atom).

IV. *Questions concerning Polarisation; and the EMF needed to send a current through an electrolyte.*

The chemical changes which go on in a circuit wholly electrolytic, or in any homogeneous portion of a circuit, are decomposition and identical recomposition, and consume no energy: accordingly no finite EMF is needed to send a current through an electrolyte *when the force is really applied to it*, and Ohm's law is obeyed by electrolytes exactly as by metals.

But at junctions of metals with electrolytes, or of electrolytes with one another, permanent chemical changes may occur, and at these places a finite EMF may be situated; and this may be either negative, when it is called polarisation, or positive, when the whole arrangement is called a battery.

Calculation of such EMFs from thermo-chemical data.

Joule's proof that the heat of chemical action is a secondary result—electric currents being the primary. The EMF (whether positive or negative) of any arrangement is obtained in volts, if the total heat produced by the chemical changes per dyad gramme-equivalent be divided by 46,000.

Total polarisation may be regarded as the sum of two kinds:

(*a*) Temporary polarisation, existing during continuance of current.

(*b*) Residual polarisation, existing afterwards.

(*b*) is caused by a more or less permanent alteration of the surface of the electrodes by the clinging or combined ions.

(*a*) is caused, according to Helmholtz's theory, by a Leyden jar action of the charged atoms straining across molecular distance of the surface of each electrode, and unwilling to part with their charges. When the ions are able to combine with the electrode, or otherwise retain their charges, this (*a*) portion is very small.

Effect of secondary actions in destroying polarisation, and rendering possible a permanent current even when apparently insufficiently propelled. Helmholtz's air-free cell.

Intense currents diminish the amount of secondary action; and also modify maximum polarisation values, raising them above their customary amounts.

V. *Mechanism of Electrolytic Conduction.*

Electrolytic conduction is certainly a convection of Electricity by atoms of matter; but concerning the mode in which the atoms make their way through the fluid there are several hypotheses:

(1) The molecular chain of Grotthus; modified and accepted by Faraday and many others, modified further by Hittorf to explain migration.

(2) The dissociation hypothesis of Clausius and Williamson; virtually accepted by Maxwell, modified by Quincke to explain migration, and shewn by Kohlrausch to explain the facts of conductivity.

(3) The electrostatic hypothesis of Helmholtz.

Because Ohm's law is obeyed, it is certain that no polarisation can exist inside a homogeneous electrolyte: in other words, there is no *chemical cling* of the atoms there, but only a frictional rub. Wiedemann's view that conductivity is inversely proportional to ordinary viscosity.

Probable independence of conductivity and tenacity of combination. Such facts as these, if well established, render necessary *some form* of dissociation hypothesis.

A Grotthus chain of quite *equidistant* atoms might serve, instead of actual dissociation, or a momentary dissociation would be sufficient; but no hypothesis which involves a tearing asunder of molecules in the *interior* of a homogeneous electrolyte can be permitted.

Herein lies the great distinction between electrolytes and dielectrics.

Hypotheses (1) and (2) may be held in either of two forms:

(*a*) The electrical influence of the electrodes may be supposed to reach every molecule of the fluid. This was Grotthus's form of (1), and is Quincke's form of (2).

(*b*) The electrical influence of each electrode may only extend within molecular distance of its surface, while the adjustments occurring in the main body of the fluid are effected by ordinary diffusion. This was probably Faraday's form of (1) and it is Maxwell's form of (2).

Helmholtz's hypothesis (3) emphasises the (*b*) aspect of the matter by appealing to electrostatic interactions of the atoms to maintain uniformity of composition. And within a range of 10^{-8} centimetres of each electrode there is supposed to exist an ordinary electrostatic strain, like that in an ordinary dielectric condenser plate.

The great magnitude of the atomic charges explains the feebleness of the difference of potential required to effect decomposition on electrostatic principles. And the same thing suggests a mainly electrical theory of chemical affinity.

To separate an atom from its charge requires expenditure of work, hence Helmholtz's theory of a specific attraction between matter and electricity, which he uses to explain Volta's "contact force," the charge of atoms in a molecule, frictional electricity, and many other phenomena.

VI. *Addenda.*

Calculation of EMF needed to effect decomposition—
(*a*) of a dielectric,
(*b*) of an electrolyte,
on electrostatic principles.

Suggested theory of disruptive discharge.

Possible distinction between chemical compounds and molecular aggregates.

Discussion of various phenomena from the point of view of a possible "atomic" theory of electricity.

NOTES

SINCE our last issue Dr. Harting, of the Dorpat Observatory, has announced an apparent variation in the great nebula of Andromeda, which has caused some excitement in the astronomical world. As represented in all our drawings, and, still better, in a photograph which Mr. Common was fortunate enough to obtain last year, the centre of the nebula appeared to be only moderately condensed. There was no star or stellar point. Now, on the contrary, there is a most unmistakable star of the eighth or ninth magnitude. The question is, is this a *stella nova* in the line of sight of the nebula, or has the phenomenon been produced by a new condensation in the centre of the nebula itself? Opinion inclines to the latter view, as, according to some accounts, other accompanying changes have been seen with large instruments, &c. But, on the other hand, spectroscopic evidence that the apparent nebula is not a very distant cluster is absent. By our next issue we may hope for a large harvest of telescopic and spectroscopic observations of this new object.

THE International Congress of Schoolmasters was opened in the Grand Theatre at Havre on the afternoon of the 6th instant, Mr. Goblet, the Minister of Public Instruction, presiding.

THE Severn tunnel has now been completed, and on Saturday last a train containing officials and their friends passed through it from end to end.

A CASE of Asiatic cholera has occurred at Cardiff. A labourer, loading a vessel which had recently arrived from Barcelona, drank water which had been put into a cask at that port, and which was described by the medical inspector as totally unfit to drink, having the appearance of discoloured milk, and being putrid. The man died in a few hours of Asiatic cholera.

ON August 25 and subsequent days was held in Turin the International Congress of Alpine Clubs. The principal topic of discussion was the better management of refuges erected in different parts of the Alps, new regulations for guides, and pensions to be granted to them. The honorary president was the King of Italy, His Majesty being represented by M. Loyi; the acting president was Prof. Ferrati. The readings of minimum and maximum thermometers were also collected and discussed. Several excursions took place at the close of the session.

THE German Meteorological Society met for its third congress at Munich last month. Prof. Bezold, of Munich, who delivered the address of the meeting, took for his subject "The Advances of Meteorology during the last Ten Years," dwelling mainly on the alterations made by the introduction of the synoptical method in connection with telegraphy.

THE eleventh *Bulletin* of the United States Geological Survey is a paper on the quaternary and recent mollusca of the Great Basin, with descriptions of new forms, by Mr. R. Ellsworth Call, with an introduction containing a sketch of the quaternary lakes of the Great Basin, by Mr. G. K. Gilbert.

REPEATED severe shocks of earthquake have occurred in the south-east of Lower Austria and in the north of Styria, and have been followed by further shocks in Bonia, described as moving from east to west.

WE have received Prof. Holden's account of the progress of astronomy in 1884, and Prof. Rockwood's account of vulcanology and seismology for the years 1883 and 1884, reprinted from the Smithsonian Report for 1884; also Mr. Albert Williams's report on placer mines, and mining districts, from the report of the tenth census of the United States on the statistics and technology of the precious metals.

THE programme of the technological examinations of the City and Guilds of London Institute for the Advancement of Technical Education for the session 1885-86 has been published. It contains a detailed syllabus of the examinations for the different grades on each subject, and copies of recent examination papers. It is to be obtained at the offices at Gresham College, and at Exhibition Road.

MR. G. J. SYMONS, who has examined the trees recently damaged by lightning in Richmond Park, has communicated the results of his observations to the *Times*. They are two of a group of oaks in the eastern part of the park, slightly south-west of, but very near, the White Lodge. They were fine trees, their girth at 3 feet being 11 and 12 feet respectively; the trunks are 23 feet apart, and one is nearly due north of the other. There are three other trees quite close to them (within 40 feet), which are uninjured, except by the branches which were thrown upon them. The injury to one tree, though fatal to it, is unimportant, but the other tree affords a tremendous instance of disruptive power. It appears to have been cut through horizontally at about 3 feet above the ground; the upper portion shows comparatively little injury, but the lower part is not merely stripped of its bark, but burst open in a very intense way; spikes of the stem, several inches thick and 10 to 15 feet long, stand out from the trunk somewhat like the ribs of an umbrella before it is fully opened, and grip between themselves and the centre of the trunk branches which fell from the upper part before they had time to reclose, while the ground for perhaps 200 feet around is strewn with the bark and fragments of the trunk, from scraps like lucifer-matches to pieces which some men could not lift. From this state of facts Mr. Symons suggests some problems: Why one tree rather than another should be struck if it be not the tallest? why, as in this case, the wreck of one tree is greater than that of the other 23 feet away? what produces this disruptive force? &c. A curious question is, Why oaks and elms are especially liable to be struck? It was stated in 1787 that the elm, chestnut, oak, and pine were the trees most often struck in America; in 1860 Mr. Symons himself stated, in a paper read to the British Association, that the elm, oak, ash, and poplar were the most frequently struck in this country. The last number of *Das Wetter* of Magdeburg contains an abstract of ten years' records of trees injured; 265 are reported, and of these 165 were oaks; the only other trees of which the number was more than trifling were: Scotch firs, 34; pines, 22; and beeches, 20. It has been suggested that the frequency with which oaks are struck is due to the presence of iron in the wood.

It is strange to contrast the weather which we have had during the summer in England, and indeed in Western Europe, with that prevailing in China, Japan, and the rest of Eastern Asia. While here it has been exceedingly dry, with as a rule a hot sun during the day, in Japan it rained almost without intermission throughout June and July, and the sun was rarely seen. It has been in fact a season of unusually heavy rainfall; while with us the reverse has been the case. When the latest mails left, landslips and inundations were of daily occurrence. Between Yokohama and Tokio the railway line was blocked in several places by masses of earth which had fallen, a great part of the country was under water; and the same reports come from Osaka in the south of the main island. Here the water invaded the line, washing away the ballast, and rendering passage impossible; the inundations had rendered many people homeless, and great distress prevailed in many places. The same story comes from China. In the south, in the Kwangtung province, the rivers which debouche at Canton had become swollen with the constant rains, overflowed their banks, and spread desolation far and wide. Whether there is any connection between the extreme dryness here and the extraordinary rains in the far East, and whether either, as has been suggested, has any connection with the unusual seismic activity prevailing at present, must be left to meteorologists to determine; but as this activity, whether, as volcanic eruptions or as earthquakes, appears impartially distributed all over the globe, from Hungary to South America, from the Eastern Archipelago and Japan to Cashmere, it is not easy *primâ facie* to see how it could be the cause of, or have any connection with, such strikingly different phenomena in different parts of the Old World.

THE *Auk* (vol. ii. Nos. 2, 3), published at Boston for the American Ornithologists' Union by Messrs. Estes and Lauriat, continues to furnish evidence of the great activity with which ornithology is prosecuted in North America, though the students of that branch of science still affect rather the particular than the general, much as did most British ornithologists some thirty years ago, and as many do now. This perhaps is only to be expected, and since the avifauna of North America is so enormously larger than that of the British Islands, the condition may very likely last longer there than here. Nearly every paper in these two numbers (for April and July of the present year)—reviews of books apart—refers only to the birds of the Nearctic Region or Sub-region; but most of them seem to the eye of a European to be good of their kind. It looks as if the nomenclatural paroxysm, which lately afflicted our esteemed brethren in the United States, were gradually passing away, and we trust that they will then have time to apply their energies to more important subjects. Dr. Stejneger, however, has a fifth series of his "Analecta Ornithologica." His views are in the main so entirely in accordance with what has generally been held in England to be orthodox, that we cannot object to his labours, whatever be the trouble they may cause; and we greatly regret the rare occasions in which we think him mistaken. One of them is in his present paper (pp. 183, 184), where he strives, and we consider fails, to make out that the generally accepted name of *Scops* for a genus of Owls ought to be dropped. Because Brünnich in 1762 turned Brisson's *Scopus* into *Scops*, the latter term was obviously not thereby established; and the former being, as Brisson tells us (*Ornithologie*, v. p. 503), his own coinage from the Greek σκιά (*umbra*) properly a shadow, but taken by him to mean also the colour umber—a signification it seems never to have possessed—it is a wholly different thing from the classical σκώψ, which has always meant an Owl of some sort. Thus the two words are absolutely distinct, and Brünnich can be only regarded as having made a misdirected attempt at grammatical emendation. We therefore hold that even the ornithologists of America, who recognise Brünnich's generic names (which the ornithologists of Europe in general do not), will be fully justified in retaining the name *Scops* in the sense in which Savigny used it. Dr. Merriam has a notice (p. 312) headed "The eggs of the Knot (*Tringa canutus*) found at last!" but we must beg leave to remind him that sixty-five years ago this bird was found to breed abundantly on the Parry Islands, and, though admittedly no eggs are now forthcoming in collections, it has always been understood that specimens were then brought thence. It does not now appear that Lieut. Greely brought home any, though we trust he may have done so; but if he did not we are much in the same position as before in regard to that oological *desideratissimum*. Mr. Ernest E. T. Seton has a letter (p. 316), admirable for its common sense, on "The popular names of Birds," which in a new country, inhabited by English-speaking men and women, is by no means a matter to be neglected. We have to congratulate Mr. Allen on his promotion to the Curatorship of the Central Park Museum in New York City, and Mr. Brewster on succeeding to the appointment at Harvard University thereby vacated. Both these gentlemen are so well known by name to English ornithologists, that it is quite unnecessary to point out their eminent qualifications for the posts they now respectively hold, and we hope will long continue to enjoy. The name of Dr. Coues does not appear as a contributor in either of these numbers, which fact is, we suppose, attributable to his departure westward, where we trust he will continue those field-observations for which he became distinguished so long ago. We miss also any important communication from Dr. Shufeldt. Migh we venture to suggest that the quantity of small type used in this excellent journal is rather trying to some eyes? It unfortunately happens that even ornithologists are not exempt from some of the bodily inconveniences of advancing years, however young they may continue mentally; and at present the volume of the *Auk* is not so obese but that it might wax fatter without losing its volant powers.

COL. YOLLAND, C.B., F.R.S., one of the Inspectors of Railways under the Board of Trade, died on Friday last at Baddesley Vicarage, Atherstone, Warwickshire. He was born in 1810, was admitted into the Royal Military Academy, and obtained his commission in the Royal Engineers in 1828. He rose by regular promotion until he became lieutenant-colonel in 1855, and a brevet colonel in the army in 1858. After being employed in Canada till 1835, he was employed successively at the Ordnance Survey at the Tower of London, at Southampton, Dublin, and Enniskillen. During this interval he superintended the publication of astronomical observations, first those made with Ramsden's zenith sector, and afterwards with Airy's, the latter observations being for the purpose of determining the latitudes of various trigonometrical stations in Great Britain and

Ireland. He also compiled an account of the measurement of the Loch Foyle base, which was made during the years 1827–29. The article on geodesy, which forms part of the mathematical text-book used at the Royal Military College, was written by Col. Yolland. In 1854 Col. Yolland was appointed one of the Inspectors of Railways under the Board of Trade. In 1856 he was selected as the engineer member of the Commission appointed by the Secretary of State for War to consider the best mode of reorganising the system of training officers of the scientific corps, with the special intention of abolishing patronage and opening the commissions in those corps to competition. The Commissioners, the other two of whom were Col. W. J. Smith, R.A., and the Rev. W. C. Lake, visited France, Prussia, Austria, and Sardinia, and, after studying the methods of appointment in use in those countries, drew up a report, which was printed by order of the House of Commons.

DR. SCHOMBURGK's Report on the Progress and Condition of the Botanic Garden and Government Plantations in South Australia for the year 1884, which is dated from the Botanic Garden, Adelaide, in March last, gives, as usual, a good deal of interesting matter on the cultivation of useful plants. The co-operation, which has of late years been so much extended between the botanic gardens in all our colonial and foreign possessions, has been the means of inciting the several directors to increased energy in the development of new resources and the interchange of valuable plants, so that matter of a similar character, or treating of the same plants, often appears in reports from gardens widely separated geographically from each other. Thus we find in the report before us notes on the suitability or otherwise for Australian culture of many plants that have been similarly reported on from other parts of the world. Amongst those reported upon by Dr. Schomburgk may be mentioned mustard, rape, sesamum, ground nut, tobacco, hops, canary seed, chicory, capers, esparto, &c., &c. Speaking of esparto grass (*Macrochloa tenacissima*), which is a native of Spain, Portugal, and North Africa, and is, we are reminded, exported into England alone to the amount of 140,000 to 150,000 tons a year, so that it is becoming scarcer every day, and consequently fetching higher prices, Dr. Schomburgk says: "Considering the similarity of our climate with that of Spain, I endeavoured to introduce this valuable grass into the Colony, which, after many difficulties, I succeeded in accomplishing, and I have not been disappointed in its acclimatisation in South Australia. The grass which I have now cultivated for the last five years grows admirably with us, notwithstanding the most severe droughts we have to contend with. It is propagated by seed. The question will naturally be asked, 'Suppose we succeed in growing the grass here, where shall we find a market for it?' Our enterprising and go-ahead neighbours in Victoria have already established two paper mills, and I understand Sydney also possesses one, so that, if we succeed, the market for the grass is close at hand, and I think it would even pay to export the grass to England, as by means of hydraulic pressure the bulk would be considerably reduced." Another industry which seems to promise well in South Australia is the production of sumac, which consists of the powdered leaves and twigs of *Rhus coriaria* and *Rhus cotinus*, shrubs of the Mediterranean region, and grown largely in Southern Europe for the sake of the leaves. Dr. Schomburgk says both plants grow in the Adelaide Botanic Garden, and the climate seems to suit them; he recommends, however, that trials should be made to ascertain whether they would thrive in poor or sandy soil. On this subject the British Consul at Palermo, in the neighbourhood of which the best sumac is grown, says the soil best adapted for the plant is that of a sandy nature. It is propagated by cuttings. The bulk of the sumac is shipped from Palermo to various countries, but principally to the United States. A catalogue of plants added during 1884 to the collection under cultivation at the Botanic Garden is given in the form of an appendix.

IT was hardly to be expected that the season should pass without the appearance of the sea-serpent somewhere, and if we are to believe the information forwarded to us from a correspondent in Norway, it has just visited the coast of Nordland. Three Sundays ago some lads were returning to the Island of Röd from the church at Melö, in the middle of the day, when they saw far out in the fjord a streak in the sea, which they believed to be a flock of wild ducks swimming. On proceeding further, however, they heard the whizzing as of a rushing fountain, and in a few moments perceived a great sea-monster with great velocity making straight for the boat. It appeared to be serpentine in shape, with a flat, scaly head, and the lads counted seventeen coils on the surface of the water just as it passed the stern of the boat so closely that they could have thrown a boat-hook into it. By subsequent measurements on land the length of the animal was estimated at about 200 feet. It pursued its course on the surface of the sea until close behind the boat, when it went down with a tremendous noise, but reappeared a little after, shaping its course for the Melö, where it disappeared from view. Naturally the lads were greatly frightened. The weather at the time was hot, calm, and sunny. Our informer states that the lads are intelligent and truthful, and that there is no reason to discredit their unanimous statement, made, as it were, in a terribly frightened condition. It might be added that the waters in which the animal was seen are some of the deepest on the Norwegian coast, and that it is not the first time fishermen have averred having seen the sea-serpent here. The existence of the sea-serpent is fully believed in along the coast of Norway.

WE have received the *Journal* and *Proceedings* (vol. xviii.) of the Royal Society of New South Wales for 1884. Besides the President's address, it contains several papers, reports of the various meetings, an abstract of the meteorological observations at the Sydney Observatory, and a rainfall map. Amongst the papers we find one on the removal of bars from the mouths of rivers, by Mr. Shellsbear; on some New South Wales minerals, by Prof. Liversidge; on the oven-mounds of the aborigines of Victoria, by Mr. MacPherson; on a new form of actinometer, by Mr. Russell; on the water supply of the interior of New South Wales; and shorter papers on gold, on the trochoided plane, on doryanthes, &c., Mr. Caldwell's paper on the embryology of the marsupiala, monotremata, and ceratodus.

WE have to acknowledge a copy of the English translation of the paper read by Messrs. Thorell and Lindström to the Royal Swedish Academy of Sciences, on the Silurian scorpion found in Gothland (NATURE, vol. xxxi. p. 295). It is published by Norstedt and Sons, Stockholm.

THE ceremony of the Chevreul centennial has been postponed until January 1, 1886. To give more solemnity to the celebration all the Paris students will be present at the *fête;* now most of them are in the provinces or abroad. The health of M. Chevreul continues excellent, and the delay is not likely to prove an obstacle to the ceremony.

PROF. DOOLITTLE, of the Lehigh University, Pennsylvania, has published a treatise on practical astronomy, as applied to geodesy and navigation (New York: Wiley; London: Trübner). It is intended as a text-book for universities and technical schools, and as a manual for the field astronomer. The object has been to present in a systematic form the most approved methods in use at the present time, and these are illustrated by complete numerical examples. In the introduction the method of least squares is developed with special reference to the requirements of this particular class of work.

NEARLY all the ironworks at Pittsburgh, besides some forty iron firms within a radius of thirty miles, are now using the natural gas of the district, as are also most of the glass factories, distilleries, breweries, &c. This is creating an entire revolution in the labour market there. The output of iron and steel at Pittsburgh is about 750,000 tons per annum, and as it takes some 50 bushels of coal to make one ton of iron, it follows that at least 38,250,000 bushels of coal will be dispensed with in the yearly consumption, throwing out of employment an enormous number of miners, firemen, ashmen, roadmen, and other *employés* of the collieries. The cause of this great change being entirely one of nature's arrangement renders it an impossibility for trade unions and labour agitators to deal with the matter.

WE have received the *Report* and *Proceedings* of the Bristol Naturalists' Society for the year ending April 30 last. The principal paper is a long one, with illustrations, by Prof. Lloyd Morgan, on sub-aërial denudation and the Avon gorge, in which he has worked out in detail the subject of the influence of geological structure on the scenery of the Avon, more particularly of that section of the Avon basin lying between Bristol and the Channel. There are also papers on the mapping of the millstone grit at Long Ashton near Bristol by the same writer, on a common fin whale stranded in the Bristol Channel by Mr. Wilson, and on the newly-discovered phenomenon of apospory in ferns by Mr. Druery. There are also papers on the rainfall at Clifton in 1884, and meteorological observations with regard to temperature during the same year. Finally Mr. Bucknall prints the eighth part of his fungi of the Bristol district, and Mr. White additions to his *flora* of the Bristol coal-field. The report shows that only a portion of the papers read are printed. Perhaps it is right to add in conclusion that the society is in a flourishing financial condition, for it has not only a comfortable balance on the right side of its current accounts, but has actually a capital to the amount of 17*l*. 10*s*. invested in securities.

A REPORT from the Government Astronomer in the *Hong Kong Government Gazette* upon the progressive motion of typhoons gives the following average velocities. The course of the typhoon is here followed from its commencement on the east coast of Luzon, the cradle of the typhoons of the China seas, into the Sea of Japan, beyond which they are dissipated and lost in the North Pacific :—

	Nautical miles an hour
East of Luzon	7
China Seas between 12° and 18° N.	6
China Seas between Hong Kong, Luzon, and Southern Formosa	11
About Hainan	13
East of Formosa	10
In Southern China: Kwangtung, Fokien, and Kiangsi	10
In the Formosa Straits	12
About Shanghai	12
In Northern China	23
About Japan	19
In the Sea of Japan	30

DR. NICKERSON, of New York, has published as a pamphlet the memorial address by him on Joseph Henry and the magnetic telegraph, delivered at Princeton College. It is printed at the request of the President and members of the College, and is published by Charles Scribner and Sons, of New York.

WE have to acknowledge Mr. G. J. Symons's "British Rainfall" for 1884. The issue for 1860, in four pages, is reprinted and bound with the volume, and is interesting as the beginning of the elaborate work which Mr. Symons now publishes every year. The present volume differs from its predecessors, inasmuch as it contains no articles from observers upon experimental or other branches of rainfall work; but their place has been supplied by notes by the editor scattered throughout the book. He has invited observers to report any facts within their knowledge bearing on the effect produced upon the level of water in wells, &c., by the small rainfall of the year. Consequently observers' accounts occupy a considerable space. Mr. Symons has added a full account of the drought.

WE have received the report of the *Verein für Naturkunde* of Mannheim for the fiftieth and fifty-first years of its existence. The report contains the jubilee address, and also a lecture delivered by the late Dr. Schimper in the year 1834, on the classification and succession of organisms, together with a brief biography of the author and a bibliography of his writings.

THE additions to the Zoological Society's Gardens during the past week include a Purple-faced Monkey (*Semnopithecus leucoprymnus*) from Ceylon, presented by Mr. Ernest Greathead; a Weeper Capuchin (*Cebus capucinus* ♂) from South America, presented by Mrs. A. Sinclair; a Ring-tailed Coati (*Nasua rufa* ♂) from South America, presented by Master J. C. Robinson; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♀) from South Australia, presented by Mr. C. W. Holden; a Levaillant's Cynictis (*Cynictis penicellata* ♀), a Suricate (*Suricata tetradactyla* ♀) from South Africa, presented by Mr. John Constable; four Black Water Voles (*Arvicola amphibius*) from Scotland, presented by Mr. W. Arkwright, F.Z.S.; a White-backed Piping Crow (*Gymnorhina leuconota*) from South Australia, presented by Miss A. Charsley; a Poë Honey-eater (*Prosthemadera Novæ-Zealandiæ*) from New Zealand, presented by Mr. Charles Clifton, F.Z.S.; a Humboldt's Lagothrix (*Lagothrix Humboldti*) from the Upper Amazons, a Glutton (*Gulo luscus*) North European, deposited; a Jaguar (*Felis onça*) from America, deposited; two Long-fronted Gerbilles (*Gerbillus longifrons*), two Snow Birds (*Junco hyemalis*), five Common Vipers (*Vipera berus*), thirty Striped Snakes (*Tropidonotus sirtalis*) bred in the Gardens).

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, SEPTEMBER 13–19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on Sept. 13

Sun rises, 5h. 34m.; souths, 11h. 55m. 44·2s.; sets, 18h. 18m.; decl. on meridian, 3° 38′ N.: Sidereal Time at Sunset, 17h. 50m.

Moon (at First Quarter on Sept. 16) rises, 10h. 52m.; souths, 15h. 50m.; sets, 20h. 42m.; decl. on meridian, 13° 54′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 6	10 56	17 46	9 5 N.
Venus	8 49	14 3	19 17	9 52 S.
Mars	0 27	8 30	16 33	21 31 N.
Jupiter	5 10	11 45	18 18	5 56 N.
Saturn	22 53*	7 1	15 9	22 22 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Sept.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
19	13 Capricorni	6	20 4	21 23	122 272
19	14 Capricorni	5	21 33	22 41	151 273

The Occultations of Stars are such as are visible at Greenwich.

Sept. h.
18 ... 19 ... Mercury at greatest elongation from the Sun, 18° west.

ASTRONOMICAL NOTES

NEW COMET.—A new comet, discovered by Mr. Brooks, has been observed by Mr. Wendell, of Harvard College Observatory, and Mr. Ainslie Common, of Ealing. On Friday night its approximate position was R.A. 13h. 53m., and N.P.D. 52° 20′. Its R.A. is increasing and N.P.D. decreasing; diameter, 9 minutes of arc, and getting brighter.

NEW MINOR PLANET.—On the evening of the 3rd inst. Herr Palisa, of Vienna, discovered a minor planet, thus bringing the number of these bodies to 250. The following are the particulars of the discovery:—September 3, 9h. 53s. (Greenwich mean time); right ascension, 23h. 34m. 44s.; north polar distance, 106° 9′ 35″; daily motion in right ascension, 48s. decreasing, in polar distance 3′ increasing; magnitude, 11th.

GEOGRAPHICAL NOTES

THE Caroline Islands, which are attracting so much political attention now, are described at some length in the *Gazette Géographique*. It is generally acknowledged that they were discovered by a Portuguese navigator in 1526, and during the rest of the sixteenth century they were frequently visited by Spanish and Portuguese explorers. They were called the Carolines about 1686 by a pilot named Lezcano, who saw many islets there, but could not tell to what group they belonged, or indicate their exact position. The name was given to them after Charles II.; they have also been called the New Philippines, but this has never prevailed. Towards the end of the seventeenth century the Spaniards in the Philippines and Mariannes learned something of the Carolines, and in 1705 an imperfect map of the group was sent to Pope Clement XI., and then the Jesuits of the mission at Manila resolved to establish a branch in the Carolines. In 1710 the missionaries and a few soldiers set sail, but on arriving at the Pelews were all massacred. Up to 1817 the Carolines were visited by navigators of all nations, but the number of the islands, their exact position, and the hydrography of the seas in which they were situated, was totally unknown. In that year Kotzebue, and subsequently Freycinet, Duperrey, Dumont d'Urville, and others, visited the whole of the Archipelago, and from them we got our first accurate accounts of the Carolines and their inhabitants. The Caroline archipelago forms part of Micronesia, and is situated to the south of the Ladrones, to the west of the Marshalls, and to the north of New Guinea. It consists of about 500 islands, of which the greater number are only *atolls*. The number of real islands is only forty-eight, but as each of these is surrounded by a certain number of islets, it may be said that the archipelago consists of forty-eight groups; forty-three of these are low coral islands, while five are composed of basalt with coral at the base. The superficial area over which the archipelago is spread is about forty-five square leagues. Geographically it may be divided into three main groups, separated by two large channels: the eastern group, of which the principal island is Ascension or Ponape; the central group, and the western group, the principal island being Eap or Jap, of which much is being heard just now. Ponape is between 50 and 60 miles round, and has a peak in the centre which rises to a height of 2860 feet. At one part of its coast there are curious ruins which are still a problem for ethnologists; they are apparently the remains of a large building constructed of huge blocks of basalt. The archipelago, although close to the equator, enjoys a temperate climate; there are two rainy seasons—one in January, the other in August. The islands are of astonishing fertility; the principal productions are the bread-fruit, cocoa-nut, the palm, bamboo, orange, and clove tree, sugar-cane, beetle, sweet potato, &c. The population is generally estimated at 18,000 to 20,000, and belongs ethnologically to the Micronesian family. The principal elements are Malay and Maori; but there is also a mixture of Negrito and Papuan, to which in later times was added a Chinese and Japanese element. The language is as mixed as the race; the grammatical constructions are the same as those of the Maori, but Malay influence is also evident. In some of the islands there are two languages, as in Java—the vulgar and polished. They have no religion properly so-called; they believe in spirits, which are the souls of their deceased ancestors, and they have a great respect, a kind of cult for their dead, whom they preserve till the body falls to pieces. As in all the islands of the Pacific, *tabu* is practised. Each group of islands is governed by a chief or king. His power in time of peace is purely nominal, but he enjoys the respect of all; but in the frequent bloody wars his authority is unbounded, and all submit blindly to his will.

THE Pelews or Palaos Islands are quite distinct from the Carolines; they are the most western islands of Micronesia, and are situated about 600 miles east of the Philippines. The archipelago consists of ten principal islands and a number of islets. The principal one, called Babelthuap, is 30 miles long, the southern part being very mountainous. All the islands are covered by thick forests, the trees of which are used by the natives to construct their large canoes. Besides the yam and the cocoa-nut there are also bananas, oranges, and a large number of nutritious roots. The population is about 3500 souls, belonging to a race which is quite distinct from the Caroline Islanders. They present all the characteristics of the Malay and Papuan races, and are probably the result of the mixture of a superior Malay tribe with an inferior aboriginal people. Old travellers speak very well of these natives: they are said to be in every way superior to the inhabitants of the Caroline Islands. Here also there are two languages: one for addressing superiors, the other inferiors; possibly it would be more correct to say that there is only one language, with copious honorific forms. The king has instituted an order, which he gives or withdraws at his pleasure: the insignia is the first cervical vertebra of the fish *dugong*.

THE *Rundschau für Geographie und Statistik* for September reproduces a forgotten discourse of Alexander von Humboldt. It was never published, although it was privately printed for the use of the members of the Society before whom it was delivered. It deals with the primitive peoples of America and the monuments which they have left behind them, and was delivered before the Philomatic Society of Berlin in January, 1806; that is a few months after his return from his travels. It had grown to be a bibliographical curiosity; part of its contents was afterwards reproduced in his "Ansichten der Natur" and "Vues des Cordillères," and later investigations have materially altered some positions taken up; but the discourse is otherwise very interesting, especially after its disappearance for nearly eighty years.

CONTENTS

THURSDAY, SEPTEMBER 17, 1885

THE NEW STAR IN ANDROMEDA

We have received the following important communications from Lord Rosse and Dr. Huggins relating to the new star. Whether the star be connected with the nebula or not, during the last week evidence has been brought forward that it has changed both its brilliancy and position with regard to the nucleus. This question of change of position is of the highest importance, for arguments were advanced in this journal (NATURE, vol. xvi. p. 413) on the occasion of the outburst of the stella nova in 1866, which suggested that a body which reduced its lustre so rapidly could have no very great mass, and that therefore it might not be so very remote.

Dr. Huggins is able to decide between the different statements which have been published as to the spectrum of the star: he has little doubt as to the existence of bright lines between D and *b*. This endorses Lord Rosse's observation which we printed last week.

SINCE my communication of September 8 our books have been searched for information on the past history of the nucleus of the Andromeda nebula. I subjoin in full the entries bearing upon the question whether the "new star" is now seen for the first time, or is a variable now shining out with abnormal brilliancy. The latter would appear to be the case. The nebula was frequently observed in past years with the 6-foot reflector and measures made. These measures being too few in number for a proper survey of the nebula, publication was postponed in 1878, and the details of configuration of the nebulosity have not appeared such as to merit a monograph. ROSSE

September 12

The Great Nebula in Andromeda as observed at Birr Castle with the 6-foot Reflector

1848, December 13.—Three new stars seen near nucleus. Others stars at moments suspected in large nucleus.

1848, December 15.—Confirmed previous night's observations about the three stars *n n f* of nucleus.

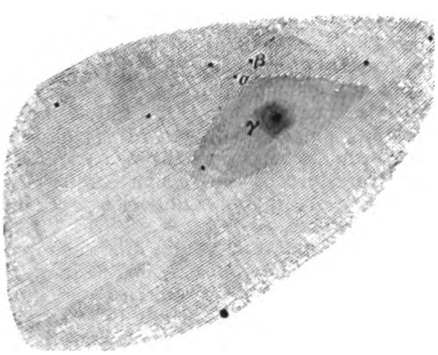
1851, October 25.—[On a rough sketch accompanying micrometrical measurements the nucleus is indicated by a point].

1852, September 16.—Nucleus looked very sharp. Had suspicion of a point in centre of nucleus of large nebula which formed one angle of a quadrilateral of which the other three are small stars to the left.

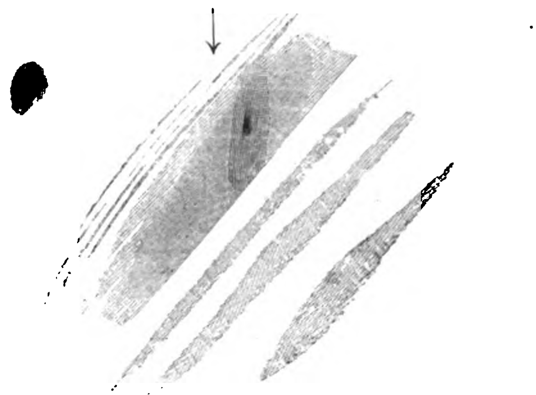
1855, October 15.—With higher power several stars become visible about the nucleus. Nucleus itself suspected at moments to be resolvable.

1856, October 28.—I observed the nucleus attentively for a long time, and I thought I could at times see stars along its north edge, but I am not very confident about it.

1857, October 16.—The higher power of single lens brings out a great many very faint stars around the nucleus. α seen steadily, β seen by glimpses and I suspect a star in the neighbourhood of γ. The sketch represents the central portion of the nebula. [A point is indicated in the centre of the nucleus.]



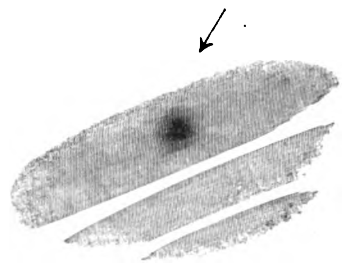
1860, October 19.—I think the nucleus is extended as in accompanying sketch.



1860, November 13.—[A sketch was carefully made, which is almost identical with the sketch of 1860, October 19, showing the extension of the nucleus very plainly. No point is indicated in the centre of the nucleus.]

[In 1861 and 1862 numerous micrometrical measures were taken, accompanied by rough sketches, showing the nucleus as a diffused nebulous patch, either round or slightly extended as on 1860, October 19.]

1871, October 7.—A rough sketch was made [showing the nucleus round and rather distinct.]



1872, August 7.—Nucleus very distinct on ground of nebula.

1877, November 2.—Nucleus extends in same direction as nebula; immediately following the nucleus the nebulosity decreases quickly in brightness, more so than on preceding side.

THE star was observed here first on the night of the 3rd inst. It presented the appearance of an orange-coloured star of from the 8th to the 9th magnitude. With a spectroscope of low dispersive power a continuous spectrum was seen from about C in the red to a little beyond F. There was an apparent condensation of light from about D to *b*, which might be due to bright lines in that part of the spectrum. This supposition was strengthened by the employment of a more powerful spectroscope, but I was not able to be certain on this point.

On the 9th the star, which was then distinctly on one side of the principal point of condensation in the nebula, appeared to me to have a less decided orange tint. It presented an appearance in the spectroscope similar to that which it had on the 3rd, with the exception that the light was less strong about D. I was so far confirmed in my suspicion of bright lines that I have little doubt that from three to five bright lines were present between D and *b*.

On the 3rd inst. the star did not appear clearly defined in the refractor of 15 inches aperture, but the state of the sky was not good enough to enable me to be sure that the star was truly nebulous. On the 9th the star was certainly free from nebulosity. WILLIAM HUGGINS

Upper Tulse Hill, S.W.

ON September 8 the new star in the nebula (Messier 31) in Andromeda was examined in my 10-inch reflector. The *nova* shines with a yellowish tint and looks like an ordinary star of about $7\frac{1}{2}$ mag., being a perfectly sharp and well-defined stellar point situated near the central region of the nebula. It is quite free from any blurred appearance or any aspect of indefiniteness other than that introduced by the nebula on which it is projected.

On later nights the star seemed to have slightly decreased; its light was feebler and less sparkling, but I made no exact comparisons for tracing the decline of brilliancy, if any.

During many years the naked eye appearance of this conspicuous nebula has been familiar to me, and I have been accustomed to notice it particularly while engaged in prolonged watches for shooting stars. No sharply-defined nucleus was ever perceptible, but now the involved star is distinctly visible by slightly averting the vision. When the air is very clear the glowing out of the star now and then is very obvious, and I mention the fact in proof that the variation of the nebula by this new phenomenon is sufficiently great to affect its naked-eye aspect. W. F. DENNING

Bristol, September 13

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Red Rays after Sunset

THERE have lately been seen here some remarkable examples of rose-coloured streamers radiating from the sun at an interval of from 20 to 30 minutes after sunset, particularly on the 3rd, 5th, and 6th of this month. On the 3rd the appearance was especially striking, the contrast of colour between one very broad, vertical ray and the greenish-gray sky which separated it from its neighbours being most marked.

That these rose-coloured rays are essentially identical with the diffused rose-tint observed on other occasions is evident, not only from the similarity of colour and of interval after sunset at which they appear, but also from the occurrence of intermediate examples, in which the rays are so far and so broad that the radiate character is almost lost.

It is, however, by no means so clear why the coloured tract of sky should be sometimes split into rays, and it is with a view to ventilate this question that I desire to call attention to the subject.

I believe it is generally supposed that the dark spaces between the rays are due to masses of cloud intercepting the sun's light, but there are difficulties in the way of this explanation which I have never seen met.

It need hardly be pointed out that the matter (whatever it be) which reflects the red light must be at an altitude far above any such masses of cloud as could intercept the sun's rays; it could not otherwise receive and reflect those rays half an hour after the sun had set to the observer. But although above the level of the clouds, the reflecting matter would still be subject to interception of the sun's rays by cloud at sunset, and in order to judge whether the phenomenon can be so accounted for it is necessary to consider what kind of horizon that would be behind which the sun would set to an observer at the altitude supposed. My impression is that the horizon as seen from such a height would be so distant that whatever the irregularities of cloud-surface forming it, it would be practically a level line, and that the most mountainous masses of cumulus-cloud would be insufficient to cast at that distance the enormous shadows which would be necessary to account for the rifts between the rays.

Clifton, September 8 GEORGE F. BURDER

Fireball

A LARGE fireball was visible at Bristol and other places on September 11, at about 9h. 25m. p.m. It was described to me by several observers who approximately assigned its path as from *Altair* towards the western horizon. The sky was much clouded here at the time, with only 1st magnitude stars visible, but the light of the meteor appears to have been something astonishing.

Mr. G. T. Davis, of Theale, near Reading, writes me that, when first seen there, the meteor was near β Ophiuchi, and seemed to describe a slightly curved path to the horizon, which it touched apparently under β Serpentis. It exhibited a greenish tinted disk with bright, white aureole around it, and left no train. The aureole was at least 16′ in diameter.

It will be desirable to collect further accounts of this fine meteor. The direction of its path suggests that it may belong to the same system as that of the detonating fireball of September 14, 1875, which had a radiant point at α 348°, δ 0° ± (Tupman). During the past fortnight I have observed a considerable number of shooting-stars, and one of the best radiant points is at α 346, δ 0° ±, or 2° W. of that of Col. Tupman's fireball of September 14, 1875. W. F. DENNING

Bristol, September 13

Pulsation in the Veins

IF Mr. Hippisley will refer to Landois' text-book, vol. i. p. 196, he will find it there stated, on the authority of Quincke, that a venous pulse occurs on rare occasions, normally, in the veins on the back of the hand and foot, when the peripheral ends of the arteries become dilated and relaxed. But it is to be remembered that the very same phenomenon may obtain *abnormally*, owing to some pathological condition of the heart, as stenosis of the mitral orifice, or insufficiency in action of the mitral valve. Mr. Hippisley does not state in his letter whether the heart was in a healthy condition, or whether any lesion of that organ was present in those on whom his experiment was tried. J. W. WILLIAMS

Middlesex Hospital

"Furculum" or "Furcula"

Is there any authority for the use of furc*ulum* for the *os furculatorium* of birds? I am told by a contributor to the *Proceedings* of this Society, whose phraseology I have ventured to interfere with, that "furc*ulum*" has been employed by Balfour, Huxley, and Rolleston. Such may be the case, but it is possible that even these great anatomical writers may have erred in the use of a Latin termination. No dictionary that I have been able to refer to contains the word "furculum."

The Zoological Society of London P. L. SCLATER

THE BRITISH ASSOCIATION

Aberdeen, Monday

THERE have been few meetings of the British Association so crowded with papers in nearly all the sections. On Saturday several sections met which, unless under the greatest pressure, never meet on that day. Section D has been compelled to split up into three subsections, and probably most of the sections will have to meet on Wednesday morning. The social distractions have been much more numerous than usual, and we suspect have somewhat seriously interfered with the legitimate work of the meeting. As might be expected, the Music Hall was crowded on Wednesday evening last to hear the President's address, which seems to have produced a great impression on the audience.

It is being more and more strongly recognised that such pre-arrangements as those of Sections A and B ought to become general throughout the sections. The discussions in the two great sections, of which the programmes have appeared in NATURE, have certainly excited great interest among real workers in physics and chemistry. It is to be hoped that a full abstract of these discussions will be placed on record, as otherwise they cannot have any great permanent results. Perhaps the most popular feature in the regular sectional work has been the reading of Sir John Lubbock's paper on ants, in Section D, on Friday.

The number of entertainments, afternoon parties, excursions, and *conversaziones* is almost without precedent. The *conversazione* in the Art Galleries on Thursday last was in every way successful, though the place was overcrowded. The flower and fruit show and the illuminations outside reminded many of the South Kensington displays. It was satisfactory to notice that, thanks to

Prof. Traill, the nucleus of a valuable local natural history collection has been formed. Prof. Osborne Reynolds's illustrations of compression of solids was one of the most attractive features of the evening. The collection of pictures was large and highly creditable, while the precious collections of old manuscripts and books lent by the Earl of Crawford had many admirers. One of the most successful afternoon parties was given the same day at Tollshill Wood by Mr. David Stewart. Of course, of the numerous Saturday excursions, that to Balmoral was the most popular. In spite of the wretched weather 200 people must have left Aberdeen for Ballater at 1 p.m. and happily by the time the end of the railway journey was reached the weather greatly improved. The drive from Ballater to Balmoral evidently gave great enjoyment to the occupants of the long cavalcade of miscellaneous "machines" which wound along the banks of the Dee, and no less, we may be sure, did the sumptuous five o'clock dinner ("lunch," it was called) which was provided in the ball-room of Balmoral. Gen. Gairdner presided at the table, and, after proposing the Queen's health, drank, by command of Her Majesty, prosperity to the British Association. Under the guidance of Dr. Profeit the guests made a round of the fine grounds of Balmoral, and on driving back to Ballater, passed Her Majesty on her return from a day's outing. The excursion to Dunecht was also a great success, the arrangements at Lord Crawford's observatory exciting much interest.

A deputation from Birmingham is here to make arrangements for the visit to that town next year. It is evident that the Birmingham people mean to make the 1886 meeting a success, though, so far as social arrangements go, it will be difficult to surpass that of Aberdeen. It is expected that Manchester will be the place of meeting in 1887, and for 1888 or 1889 several enterprising members hope to secure the selection of London, in order to have a meeting in common with the American Association. Against this choice, however, there will probably be a strong protest, though of course the American Association will be sure to receive an enthusiastic welcome whenever it chooses to visit the old country.

Prof. Adams's lecture on Friday attracted a large audience, and on Saturday evening the Music Hall was filled with an enthusiastic audience of genuine working men to listen to Mr. H. B. Dixon's lecture and admire his experiments. Mr. Murray's lecture to-night will certainly be of popular interest, but, summing up as it does the present position of oceanography, it will also be of the highest scientific value. The diagrams are very striking, and certainly original. A full report will no doubt appear in NATURE.

The regret at the resignation of the secretaryship of the Association by Prof. Bonney is universal, though it is confidently expected that Mr. Atchison will be a thoroughly competent successor.

The additional arrivals up to this morning will bring the total number present at the meeting up to 2500.

SECTION B

CHEMICAL SCIENCE

OPENING ADDRESS BY PROF. HENRY E. ARMSTRONG, PH.D., F.R.S., SEC. C.S., PRESIDENT OF THE SECTION [1]

I NOW pass to the consideration of a subject of special interest in this section, which I think requires the immediate earnest attention of chemists and physicists combined—that of *Chemical Action*. In his Presidential Address to the Association last year Prof. Lord Rayleigh made only a brief reference to chemistry, but many of us must have felt that his few remarks were pregnant with meaning, especially his reference to the importance of the principle of the dissipation of energy in relation to chemical change. A year's reflection has led me to think them of peculiar weightiness and full of prophecy. I would especially draw attention to the closing paragraph of this portion of his address: "From the further study of electrolysis we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. I am not qualified—I wish I were—to speak to you on recent progress in general chemistry. Perhaps my feelings towards a first love may blind me, but I cannot help thinking that the next great advance, of which we have already some fore-shadowing, will come on this side. And if I might, without presumption, venture a word of recommendation, it would be in favour of a more minute study of the simpler chemical phenomena."

[1] Continued from p. 453.

Chemical action may be defined as being any action of which the consequence is an alteration in molecular constitution or composition; the action may concern molecules which are of only one kind—cases of mere decomposition, of isomeric change and of polymerisation; or it may take place between dissimilar molecules—cases of combination and of interchange. Hitherto it appears to have been commonly assumed and almost universally taught *by chemists* that action takes place directly between A and B, producing AB, or between AB and CD, producing AC and BD, for example. This, at all events, is the impression which the ordinary average student gains. Our text-books do not, in fact, as a rule, deign to notice observations of such fundamental importance as those of De La Rive on the behaviour of nearly pure zinc with dilute sulphuric acid, or the later ones of Faraday ("Exp. Researches," Series vii., 1834, 863, *et seq.*) on the insolubility of amalgamated zinc in this acid. Belief in the equation $Zn + H_2SO_4 = H_4 + ZnSO_4$ hence becomes a part of the chemist's creed, and it is generally interpreted to mean that zinc *will* dissolve in sulphuric acid, forming zinc sulphate, not, as should be the case, that *when* zinc dissolves in sulphuric acid it produces zinc sulphate, &c. In studying the chemistry of carbon compounds we become acquainted with a large number of instances in which a more or less minute quantity of a substance is capable of inducing change in the body or bodies with which it is associated without apparently itself being altered. The polymerisation of a number of cyanogen compounds and of aldehydes, the "condensation" of ketonic compounds and the hydrolysis of carbohydrates are cases in point; but so little has been done to ascertain the nature of the influence of the contact-substance, or *catalyst*, as I would term it, the main object in view being the study of the product of the reaction, that the importance of the catalyst is not duly appreciated. Recent discoveries, however—more particularly Mr. H. B. Dixon's invaluable investigation on conditions of chemical change in gases, and the experiments of Mr. Cowper with chlorine and various metals, and of Mr. Baker on the combustion of carbon and phosphorus—must have given a rude shock, from which it can never recover, to the belief in the assumed simplicity of chemical change. The inference which I think may fairly be drawn from Mr. Baker's observations—that *pure* carbon and phosphorus are incombustible in *pure* oxygen—is indeed startling, and his experiments must do much to favour that "more minute study of the simpler chemical phenomena" so pertinently advocated by Lord Rayleigh.

But if it be a logical conclusion from the cases now known to us that chemical action is not possible between any two substances other than elementary atoms, and that the presence of a third is necessary, what is the function of the third body—the catalyst—and what must be its character with reference to one or both of the two primary agents? In the discussion which took place at the Chemical Society after the reading of Mr. Baker's paper, I ventured to define chemical action as *reversed electrolysis*, stating that in any case in which chemical action was to take place it was essential that the system operated upon should contain a material of the nature of an electrolyte (Chem. Soc. *Proc.*, 1885, p. 40). In short, I believe that the conditions which obtain in any voltaic element are those which must be fulfilled in every case of chemical action. There is nothing new in this; in fact, it practically was stated by Faraday in 1834 ("Experimental Researches in Electricity," series vii. §§ 858, 859[1]); and had due heed been given to Faraday's teachings we

[1] "Those bodies which, being interposed between the metals of the voltaic pile, render it active, *are all of them electrolytes*, and it cannot but press upon the attention of every one engaged in considering this subject, that in those bodies (so essential to the pile) decomposition and the transmission of a current are so intimately connected that one cannot happen without the other. If, then, a voltaic trough have its extremities connected by a body capable of being decomposed, as water, we shall have a continuous current through the apparatus; and whilst it remains in this state we may look at the part where the acid is acting upon the plates and that where the current

should scarcely now be so ignorant as we are of the conditions of chemical change.

The questions—What is Electrolysis? What is an Electrolyte? are all-important to the chemist, if my contention be accepted. Moreover, the consideration of chemical action from this point of view almost of necessity obliges us also to consider what it is that constitutes chemical affinity. I will not presume to offer any opinion on this subject; but I would recall attention to the prominence which so great an authority as Helmholtz gave in the last Faraday Lecture (Chem. Soc. *Trans.*, 1881, 277) to the view held by Faraday, and which is so definitely stated in a passage in his "Experimental Researches"[1] (series viii. 918, also 850 and 869).

Helmholtz used the words: "I think the facts leave no doubt that the very mightiest among the chemical forces are of electric origin. The atoms cling to their electric charges, and opposite electric charges cling to each other; but I do not suppose that other molecular forces are excluded, working directly from atom to atom." In the passages which immediately follow, this physicist then makes several statements of extreme importance, which directly bear upon the subject I desire to discuss, and which, therefore, I quote.[2]

The interpretation of Faraday's law of electrolysis, which Helmholtz has brought under the notice of chemists, is of the most definite and far-reaching character. Does it, however, at all events in the form in which he has put it forward, accord sufficiently with the facts as these present themselves to the chemist's mind? All will recognise that the chemical changes effected by a current in a series of electrolytic cells are equivalent to those which take place within the voltaic cells wherein the current is generated; but in neither case is the action of a simple character: in both a variety of chemical changes takes place, the precise character of which is but imperfectly understood, and we are unable to assign numerical values, either in terms of heat or electrical units, to most of the *separate* changes. Moreover, many compounds are not electrolytes, while others which are regarded by the chemist as their analogues are very readily decomposed by a current of low E.M.F., although no great difference is to be observed in their "heats of formation;" liquid hydrogen chloride on the one hand, and fused silver chloride on the other, may be cited as examples. Again, how are we to interpret on this theory such changes as that involved in the conversion of stannic into stannous chloride? The former, I suppose, is to be regarded as consisting of an atom of quadrivalent tin charged with four units of, say, positive electricity, and of four atoms of univalent chlorine, each carrying a unit charge of negative electricity; on withdrawal of two of the chlorine atoms, the residual $SnCl_2$ will have two free unit charges of positive electricity. We know that when the temperature is sufficiently lowered two such residues unite, forming Sn_2Cl_4, and it is not improbable that crystalline stannous chloride represents a still later stage of condensation. Is this compatible with the theory? That cases of this kind are contemplated would appear from the reference to "unsaturated compounds with an even number of unconnected units of affinity," which we are told may be charged with equal equivalents of opposite electricity; and also from the allusion to the existence of molecules of elementary substances composed of two atoms. It is more than probable that these anomalies would disappear on fuller statement of his views by the author of the theory: I have ventured to call attention to them in the hope of eliciting such statement.

Helmholtz tells us that electrolytes belong to the class of typical compounds, the constituents of which are united by "atomic affinities," not to the class of "molecular aggregates." Is this the fact? Before chemists can accept this conclusion many difficulties must be removed which appear to surround the question. In the first place, it is in the highest degree remarkable that, with the one single exception of *liquefied* ammonia, *no known binary hydride is in the liquid state an electrolyte*: liquid hydrogen chloride, bromide and iodide, for example, withstanding an E.M.F. of over 8,000 volts (8,040 De la Rue cells: Bleekrode). Water, again, according to Kohlrausch's most recent determinations, has an almost infinite resistance. Yet a mixture of hydrogen chloride and water readily conducts, and is electrolysed; an aqueous solution of sulphuric acid behaves similarly, although the acid itself has a very high resistance.[1] Very many similar examples might be quoted, but it is well known that aqueous solutions generally conduct more or less perfectly, and are electrolysed.[2]

The current belief among physicists would appear to be that the dissolved electrolyte—the acid or the salt—is almost exclusively primarily decomposed (Wiedemann, "Elektricität," 1883, ii. 924). We are commonly told that sulphuric acid is added to water to *make it conduct*, but the chemist desires to know why the solution becomes conducting. It may be that in all cases the "typical compound" is the actual electrolyte—*i.e.* the body decomposed by the electric current—*but the action only takes place when the typical compounds are conjoined and form the molecular aggregate*, for it is an undoubted fact that HCl and H_2SO_4 dissolve in water, forming "hydrates." This production of an "electrolytical system" from dielectrics is, I venture to think, *the* important question for chemists to consider. I do not

is acting upon the water as the reciprocals of each other In both parts we have the two conditions, *inseparable in such bodies as these*, namely, the passing of a current and decomposition; *and this is as true of the cells in the battery as of the water-cell*; for no voltaic battery has as yet been constructed in which the chemical action is only that of combination: *decomposition is always included*, and is, I believe, an essential chemical part

"But the difference in the two parts of the connected battery—that is, the decomposition or acting cells—is simply this: in the former we urge the current through, but it, apparently of necessity, is accompanied by decomposition; in the latter we cause decompositions by ordinary chemical actions (*which are, however, themselves electrical*), and, as a consequence, have the electrical current; and as the decomposition dependent upon the current is definite in the former case, so is the current associated with the decomposition also definite in the latter."

[1] "All the facts show us that that power commonly called chemical affinity can be communicated to a distance through the metals and certain forms of carbon; that the electric current is only another form of the forces of chemical affinity; that its power is in proportion to the chemical affinities producing it; that when it is deficient in force it may be helped by calling in chemical aid, the want in the former being made up by an equivalent of the latter; that, in other words, *the forces termed chemical affinity and electricity are one and the same*."

[2] "Several of our leading chemists have lately begun to distinguish two classes of compounds—viz. molecular aggregates and typical compounds, the latter being united by atomic affinities, the former not. Electrolytes belong to the latter class. If we conclude from the facts that every unit of affinity is charged with one equivalent, either of positive or of negative electricity, they can form compounds, being electrically neutral, only if every unit charged positively unites under the influence of a mighty electric attraction with another unit charged negatively. You see that this ought to produce compounds in which every unit of affinity of every atom is connected with one, and only one, other unit of another atom. This, as you will see immediately, is the modern chemical theory of quantivalence, comprising all the saturated compounds. The fact that even elementary substances, with few exceptions, have molecules composed of two atoms makes it probable that even in these cases electric neutralisation is produced by the combination of two atoms, each charged with its full electric equivalent, not by neutralisation of every single unit of affinity. Unsaturated compounds with an even number of unconnected units of affinity offer no objection to such an hypothesis: they may be charged with equal equivalents of opposite electricity. Unsaturated compounds with one unconnected unit, existing only at high temperatures, may be explained as dissociated by intense molecular motion of heat, in spite of their electric attractions. But there remains one single instance of a compound which, according to the law of Avogadro, must be considered as unsaturated even at the lowest temperature—namely, nitric oxide (NO), a substance offering several very uncommon peculiarities, the behaviour of which will be perhaps explained by future researches." The popular mistake is here made of assuming that elementary substances, with few exceptions, have molecules composed of two atoms. We now know considerably over seventy elements, but of these the molecular weights in the *gaseous* state of only thirteen have been satisfactorily determined. The gaseous elements hydrogen, oxygen, nitrogen and chlorine, and also bromine, iodine and tellurium, have diatomic molecules; phosphorus and arsenic have tetratomic molecules; those of sulphur are hexatomic, and selenium molecules are probably of similar constitution, but more readily broken down than those of sulphur; lastly, cadmium and mercury molecules are monatomic It is more than probable that carbon, and also silicon and boron, form highly complex molecules. Of the remaining undetermined elements, the greater number are metals, and it is not unreasonable to assume that many of these will be found to resemble cadmium and mercury in molecular composition. It is clear, however, that at present we have no right to say that the elementary molecules are, as a rule, diatomic. It would assist in removing this error if chemists would consistently place *after* the symbol the numeral indicating the "atomicity" of the elementary molecule—thus, Hg_1, Cd_1, O_2; and if in all cases when a numeral is absent, or is placed *before* the symbol, it were understood that advisedly no indication of the molecular state is afforded.

[1] It is more than probable that the most nearly pure sulphuric acid which can be obtained is not homogeneous, but is at least a mixture of H_2SO_4, $H_2S_2O_7$ and "hydrated compounds" in proportions depending on the temperature, and hence that (pure) sulphuric acid, H_2SO_4, like water, would behave as a dielectric.

[2] On the other hand, it is remarkable that, whereas liquefied ammonia may be electrolysed, an aqueous solution of ammonia is a most imperfect conductor (Faraday, F. Kohlrausch), although solutions of ammonium salts compare favourably in conductivity with corresponding sodium and potassium salts. This fact serves *somewhat* to allay the suspicion that Bleekrode did not take sufficient precautions to dry the ammonia; but his result cannot, I think, be accepted as final, on account of the relatively high E.M.F. required, and the repetition of the experiment with every precaution to ensure purity of the gas is most important. Faraday regarded the decomposition of ammonia on electrolysis of its solution as merely the result of secondary action.

believe that we shall be able to state the exact conditions under which chemical change will take place until a satisfactory solution has been found.

F. Kohlrausch (*Pogg. Ann.* 1876, 159, 233) has shown that, on adding sulphuric acid to water, the electric conductivity increases very rapidly until when about 30 per cent. of acid is present a maximum (6,914) is attained; conductivity then diminishes almost as rapidly, and a minimum (913) is reached when the concentration corresponds with that of a monohydrate (H_2SO_4,OH_2); from this point conductivity increases somewhat (to 1,031 at 92·1 per cent. H_2SO_4), and then again falls, and is probably zero for the pure acid; on adding sulphuric anhydride to the acid conductivity again increases. Solutions of other acids and of a number of salts—chiefly deliquescent and very soluble salts—also exhibit maximum conductivity at particular degrees of concentration. In no other case has the existence of two maxima, such as are observed in solutions of sulphuric acid, been established; but probably this is because the experiments either have not been, or cannot well be, carried out with pure substances or very concentrated solutions. Solutions of less soluble salts increase in conductivity as the amount of salt dissolved increases.

Kohlrausch has suggested, as an explanation of the influence of the "solvent" on the conductivity of an "electrolyte," that in a solution the ions which are being transferred electrolytically come less frequently into collision than would be the case in the pure substance. There is therefore less opportunity for the formation of new molecules, and the ions are able to travel farther before entering into combination.

Regarding the question from a chemist's point of view, however, I cannot help thinking that this explanation is scarcely satisfactory or sufficient; but I cannot resist the feeling that the production of electrolytically conducting solutions from dielectrics is in some measure dependent upon the occurrence of chemical action. If the composition of the solutions of maximum conductivity be calculated,[1] it will be seen that they contain but a limited number of water molecules; thus the solution of sulphuric acid of maximum conductivity (at 18°) contains 30·4 per cent. of acid, and therefore has the composition $H_2SO_4 : 12{\cdot}4\ H_2O$ (approximately); for nitric acid the ratio is 1 : 8; for acetic acid it is about 1 : 17. Now, it is highly remarkable that the solutions of maximum electric conductivity are also very nearly those in the formation of which nearly the maximum amount of heat is developed; this will at once be obvious on comparison of the curves given by Thomsen ("Thermochemische Untersuchungen," vol. iii.) and by Kohlrausch. In the chemist's experience, the point of maximum heat development is usually near to the point of maximum chemical change, and I think, therefore, that we are justified in concluding that, even if electrical conductivity be not a maximum at a particular concentration on account of the presence of a particular hydrate (belonging to the class of molecular aggregates) in maximum amount, at all events the "structure" of the system is especially favourable, and the "chemical influence" exerted by the one set of molecules upon the other is at a maximum at the point of maximum conductivity. The fact that the amount of sulphuric acid required to form a solution of maximum conductivity increases with temperature—

Temp.	0°	10°	20°	30°	40°	50°	60°	70°
Per cent.	30·2	30·9	30·7	32·5	33·5	34·1	34·5	35·4

and also the fact that the maxima and minima of conductivity tend to become obliterated with rise of temperature (Kohlrausch), are both in accordance with the view that conductivity is in some way dependent upon chemical composition, as the effect of rise of temperature would be to cause the dissociation of hydrates such as I have referred to. The increase in conductivity of aqueous solutions with rise of temperature would appear to be against the view here put forward; but it is probable that this may be largely due to diminution in viscosity and increase in the rate of diffusion.

Our knowledge of the binary metallic compounds, which are generally admitted to be electrolytes *per se*, also affords evidence, I think, of an intimate relation between chemical constitution and "electrolysability." It has been pointed out (comp. L. Meyer, "Theorien d. mod. Chemie," 4th ed. p. 554) that, whereas all the metallic chlorides and analogous compounds which cannot be electrolysed are easily-volatile bodies, the electrolysable metallic chlorides, &c., are fusible only at high temperatures. A careful discussion of the various known cases does not, however, justify the conclusion that decomposition takes place, or not, according as the temperature at which the body assumes the liquid state—and at which, therefore, there is full opportunity given for electrolysis to take place—is high or low, especially as recent observations show that electrolysis may take place prior to fusion. But it is especially noteworthy that many of the chlorides, &c., which are electrolytes undoubtedly contain more than a single atom of metal in their molecules; indeed, after careful consideration of the evidence, I am inclined to go so far as to put forward the hypothesis *that among metallic compounds only those are electrolytes which contain more than a single atom of metal in their molecules.* No difficulty will be felt in granting this of cuprous and stannous chlorides, and even of cadmium, lead, silver, and zinc chlorides; but opinions will differ as regards the metals of the alkalies and the alkaline earths.[1] Assuming the constitution of metallic electrolytes to be such as I have suggested it is not improbable that on electrolysis a part only of the metal is determined to the one pole, the remainder being transferred along with the negative radical to the opposite pole. Hittorf, indeed, has already put forward this view in explanation of the remarkable results he obtained on determining the extent of transfer of the ions in aqueous and alcoholic solutions of the chloride and iodide of cadmium and zinc.

Again, an argument in favour of a connection between chemical constitution and electrical conductivity is the fact that carbon, sulphur, selenium and *phosphorus* each exist in conducting and non-conducting modifications, as it can scarcely be doubted that the so-called allotropic modifications of these elements are differently constituted.

It appears, as I have already said, to be the current belief that when aqueous solutions are submitted to electrolysis, as a rule the dissolved substance, and not the water, is the actual electrolyte. Without reference to the question I have raised as to the constitution of an electrolyte, it appears at least doubtful whether this view can be justified by appeal to known facts; at all events, I have failed to find satisfactory evidence that such is the case. Moreover, as sulphuric anhydride dissolves in water with considerable development of heat, it would appear that more work has to be done to separate hydrogen from sulphuric acid than to separate it from water; on this account we might expect that the water rather than the acid would be decomposed. Are not perhaps both affected according to the proportions in which they are present? The marked variation in the extent to which the negative ion is transferred to the positive pole, as observed by Hittorf, when solutions of different degrees of concentration are electrolysed, would appear to support this view. The difference in the products, according as dilute or very concentrated solutions of sulphuric acid are used, may also be cited as an argument that the chemical changes effected vary with the concentration; but, on the other hand, it is quite possible that the observed differences may result from the occurrence of purely secondary changes. Ostwald has recently put forward the view that one *or more* of the hydrogen atoms of certain acids are split off according to the concentration of the solution.

I call attention to this because I conceive that it has a most

[1]

Formula	Formula weight	Per cent. in solution of max. cond.	Composition in approximate mol. ratios	Conductivity
HNO_3	63	29·7	1 : 8	7330
HCl	36·4	18·3	1 : 9	7174
H_2SO_4	98	30·4	1 : 12·4	6914
H_3PO_4	98	46·8	1 : 6	1962
$C_2H_4O_2$	60	16·6	1 : 17	15·2
KOH	56	28·1	1 : 8	5995
$NaOH$	40	15·2	1 : 12·7	3276

[1] We may regard as evidence in support of this explanation the fact that neither beryllium chloride, which fuses at 600°, nor mercuric chloride, is an electrolyte, as both of these, at temperatures not far removed from their boiling-points, exhibit the simplest possible molecular composition. It should be pointed out, however, that Nilson and Patterson found it possible to determine the density of beryllium and chloride gas at a temperature 100°—150° below the melting-point found by Carnelly; but they were not able to say that fusion took place. Clarke's recent interesting observations on mercuric chloride and iodide do not, I think, suffice to prove that these compounds are electrolytes; it is more than probable that electrolysis is preceded by the formation of mercurous compounds. Even an aqueous solution of mercuric chloride does not conduct appreciably better than water (Buff). I should perhaps add that the mere presence of more than a single atom of metal in the molecule does not, I believe, alone constitute the compound an electrolyte; much depends probably both on the nature of the metal and on the structure of the molecule.

important bearing on the discussion of the nature of the chemical changes which occur during the dissolution of metals. Formerly it was said that when zinc acts upon dilute sulphuric acid, the zinc displaces the hydrogen of the water and the resulting zinc oxide dissolves in the acid, forming zinc sulphate; the modern explanation advocated by most chemists has been that the metal directly displaces the hydrogen of the acid: in fact, that this is the nature of the change whenever an acid is acted upon by a metal. If in a solution of sulphuric acid, of whatever strength, the acid be the actual electrolyte, I imagine that we are right in accepting this modern view; but if the water be the electrolyte, we must, to be consistent, return to the view that the oxide—more probably in most cases the hydroxide—is the primary product. And if it can be shown that during electrolysis both water and acid, according to circumstances—concentration, E. M. F., &c.—undergo change, it will be necessary to teach that in a similar manner the action of metals on acids is no less complex. Our views on the action of metals on concentrated sulphuric acid, and on solutions of nitric acid of various strength, must also materially depend on the interpretation of the behaviour of these acids on electrolysis with varying electromotive forces.

Having thus fully explained why I venture to think that Helmholtz's definition that "electrolytes belong to the class of typical compounds, not to that of molecular aggregates," is somewhat open to question, it now becomes necessary to make some slight reference to the constitution of these so-called molecular aggregates. Although opinions differ widely as to the definition to be given of a typical or atomic compound, and of a molecular compound or aggregate, the majority of chemists appear to agree that we must recognise the existence of two distinct classes of compounds. Prof. Williamson, in his address to this Section at the York meeting (1881), entered at length into the discussion of this question, and in very forcible terms objected to the recognition of molecular combinations as something different from atomic combinations; in this I, in the main, agree most fully with him. He further said that he had been led to doubt whether we have any grounds for assigning any limits whatever to atomic values, and he adduced a number of cases which, in his opinion, afforded illustration of a capability of elements to assume greater atomic values by combining with both negative and positive atoms than with atoms of one kind only; for example, he cited the compounds K_2CuCl_4 and K_2HgCl_4 as proof that copper and mercury may assume hexad functions; the compound K_2AgI_3 as an illustration that silver may act as a pentad; and the compounds $KAsF_6$ and K_2AsF_7 were regarded by him as evidence of the heptadicity and nonadicity of arsenic.

I have long been of opinion that the experimental investigation of this question is of great importance, and I believe that it must ere long attract the attention it deserves. The problem will be solved, not by discussions on the fertile theme of valency, but by determining the structure—the constitution—of bodies such as were referred to by Prof. Williamson.

My own view on the question is a very decided one. So far as the mere definition of valency is concerned, I entirely agree with Lossen; and, as I have said, I hold with Prof. Williamson that in all compounds the constituents are held together by atomic affinities, and atomic affinities only, but I believe that the formation of so-called molecular compounds is mainly due to peculiarities inherent more especially in the negative elements—*i.e.* the non-metals and metalloids and not in the positive elements—the metals; in other words, to the fact that, as was first pointed out, I believe, by Lothar Meyer, the negative elements tend to exhibit a higher valency towards each other than towards positive elements. The view I take, then, is, that in the majority of so-called molecular compounds the parent molecules are preserved intact in the sense in which a hydrocarbon radical, such as ethyl, is preserved intact in an ethyl compound, being held together by the "surplus affinity" of the negative elements. Thus I would represent the compounds K_2CuCl_4 and K_2HgCl_4 as containing copper and mercury of the same valency as the metal in the parent chloride, and regard them as compounds of the radicals $(CuCl_2)$, $(HgCl_2)$ and (KCl); a view which may be expressed by the formulæ

$$Cu{Cl . ClK \atop Cl . ClK} \qquad Hg{Cl . ClK \atop Cl . ClK}$$

The arsenic compounds referred to may be similarly represented

$$F_4AsF . FK \qquad F_3As{F . FK \atop F . FK}$$

We do not hesitate to attribute to the so-called double cyanides this order of structure, without in any way supposing that the metal changes in valency. Evidence that the "constituent radicals exist unchanged in molecular compounds" is afforded by facts such as that ferrous and potassium chlorides, for example, form a compound which obviously is still ferrous, being of a green colour, which would hardly be the case if the valency of the iron were increased; and that in like manner the compounds formed from stannous chloride manifest all the properties of stannous derivatives.

Whatever be the nature of chemical affinity, it is difficult to resist the conclusion that the "charge" of a negative radical especially is rarely, if ever, given up all at once, that its affinity is at once exhausted. It would also appear that the amount of residual charge—of surplus affinity—possessed by a radical after combination with others depends both on its own nature and that of the radical or radicals with which it becomes associated. Differences such as are observed in the composition and stability of the hydrates of the salts of an acid—the sulphates, for example—clearly point to this. Other illustrations are afforded by the manner in which chlorhydric acid yield chlorhydrates of some metals and chlorides of others.[1]

It is noteworthy, however, that often those elements which from the ordinary point of view are regarded as possessed of feeble affinities are those which manifest the greatest tendency to form molecular compounds. Thus it is commonly held that, of the three elements, chlorine, bromine and iodine, chlorine has the highest and iodine the lowest affinity, and this views accords well with the recent observations of V. Meyer on the relative stability of their diatomic molecules at high temperatures; but nevertheless we find that the compound which HI forms with PH_3 is far more stable than that of HBr or HCl with this gas; and it is well known that mercuric *iodide* has a much greater affinity for other iodides than have mercuric bromide and chloride for the corresponding bromides and chlorides.[2]

The recognition of the peculiarity in the negative elements to which I would attribute the formation of molecular compounds must, I think, exercise an important influence in stimulating and directing the investigation of these compounds and of compounds other than those of carbon; in the near future the determination of the structure of such compounds should occupy an important share of the chemist's attention. It will perhaps afford a clue in not a few cases which are not altogether satisfactorily interpreted in accordance with the popular view of valency. I may instance the formation of (?) polymeric metaphosphates, of complex series of silicates and tungstates, and of compounds of hydrocarbons with trinitrophenol. It may even serve to explain some of the peculiarities of the more complex carbohydrates.

It is one of the most clearly established of the "laws of substitution" in carbon compounds that negative radicals tend to accumulate: numerous instances are afforded by the behaviour of paraffinoid compounds with chlorine, bromine and oxidising agents, and by that of unsaturated paraffinoid compounds when combining with hydrogen bromide and iodine. The special affinity of negative elements for negative is not improbably the cause of this accumulation. A similar explanation may perhaps be given of some of the peculiarities which are manifested by benzenoid compounds.

I would even venture to suggest that in electrolysing solutions the friction arising from the attraction of the ions for each other is perhaps diminished, not by the mere mechanical interposition of the *neutral* molecules of the solvent—in the manner suggested by Kohlrausch—but by the actual attraction exercised by these molecules upon the negative ion in virtue of the affinities of the negative radicals.

One result of increased attention being paid to the investigation

[1] The name chlorhydric acid is here applied to the compound $HCl(OH_2)_x$—probably x = 1—which, according to Thomsen, is present in an aqueous solution of hydrogen chloride. It would be an advantage if we ceased to speak of HF, HCl, HBr, HI, as acids, and always termed them hydrogen fluoride, chloride, bromide and iodide respectively. The names hydric chloride, bromide, &c., might with equal advantage be altogether abandoned; hydrochloric acid is objectionable, as suggesting a relation to chloric acid. The names fluor-, chlor-, brom-, and iodhydric, as applied to the *acids* present in aqueous solutions of the hydrides, are especially appropriate as indicating that they are compounds containing the radical water—that they are hydrates: indeed, it would be well to restrict the use of hydric and hydro- to bodies of this kind, and to speak of hydrides as hydri-, not as hydro-, derivatives. It would then be possible to give comparatively simple names even to complex hydrates.

[2] Thomsen gives the values in heat units as—

$$HGCl_2,2KClAq = 1380$$
$$HgBr_2,2KBrAq = 1640$$
$$HgI_2,2KIAq = 3450$$
$$HgCy_2,2KCyAq = 8830$$

of problems such as I have indicated will probably be that we shall be called upon to abandon some even of our most cherished notions. I would suggest, for example, that it may become necessary to regard nitrogen peroxide not as a mixed anhydride of nitrous and nitric acids, but as a compound of two NO_2 groups; its conversion into nitrite and nitrate affords no proof of its constitution, as chlorine peroxide, ClO_2, which exhibits no tendency whatever to combine with itself, also yields both chlorite and chlorate. A greater shock may result from a conviction arising that not only carbon dioxide, but sulphur dioxide, and perhaps even sulphur trioxide, dissolve in water, forming *hydrates*—$SO_2{\cdot}OH_2$, $SO_3{\cdot}OH_2$—not *hydroxides*. In recent times, in discussing questions of this kind, we have perhaps often been led to attach too much importance to the argument from analogy; it is not improbable that, especially in the case of compounds other than those of carbon, chemical change involves change in structure more frequently than we are apt to believe.

It is possible that a precise estimate of what, for want of a better name, I have spoken of as residual affinity, may sooner or later be obtained, if the view Prof. Lodge has propounded in his paper "On the Seat of the Electromotive Forces in a Voltaic Cell" be correct, that the cause of the volta effect is the *tendency to chemical action* between the bodies in contact; that, for example, chemical strain at the air-contacts is the real cause of the apparent contact-force at the junction of two metals in air. Prof. Lodge, if I understand his argument, appears to assume that the air effects are in some way dependent on the presence of "dissociated oxygen atoms." I think this is probably an entirely unnecessary assumption: of late years, no doubt, it has been the fashion to attribute the occurrence of changes of various kinds to the presence of products of dissociation, but probably to a very unnecessary extent. Recent investigations to which I have alluded show that there are other factors of extreme importance: for example, that water must be present in order to render a mixture of carbonic oxide and oxygen explosive. Again, the observations of V. Meyer and Langer have shown that, whereas chlorine *violently attacks* platinum at low temperatures, it is *without action* upon it at temperatures between about 300° and 1300°, but then *again begins to act* upon it, the action becoming violent at 1600° to 1700°. I have little doubt that the action at low temperatures is dependent upon the presence of moisture; if it were due to dissociated chlorine atoms, the action should increase with rise of temperature without break. In short, I see no reason to assume that oxygen at ordinary temperatures consists of other than diatomic molecules.[1] Assuming Prof. Lodge's view to be correct, the strain exists in virtue of the attraction which the oxygen molecules exert upon the metal molecules. On this assumption I can well understand that the method of calculation followed by Prof. Lodge will not uniformly lead to satisfactory results. The "heat of combination" is not necessarily a measure of "affinity." The values are in all cases algebraic sums of a series of values, scarcely one of which is known, and, as I have already pointed out, the affinities of the molecules are by no means always of the same order as the affinities of the constituent atoms; for example, in all probability, oxygen stuff has a higher absolute affinity than sulphur stuff; chlorine stuff a higher absolute affinity than iodine stuff; yet iodine and sulphur compounds, more often than not, seem to exhibit more residual affinity than chlorine and oxygen compounds. So that, from Prof. Lodge's point of view, chlorine would have the higher and iodine the lower contact values; whereas from my point of view the reverse might often be the case. I point this out because it appears to me that we here have an opportunity of testing the question experimentally, and seeing that it is possible practically to prevent chlorine from attacking metals by excluding moisture, I do not take the hopeless view that Prof. Lodge and others seem to hold regarding the possibility of settling the important question of pure contact *versus* chemical action by appeal to experiment. I may also point out that according to my hypothesis it is possible that the metals may exert a considerable attraction for each other, especially those having monatomic molecules:[2] many alloys are undoubtedly compounds; possibly not a few are compounds of the "molecular aggregate" class.[1]

To return now for but a few moments to the subject of chemical change and its intimate connection with electrical phenomena. One application I would make of the views here put forward would be to explain the superior activity of bodies in the *nascent state*, and in particular of nascent hydrogen. Briefly stated, I believe it to consist in the fact that nascent hydrogen is hydrogen in circuit—hydrogen in electrical contact with the substance to be acted upon. The experiments of Faraday and of Grove afford the clearest evidence that in order to bring about action between hydrogen and oxygen at ordinary temperatures it is merely necessary to make them elements in a voltaic circuit. The difference in the effects produced by "nascent hydrogen" from different sources is, I imagine, attributable to the variations in E.M.F., which necessarily attend variations in the constituent elements of the circuit.

It is not so easy, however, as yet to explain some of the changes which take place at high temperatures. Mr. Dixon's experiments have proved that a mixture of carbonic oxide and oxygen is non-explosive, but that explosion takes place if moisture be present, the velocity of the explosive wave depending upon the amount of water present. When the mixture of the two gases is "sparked," change takes place, but only in the path of the discharge. Mr. Dixon considers "that the carbonic oxide becomes oxidised at the expense of the water, the hydrogen *set free* then becoming reoxidised. M. Traube, who in a series of papers has called attention to the importance of water in promoting oxidation, has suggested that the oxygen and carbonic oxide together act on the water, forming hydrogen peroxide and carbonic acid: $CO + 2OH_2 + O_2 = CO(OH)_2 + H_2O_2$; and that the peroxide then reacts with carbonic oxide to form carbonic acid: $CO + O_2H_2 = CO(OH)_2$. The carbonic acid, of course, is resolved into carbon dioxide and water (*Berichte*, 1885, p. 1890). Traube actually shows that traces of hydrogen peroxide are formed during the combustion. It appears to me that the water may exercise the same kind of action as it (or rather dilute sulphuric acid) exercises in a Grove's gas battery, and that its hydrogen does not become free in any ordinary sense. The production of hydrogen peroxide is not improbably due to a secondary simultaneous change.

Unlike a mixture of carbonic oxide and oxygen, a mixture of hydrogen and oxygen is violently explosive. If we assume that in both cases the reacting molecules are electrolysed by the very high E.M.F. employed, and that the atoms then combine, it is difficult to explain the difference in the results. Does it arise from the fact that hydrogen is an altogether peculiar element? Or are we to attribute it to an influence which water itself exercises upon the formation of water from hydrogen and oxygen—as in the Grove gas battery? It is noteworthy that the velocity of the explosive wave in electrolytic gas, according to Berthelot and Vielle, is a close approximation to the mean velocity of translation of the molecules in the gaseous products of combustion calculated from the formula of Clausius (H. B. Dixon, *Phil. Trans.*, 1884, p. 636). And this is also true of mixtures of carbonic oxide and oxygen, and of nitrous oxide and oxygen with hydrogen. May we therefore assume, as the velocity corresponds with that of the products, that the water exercises the important office of inducing change throughout the mass, and not that the hydrogen is peculiar? I am tempted here to suggest that perhaps the "induction" observed by Bunsen and Roscoe in a mixture of chlorine and hydrogen is due to the occurrence of a change in which a something is produced which then promotes reaction between the two gases. I here assume that there would be no action between the pure gases.

If I have allowed myself to flounder in among these difficult questions, it is not because I feel that I am justified in speaking

[1] This conclusion would also lead me to disbelieve entirely in the explanation which Clausius has given of electrolysis.

[2] Assuming that the heat absorbed in raising the temperature of a solid is mainly expended in overcoming intermolecular attraction, the high "atomic heat" of metals may be regarded as evidence that their molecules powerfully attract each other, and hence that their molecular composition is relatively simple; and on this view the "atomic heat" of carbon and of a number of other non-metals and of some metalloids is low owing to the extent to which the "affinity" of the atoms is, as it were, exhausted in the formation of their molecules. Comparison of the "molecular heats" of chlorides and similar compounds with those of the oxides lends much support to this view, as we have reason to believe that the chlorides—which have high "molecular heats"—are of relatively simple molecular composition, and that the oxides—which have low "molecular heats"—are of relatively complex molecular composition.

[1] The study of alloys from this point of view will probably furnish interesting results. It is noteworthy that the contact difference of potential of brass is less than that of copper, and much less than that of zinc, with the same solution, in all the cases quoted by Ayrton and Perry; thus—

	Zinc	Copper	Brass
Alum ...	− ·536 volt.	− ·127	− ·014
Sea salt	− ·565 ,,	− ·475	− ·435
Sal ammoniac	− ·637 ,,	− ·596	− ·348

It is especially important to examine the copper-tin alloys, which vary in electrical conductivity in so remarkable a manner.

with authority, but in the hope that I may be the "fool," and that the "angels" who are well able to discuss them will be led to do so without delay: for chemists are anxiously awaiting guidance on matters such as I have referred to.

Attention must, however, be directed to the study of electrical phenomena by the recent publications of Arrhenius and of Ostwald (*Journal für praktische Chemie*," 1884, 30, 93, 225; 1885, 31, 219, 433), and especially by the statement put forward by the latter that the rate of change under the influence of acids (in hydrolytic changes) is strictly proportional to the electrical conductivities of the acids. There cannot be a doubt that these investigations are of the very highest importance.

I trust that in the discussions which we are to have on molecular weights of liquids and solids, and on electrolysis, there may be a free exchange of opinion on some of the points here raised. My reason for selecting these subjects for discussion in this Section will have been made sufficiently clear, I imagine. Last year in the Physical Section the idea assumed shape which had long been latent in the minds of many members of the Association, that it is unadvisable, as a rule, to encourage the reading of abstract papers, which rarely are, or can be, discussed. Two important discussions were *introduced* by Profs. Lodge and Schuster. We must all cordially agree with Prof. Lodge's remarks on the importance of discussing subjects of general interest at these meetings. It appears to me, however, that even a more important work may often be accomplished if the discussion consist of a series of papers which together form a monograph of the subject. I have endeavoured to carry this idea into practice on the present occasion, and a number of friends have most kindly consented to assist. Unexpected difficulties have arisen, and probably we shall none o us succeed in doing all we might wish. I trust, however, that the Section will approve of this first attempt sufficiently to justify my successors in this chair in adopting a similar course.

I much regret that it is impossible for me to attempt any review of recent work in chemistry. Not a few really important discoveries might be chronicled, and the patient industry of many who have toiled long to win results apparently insignificant should have been mentioned with high approval. A few remarks I will crave permission for, as regarding the general character of the work being done by chemists, and regarding that which has to be done.

Complaints are not unfrequently made in this country that a large proportion of the published work is of little value, and that chemists are devoting themselves too exclusively to the study of carbon compounds, and especially of synthetical chemistry. We are told that investigation is running too much in a few grooves, and it is said that we are gross worshippers of formulæ. Most of these outbursts are attributable to that pardonable selfishness which consists in assigning a higher value to the particular class of work with which one happens to be engaged or interested in than to any other line of investigation; too frequently they result from want of sympathy with, if not absolute ignorance of, the scope and character of the work complained of. It must not be forgotten that chemical investigation, like other investigation, is to a large extent the work of genius; the rank and file must necessarily follow in the order of their abilities and opportunities; hence it is that we work in grooves. The attention paid to the study of carbon compounds may be more than justified both by reference to the results obtained and to the nature of the work before us: the inorganic kingdom refuses any longer to yield up her secrets—new elements—except after severe compulsion; the organic kingdom, both animal and vegetable, stands ever ready before us; little wonder, then, if problems directly bearing upon life prove the more attractive to the living. The physiologist complains that probably 95 per cent. of the solid matters of living structures are pure unknowns to us, and that the fundamental chemical changes which occur during life are entirely enshrouded in mystery. It is in order that this may no longer be the case that the study of carbon compounds is being so vigorously prosecuted: our weapons—the knowledge of synthetical processes and of chemical function—are now rapidly being sharpened, but we are yet far from ready for the attack. As to the value of this work, I believe that every fact honestly recorded is of value; an infinite number of examples might be quoted to prove this. No unprejudiced reader can but be struck also with the improvement in quality which is manifest in the majority of the investigations now published; at no time was more attention given to the discovery of all the products of the reactions studied, and to the determination of the influence of changes in the conditions. As regards our formulæ, those who look upon the outward visible form without proper knowledge of the facts symbolised, and who take no pains to appreciate the spirit in which they are conceived, are undoubtedly misled by them. The great outcome of the labours of carbon-chemists has been, however, the establishment of the doctrine of structure;[1] that doctrine has received the most powerful support from the investigation of physical properties, and it may almost, without exaggeration, be said to have been rendered visible in Abney and Festing's infra-red spectrum photographs. Some of us look forward to the extension of the doctrine of structure not only to compounds generally, but even to the "elements." The relationships between these are in so many cases so exactly similar to those which obtain between carbon compounds, which we are persuaded differ merely in structure, that it is almost impossible to avoid such a conclusion, even in the absence of all laboratory evidence.[2]

As the field of view opens out before us, so does the vastness of the work to be accomplished become more and more apparent; and Faraday's words of 1834 may be quoted as even more appropriate than half a century ago.

"Indeed, it is the great beauty of our science, Chemistry, that advancement in it, whether in a degree great or small, instead of exhausting the subjects of research, opens the door to further and more abundant knowledge, overflowing with beauty and utility, to those who will be at the easy personal pains of undertaking its experimental investigation.

SECTION C

GEOLOGY

OPENING ADDRESS BY PROF. J. W. JUDD, F.R.S., SEC. G.S., PRESIDENT OF THE SECTION [3]

CONCERNING the overlying formation of quartzites and limestones, much yet remains to be made out. Nicol, Lapworth, and the officers of the Geological Survey, have shown it to be made up of three principal members—the identity of which cannot be mistaken although different names have been assigned to them. While Nicol estimated the total thickness of this formation at from 300 to 800 feet, however, and Lapworth places it at the smaller of these amounts, the officers of the Survey believe it to be no less than 2,000 feet thick.

Even greater uncertainty still exists as to the exact geological age of this important formation. Murchison, who in his later years made "Silurian" a mere synonym for Lower Palæozoic, was no doubt right in regarding these rocks as being of that age. I have no intention of attempting to flog that dead horse—the controversy concerning the names which should be applied to the great systems containing the three faunas which Barrande so well showed to be present in the Lower Palæozoic rocks. That controversy, commencing, it must be confessed, with some tragic elements, has long since passed into the sphere of comedy, and now bids fair, if still persisted in, to degenerate into farce. Little, if anything, has been added to the work of Salter in connection with these fossils of the Durness limestone. With their abundance of that remarkable and aberrant mollusc, *Maclurea*, they can be paralleled with no other British or even European deposit, unless it be the Stinchar limestone of the Girvan district. Salter thought that this remarkable Scotch formation had its nearest analogues in the Calciferous sandstone and the Chazy limestone of North America. As those rocks contain "Primordial" forms of Trilobites, they must probably be regarded as either of Cambrian age, or as constituting a link between the rocks containing Barrande's first and second faunas respectively. Under these circumstances, it is a piece of welcome intelligence that the officers of the Geological Survey have succeeded in obtaining a rich and varied collection of organic remains from the beds of Sutherland; and the results of the examination and discussion of these fossils will be awaited by all geologists with the greatest interest.

Whether, as in the case of Scandinavia, other fossiliferous

[1] I venture here to direct attention to an extension of the acknowledged theory of structure suggested (by myself, I may say) at the close of the discussion of the van 't Hoff-Le Bel hypothesis of isomerism in Miller's "Chemistry," vol. iii., 1880 edition, p. 993. The same view was soon afterwards independently put forward by Dr. Perkin

[2] F. Exner, in a recent paper (*Monatshefte für Chemie*, 1885, p. 249). "On a New Method of Determining the Size of Molecules," actually puts forward an hypothesis as to the structure of elements.

[3] Continued from p. 458.

deposits of Silurian age will be found to be represented in a highly metamorphosed condition in our Scottish Highlands, remains to be discovered. There is such a perfect parallelism between the several members of the Silurian in Scania and in the Scottish Borderland, so well shown by the researches of Linnarson and Lapworth, that, as Nicol always anticipated, we may not improbably find a portion of the rocks of the Highlands to be altered forms of those of the Borderland.

Since the last meeting of the British Association in the Highlands, much progress has been made in the study of that pre-eminently British formation—the Old Red Sandstone. Dr. Archibald Geikie has thrown much new light, by his valuable researches, on the relations of the several members of the vast series of deposits which go by that name; while Dr. Traquair, bringing to bear on the subject great anatomical knowledge, has re-examined the collections of fossil-fish made by that indefatigable explorer, Hugh Miller. The Old Red Sandstone is the only great system of strata which we possess, while it is either wholly absent, or very imperfectly represented, in Scandinavia.

In the year 1876, I was able to announce that a vestige—a small but highly interesting vestige—of the great Carboniferous system exists within the limits of the Scottish Highlands. Well do I recall the deep, the ineffaceable impression made upon my mind when, standing at the Innimore of Ardtornish, I beheld for the first time this relic of a great formation, preserved by such a wonderful series of accidents. What the inscribed stone of Rosetta or the papyri of Herculaneum are to the archæologist, this little patch of sandstone is to the geologist. Overwhelmed by successive lava-streams that were piled upon one another to the depth of many hundreds of feet, and then carried down by a fault which buried it at least two thousand feet in the bowels of the earth, this fragment has remained while every other trace of the formation has been swept from the Highlands by the besom of denudation.

Highly interesting and important in these northern areas are the Mesozoic deposits, which in places attain a vertical thickness of several miles, and which must have originally covered enormous tracts of country. Now, judged by that very fallacious test, the space which they cover upon our geological maps, they appear in the Scottish Highlands to be absolutely insignificant.

The correspondence in characters between the several Secondary formations on the two sides of the North Sea is of a most striking kind. I have had the good fortune to study the Secondary rocks of Scania under the guidance and with the assistance of Professor Lundgren, of the University of Lund, who has made so many important discoveries in connection with them. While doing so, I have again and again felt almost constrained to pause and rub my eyes, to convince myself that I was not back again in Scotland—so complete is the correspondence between the mineral characters, the fossils, and the geognostic relations of these strata in the two areas.

The Triassic rocks of Scandinavia, consisting of variegated sandstones and conglomerates, containing much calcareous material, are absolutely undistinguishable from those of the Western Highlands. In both countries the thickness of the deposits of this age varies within very short distances, their development being local and inconstant. The formation which in places exceeds a thousand feet in thickness, at other points is reduced to an insignificant band of conglomerate. On the eastern flank of our Highlands, yellow sandstones belonging to this formation have yielded to Mr. Duff, Dr. Gordon, Mr. Grant, and others that interesting series of reptilian remains which, in the hands of Professor Huxley, have been made to throw such important light on the forms of life which existed at that remote geological period. In the very similar deposits which occur in Scandinavia, however, reptilian remains have not as yet been obtained. The abundance and variety in form and size of the footprints which occur in our Scottish rocks of this age indicate the richness of the vertebrate fauna which must have existed at that distant epoch.

On both sides of the North Sea, the Triassic rocks are found passing up insensibly into the great formation known as the Rhætic and Infralias—a formation imperfectly represented in England and Central Europe by a few thin and insignificant strata, but in our Highland districts attaining a vast thickness and exhibiting a magnificent development. This system of strata consists of alternation of marine and estuarine deposits, the latter containing in both areas thin seams of coal. In Scania, the working of the coal and fire-clays of these deposits has brought to light vast numbers of fossil plants, which have been so well described by Nathorst. Several very distinct floras, occurring at different horizons, have been made out, and the relations of the beds containing these floras to one another, and to the marine strata with which they are intercalated, have been clearly demonstrated by the researches of Hébert, Erdmann, and Lundgren. That similar rich stores of fossil plants would reward a search as skilful and persevering as that made by our Scandinavian brethren, if carried on in the equivalent strata of Scotland, there can be little doubt.

The whole of the vast Jurassic system in these northern latitudes, attaining a thickness of 3,000 or 4,000 feet, appears to be similarly made up of alternations of marine and estuarine strata. Time would fail me to indicate even in the briefest manner the numerous problems of the highest interest suggested by the study of these vast deposits. At many different horizons, beds of coal and the relics of a rich terrestrial vegetation abound. Most of these await careful study and description. So far as they are yet known, the Ferns, the Cycads, and the Conifers of the Jurassic rocks of the Highlands present wonderful resemblances with those described by Heer from strata of the same age in Norway, in Russia, in Siberia, and even far away in the Arctic regions. The marine forms occurring in the associated strata seem to indicate that they belong to an ancient life-province, distinct from those in which the Jurassic rocks of Central and of Southern Europe were deposited. In the Upper Jurassic, so well represented in Sutherland by strata not less than 1,000 feet in thickness, we find evidence of the existence of mighty rivers, the banks of which, though clothed with tree ferns, Cycads, and gigantic pines, yet at certain seasons must have borne down ice-buoyed blocks of vast dimensions.

That the succeeding Neocomian period was for Scandinavia and Scotland an epoch of elevation and of the prevalence of terrestrial conditions is indicated by the total absence of any trace of marine deposits of this age, no less than by the enormous denudation which can be shown to have followed the Jurassic and preceded the Cretaceous period. Our now ruined mountain-chain then probably formed the lofty watershed of a great continent, through which flowed the mighty rivers that formed the deltas known as the English and German Wealdens.

How powerful and prolonged were the agencies of sub-aërial waste during this period is shown by the fact that the relics of the Cretaceous formation are found resting in turn on every member of the Jurassic, the Rhætic, the Trias, and all the different Palæozoic and Archæan rocks. A great portion, indeed, of the thick and widespread Rhætic and Jurassic strata seems to have been removed by denudation before the commencement of the Cretaceous period.

That thick strata of chalk once covered large areas of the Scottish Highlands and of Scandinavia we have the clearest proofs. In Scania and the adjoining parts of Denmark deposits of this age are found let down by tremendous faults, and these include even younger members of the series than are anywhere found in England. In the West of Scotland I have shown that thin deposits of Cretaceous age, preserved to us by a wonderful series of accidents, still survive the tremendous denudation of the Tertiary periods. It is true that in Scandinavia and Scotland alike, the chalk alternates with sandstones and even with strata of estuarine origin, but the pure foraminiferal rock that occurs in both areas could have been formed in no very shallow sea. That before the commencement of the great Tertiary denudation large areas, in Scandinavia and Scotland alike, must have been swathed in winding sheets of chalky rock there cannot be the smallest doubt. That considerable portions of these winding-sheets remained to so late a period as the glacial is shown by the fact that the indestructible flints of the chalk with the rocks and fossils of the upper greensand abound in your boulder-clays of Aberdeenshire and Banffshire.

Of the vast periods of the Tertiary we have left to us, either in the Highlands or Scandinavia, but few and insignificant relics in the form of stratified deposits. In our beautiful Western Isles and in Antrim the lava poured out in successive streams, during enormous periods of time, from the lofty volcanic cones of the earlier Tertiary epoch, has here and there buried patches of lake-mud, or river-gravel, or ancient soils. But everywhere, alike in the Highlands and in Scandinavia, we behold the most impressive evidences of the sub-aërial waste, and of the elevation that promoted this waste during the Tertiary epoch. Among such evidences we may reckon the circumstance that all traces of the vast deposits of the Secondary periods have been relentlessly stripped away from the country, except where buried deeply by gigantic earth-throes, or sealed up under massive lava-streams.

Down to post-glacial times Scotland, and what are now its outlying islands, remained united with Scandinavia. I need not remind you how, during the glacial period, they were the scene of a similar succession of events; while from their then far more elevated mountain summits streams of glacier-ice flowed down and relieved the mantle of snow which enveloped them.

But at a very recent geological period, and indeed since the appearance of man in this part of our globe, the separation of the two areas, so long united, was brought about. In the district now constituting the North Sea, which separates the two countries, great faults, originating in the Tertiary epoch, appear to have let down wide tracts of the softer Secondary strata among the harder crystalline rock-masses. The numerous changes of level, of which we find such abundant evidence around the shores of this sea, facilitated the wearing away of the whole of these softer Secondary deposits, except the slight fringes that remain along the shores of Sutherland, Ross, and Cromarty, on the one hand, and the isolated patches forming Scania, Jutland, and the surrounding islands on the other. Little could the Vikings, as they sailed over this shallow sea, have imagined that their predecessors in these regions were able to roam on foot from Norroway to Suderey!

It is almost impossible to over-estimate the effects produced by the several denudations to which Scandinavia and the Scottish Highlands have been successively subjected. In that which occurred during the later Tertiary periods, almost every portion of the non-crystalline rocks that rose above the sea-level was either entirely removed or converted into level plains, which, covered with drift deposits, now form districts like Scania and Denmark. Where, as in the great central valley of Scotland, hard volcanic masses are associated with the softer sedimentary rocks, the former are left rising as picturesque crags, standing boldly up above the general level, while the latter are worn down and buried under drift. In the west of Scotland a chain of volcanic mountains, with summits towering to the height of from ten to fifteen thousand feet, have been reduced by this same denudation to basal-wrecks, the highest portions of which attain to but little more than 3,000 feet above the sea-level!

During the great elevation and denudation which marked the Neocomian period, thousands of feet of strata must have been removed over wide areas, as is proved by the wonderful overlap of the Cretaceous beds on all the older strata.

Of the enormous sub-aërial waste which went on in these Northern Alps during the Newer Palæozoic periods we have impressive evidence in the vast masses of the Old Red Sandstone and Carboniferous rocks—themselves only a series of fragments that have survived the later denudations—for these rocks are built up of the materials derived from our Northern Alps.

The Torridon Sandstone is the monument, and a very striking monument too, of another and still earlier period of enormous denudation. The thousands of feet of conglomerate and sandstone of which it is made up consist of the disintegrated crystals of granites and gneisses that have been swept away.

When we penetrate towards the axis of this eroded mountain-chain, the proofs of the magnitude of these denudations become even more striking and impressive. Here we see, towering aloft, the ruined buttresses of vast rocky arches, that when complete must have risen miles above the present surface; there we find, lying side by side, rock-masses that could only have been brought together by displacements of tens of thousands of feet; yet so complete has been the planing down of the surface since, that it requires the most careful study even to detect the almost obliterated traces of these grand movements. The Alps and the Himalayas, during their elevation, have suffered enormous waste and denudation; but if the elevation were to cease and the waste to go on till these magnificent mountain-chains were reduced to masses of diminutive peaks, ranging from 2,000 to 8,000 feet in height, we should then have the counterpart of this stupendous ruin of the mountain-chain of the north.

The history of the series of successive movements to which the rock-masses of our Highlands have been subjected is one well worthy of the most attentive study. When the evidence bearing upon the subject is carefully sifted and weighed, we become convinced of the fact that many of these movements—including some on a prodigious scale—must have taken place during what we are commonly accustomed to regard as comparatively recent geological periods.

On the eastern coast of Sutherland, a mass of Secondary rocks, including several thousands of feet of Triassic, Rhætic, and Jurassic strata, has been let down by a gigantic fault, so as to be placed in juxtaposition with the Old Red Sandstone and the crystalline rocks. Now, taking the very lowest estimates of the thicknesses of the several strata affected, the vertical "throw" of this fault must have exceeded a mile! It may not improbably, indeed, have been at least double or treble that amount! Yet this great dislocation was certainly produced at a later date than the Upper-Jurassic period, for rocks of that age are found to be affected by it.

Along the coasts of the Black Isle, strata of Middle and Upper Jurassic age are similarly found faulted against the "Old Red" and the crystalline rocks.

On the other side of the North Sea, in Andö, one of the Lofoten Isles, a patch of Lower-Oolite strata, consisting of marine and estuarine strata, and including beds of coal like that of Brora, is found let down by gigantic faults into the very heart of the crystalline rocks of the district. In Scania, the whole of the Secondary rock-masses owe their preservation in the same way to a plexus of tremendous faults, by which they have been entangled among the harder rocks. These faults have affected not only the Jurassic strata, but even the very youngest members of the Cretaceous series.

Nor are we without evidence that some of the great faults are of post-Cretaceous age, in this country, for in the Western Highlands displacements of several thousands of feet have been detected, which affect not only the Upper Cretaceous, but also the Older Tertiary rocks.

The effects produced by these great dislocations, which have a generally parallel direction in our Highlands, from north-east to south-west, are of the most startling character. Great strips of Triassic and Old Red Sandstone strata, like those of Elgin, and Turriff, and Tomintoul, and of the line of the Caledonian Canal, are found let down among the crystalline rocks by these gigantic faults.

The great central valley of Scotland itself consists of masses of Newer Palæozoic strata, faulted down between the harder Archæan and Lower Palæozoic rocks, which form the Highlands on the one hand, and the Borderland on the other.

The evidences of the existence of these great faults were collected by many of the older Scottish geologists, like Landale, Bald, Chalmers, Milne-Hoem, and Nicol; and the accurate mapping of the country by the officers of the Geological Survey has, on the whole, tended to confirm their results. With regard to the age of these great dislocations of Central Scotland, it can only be *certainly* affirmed that they are of more recent date than the youngest Carboniferous strata; but I have long believed that, like many similar dislocations both in our own Highlands and in Scandinavia, they are really post-Cretaceous.

Less difficulty perhaps will be found in accepting this apparently startling conclusion, when we remember that a complicated series of fractures injected by the lavas of the Great Tertiary volcanic foci of the West, extend right across the Highlands, the central valley, and the Borderlands of Scotland, and even traverse the whole series of the Secondary rocks in the North of England.

The indications of the tremendous manifestations of subterranean energy, to which these great dislocations owe their origin, are sometimes of a very striking kind. For hundreds of yards on either side of the faults, the two sets of strata are found bent and crumpled, and not unfrequently crushed into the finest dust ("fault-rock"). In the case of the great Sutherland-fault, to which I have previously alluded, we have a beautiful illustration of the way in which mineral veins may originate along such lines of fissure, for in the interstices of the granite of the Ord, where it has been broken up along this certainly post-Jurassic, and probably Tertiary fault, fluor-spar and pyrites have been deposited in large quantities.

It is impossible to study the tremendous movements and dislocations, and the enormous amount of denudation which have taken place in the Highlands and surrounding districts during Tertiary times, without being convinced that all the existing surface-features of the country must date from a comparatively recent period. The vast movements which have placed soft and hard masses in opposition along certain parallel lines—generally ranging in a north-east and south-west direction—and the denudation which has worn away the former, while it has left the latter standing in relief, must, I believe, both be referred to the Tertiary period; though the disposition of rock-masses brought about by earlier movements would of course exercise a certain though subordinate influence in producing the existing forms of the surface of the country.

At the close of the Jurassic period, and before the commencement of the Cretaceous, during the vast epoch marked by the deposition of the Neocomian of Southern Europe, a series of disturbances similar to those of the Tertiary, and scarcely inferior in their consequences, can be shown to have taken place.

If the movements of the Scandinavian and Scottish rock-masses which took place in the Tertiary and Mesozoic periods respectively were so startling in their magnitude and so vast in their effects, what shall we say concerning those far greater disturbances which affected the same area towards the close of the Older Palæozoic and the beginning of the Newer Palæozoic, when this Northern Alps was still a living and growing mountain-chain?

These movements, in which both the Archæan and the Older-Palæozoic rocks are found to be involved, have resulted in the production, through enormous lateral pressure, of those reversed faults, caused by the disruption along their axial planes of greatly inclined and compressed folds, as so well described by Rogers.

Dr. Archibald Geikie assures us that the studies of the geological surveyors in North-West Sutherland led to the conclusion that certain masses of rock have thus been carried almost horizontally over others, along these "thrust-planes" for a distance of at least ten miles. As the result of these tremendous lateral compressions, thin beds of limestone and quartzite, which have sufficiently definite characters to permit of their recognition, may be seen in Assynt, and in other parts of the Western Highlands, to be so repeated again and again by crumpling and faulting, that they have been regarded as deposits of enormous thickness; while, on the other hand, massive formations have been crushed and rolled out, thereby acquiring a laminated structure like so much pie-crust. Great portions of rock-masses, which, like the much-discussed "Logan-rock," have been nipped between gigantic faults, show evidence under the microscope of having been crushed to powder and subsequently reconsolidated, while the surfaces of the "thrust-planes" sometimes exhibit the phenomena known as "slickensides" on the most gigantic scale.

As we pass away from the central axis of this old mountain-chain, however, these complicated puckerings and dislocations pass gradually into more ordinary folds and faults, just as is the case with the Appalachians. The oft-repeated undulations of the Lower Palæozoic strata of the Borderland, so admirably described by Professor Lapworth, bear the same relation to the far more involved disturbances of rocks of the same age in the Highlands, which the foldings of the strata in the Jura do to the intense crumplings of those of the Alps; and these in turn pass insensibly into the slightly undulating or horizontal strata of the southern half of this island.

We may perhaps add another comparison between the existing mountain-chain of Southern Europe and the "basal wreck" of Northern Europe, one which I find has been already suggested by Professor Bonney. The Miocene Conglomerates, which in the Rigi and other flanking mountain masses of the Alpine chain are found piled to the depth of many thousands of feet, seem to be exactly represented in its prototype by the vast masses of the "Old-Red" Conglomerate.

Vast as were the three series of movements to which I have been referring, I believe that the Scandinavian and Highland rocks bear the impress of a still grander series of di turbances than either of these—one at the same time of older date and far more universal in its effects.

Many writers have treated of the great divisional planes, almost everywhere conspicuous in the Highland rock-masses, as being necessarily coincident with planes of sedimentation. It is manifest, indeed, that the tracing of sequences and unconformities among such rocks must proceed upon the assumption that the planes of foliation and stratification *are* coincident. Murchison and Geikie so fully recognised the fact that this proposition lay at the very root of their arguments concerning a Highland succession, that they added a supplement to their paper to illustrate and enforce it.

It must not be forgotten, however, that the truth of this proposition has not only been doubted, but has been stoutly contested by many of the most profound thinkers on geological questions.

As long ago as 1822, Professor Henslow, in a very remarkable paper, showed that the rocks of Anglesea are traversed by a system of divisional planes, which intersect the bedding at a very high angle, and must have been produced long subsequently to the latter; and in 1835 Professor Sedgwick extended the observations and enforced the arguments of Henslow.

At an even earlier date, Poulett Scrope had shown, by his study of viscous lavas, that the planes along which crystalline action takes place are determined by pressure and strain; and he insisted that the foliation of metamorphic masses was a phenomenon strictly analogous to the banding of rhyolitic lavas.

Charles Darwin, the pupil of Henslow and the friend of Poulett Scrope—whose labours in the geological field would perhaps have met with fuller recognition had they not been overshadowed by his still greater achievements in the world of biological thought—strongly maintained the truth of these views. He added the important observation that, in the South American continent, the planes of foliation are seen everywhere, over enormous areas, to be parallel to those of cleavage; and that these latter are of secondary origin and due to lateral pressure, the observations of Sharpe and the experiments of Sorby have convincingly demonstrated.

That the schists and gneisses of our Highlands and of Scandinavia have resulted from crystallising forces, acting upon strata of sandstone, clay, and limestone, or upon igneous materials constituting lava-currents, or intrusive sheets, dykes, and bosses, I see every reason for believing. That these re-crystallised and highly-foliated masses in the great majority of cases maintain their original positions and relations, or indeed anything approaching their original positions and relations, I greatly doubt; and my doubt on this point has increased the more I have studied the Highland rocks.

Thin bands of quartzite may be the rolled-out representatives of massive beds of sandstone or conglomerate; wide-spreading schists may consist of the crystallised materials of clays and shales, crumpled, pleated, and kneaded together in endless convolutions; vast sheets of gneiss may have originally been intrusive bosses of granite or thick strata of arkose. How, then, are we to apply the ordinary principles that regulate questions concerning dip and strike, and unconformity in the case of sedimentary deposits, to highly altered rocks like these?

The observations of Jukes, Allport, and Phillips on some of the simpler and more easily explicable examples of the production of foliation in rocks require to be cautiously extended, by patient study in the field and in the laboratory, to cases of a more complex and difficult character. Especially in this connection do we welcome such contributions to our knowledge as that made by Mr. Teall in his description of the remarkable foliated dyke of Scourie.

Very significant indeed is the fact that the phenomena of foliation appears to be confined to regions which have been the scene of the most violent subterranean movement and disturbance. That solid rock-masses, subjected to the tremendous earth-strains to which they are liable during mountain-making, are capable of internal movement and flow—like the ice of a glacier—we have the clearest evidence. Many illustrations might be adduced in support of the view that crystallisation is influenced and controlled by mechanical forces—pressures, stresses, and strains. May it not also be true, as long ago suggested by Vose, that the heat which must be generated in the great shearing movements taking place in rocks have also had much to do in giving rise to that re-crystallisation which is the essence of foliation? Rock-masses, in the throes of mountain-birth, have, like glaciers, behaved substantially as viscous bodies; may not the former have undergone molecular changes analogous to regelation in the latter?

That many of the stupendous earth-movements which produced the foliation of the rocks of Scandinavia and the Scottish Highlands must be referred to Archæan times, there is not the smallest room for doubt. That similar effects have resulted from the same agencies during subsequent periods, our fellow-geologists in Scandinavia believe they have found incontrovertible proof. For my own part I look forward confidently to the establishment of the same conclusion from the study of our own Highland rocks.

But here I am conscious that I am venturing on topics upon which great and allowable differences of opinion still exist. The debates in this Geological Section during the first meeting of the British Association in Aberdeen ought, I think, to have marked the practical close of one great series of controversies. The discussions of the present meeting will, I trust, result in the recognition and clear statement of a number of other equally important problems of Highland geology which still await solution. And I am sanguine enough to hope that when this Association next gathers here, my successor in this chair will have to congratulate his audience upon a very brilliant retrospect of work actually accomplished in the interval.

I am encouraged in this optimism by the fact that in the period which has elapsed since our last meeting here, great and important improvements have been made in the methods of geological investigation. We have seen how the discovery of a few fragmentary shells in the limestone of Durness, and of sundry casts of bones in the sandstone of Elgin, have been the means of profoundly modifying our ideas concerning the age of vast tracts of rock in the Highlands. The development of modern methods of petrographical research is destined, I believe, to lead to a similar revolutionising of our views concerning the wonderful series of changes which have taken place within rock-masses, subsequently to their original accumulation.

Especially does the application of the microscope to the study of rocks, when employed in due subordination to, and illustration of, work done in the field, promise to be the source of valuable and fruitful discoveries in the field of Highland geology.

In connection with this subject, I cannot refrain from reminding you that while the initiative in the application of the palæontological method of research was taken by an English land-surveyor, we are indebted to a Scotchman in an equally lowly station of life, for overcoming some of the first difficulties in connection with petrographical study. Many microscopists had employed their instruments, and sometimes with useful results, in the study of the powders and the polished surfaces of rocks; but it is to William Nicol, of Edinburgh, the inventor of the well-known polarising prism which bears his name, that we owe the discovery of the method of preparing transparent sections of fossils, crystals, and rocks, whereby their internal structure may be examined by transmitted light. Nicol bequeathed his preparations to his friend Alexander Bryson, and some of them are now preserved in the British Museum. It is interesting, too, to recall the circumstance that it was a thin section of the granite of Aberdeen in the collection of Bryson which exhibited to Sorby that wondrous assemblage of minute cavities containing liquids, and led him, shortly before our previous meeting here, to write his paper "On the Microscopical study of Crystals, indicating the origin of Minerals and Rocks"—a paper which has indeed proved epoch-making in the history of geology.

Before concluding the remarks which by your kindness I have been permitted to offer you to-day, I cannot forbear from indulging in a pleasant reminiscence of a personal character. Nearly fifteen years have passed away since I first visited the Highlands for the purpose of geological study; it was at that time I first found myself at liberty to put into practice a scheme cherished by me from boyhood, that of studying those Secondary rocks and fossils of the Highlands among which such valuable pioneer work had been done by John Macculloch, Roderick Murchison, and Hugh Miller. I had endeavoured to prepare myself for a somewhat difficult task, by a training partly unofficial and partly official—I will not employ the terms "amateur" and "professional," for of late they have been so sadly misused—but when I came a stranger among you, I could not have deserved, and I certainly did not anticipate, that cordial welcome, that kindly aid and that generous appreciation, of which I accept my position here to-day as the crowning manifestation.

While I continue to occupy myself with the glorious problems of Highland geology—and hitherto I have found that each difficulty surmounted has resulted, like the sown teeth of the slaughtered dragon, in a plentiful crop of new ones—the many acts of kindness of my numerous friends here can never cease to be present in my mind. For not only am I indebted to those who, like your own Dr. Gordon, of Birnie, and Dr. Joass, of Golspie, have been able out of stores of their knowledge to furnish me with "things new and old," and who have been unfailing in their aid and sympathy, but to those also who have pitied, but nevertheless helped, the "daft callant that speers after the chucky stanes."

I know of no higher pleasure than that which the geologist experiences in visiting regions of great scientific interest which are new to him, and of grasping the hands of fellow-workers, whose labours and teachings he has learned to admire and to appreciate. Whatever may be my lot in this way in future years, however rich the country visited may be in objects of profound instructiveness or of surpassing interest, I can anticipate or desire nothing more valuable than the lessons, or kinder than the reception which I have met with here.

"I'll ask na mair, when I get there,
Than just a *Hielan* welcome."

SECTION D

BIOLOGY

OPENING ADDRESS BY PROF. W. C. MCINTOSH, M.D., LL.D., F.R.SS.L. & E., F.L.S., COR. M.Z.S., PRESIDENT OF THE SECTION

I HAVE selected the subject of the phosphorescence of marine animals for a few remarks on the present occasion—the theme, perhaps, being the more appropriate from its congenial local surroundings; for, like St. Andrews, Aberdeen is an

"Old University town
Looking out on the cold North Sea."

A phenomenon so striking as the emission of light by marine organisms could not fail to have attracted notice from very early times, both in the case of navigators and those who gave their attention in a more systematic manner to the study of nature. Accordingly we find that the literature of the subject is both varied and extensive—so much so, indeed, that it is impossible on the present occasion to give more than a very brief outline of its leading features. This is a subject of less moment, however, since the great microscopist, Ehrenberg, in his treatise, "Das Leuchten des Meeres," published by the Berlin Academy in 1835, has given a very full account of the early literature on phosphorescence, both in marine and terrestrial animals, no less than 436 authors being quoted. The limitation just mentioned is therefore sufficiently warranted.

Though it is in the warmer seas of the globe that phosphorescence is observed in its most remarkable forms—as for instance the sheets of white light caused by *Noctiluca*, and the vividly luminous bars of *Pyrosoma*—yet it is a feature which the British zoologist need not leave his native waters to see both in beauty and perfection. Many luminous animals occur between tide-marks, and even the stunted sea-weeds near the line of high water everywhere sparkle with a multitude of brilliant points. As a ship or boat passes through the calm surface of the sea in summer and autumn, the wavelets gleam with phosphorescent points, or are crested with light; while the observer, leaning over the stern, can watch the long trail of luminous water behind the ship, from the brightly sparkling and seething mass at the screw, to the faint glimmer in the distance. On the southern and western shores, again, every stroke of the oar causes a luminous eddy, and some of the smaller forms are lifted by the blade and scintillate brightly as they roll into the water. The dredge and trawl likewise produce, both in the shallower and deeper parts of our seas, many luminous types of great interest and beauty.

I shall, in the first instance, glance at the various groups of marine animals which possess the property of phosphorescence, and thereafter make some general remarks on the subject. It is found then that this feature is possessed by certain members of the Protozoa, and by the following groups of the Metozoa,—viz. Cœlenterates, Echinoderms, Worms, Rotifers, Crustaceans, Molluscoids, Mollusks, and Fishes.

About the middle of last century Baster found that at least three species of what he called microscopic animalcula ("Opuscula Subseciva," vol. i. p. 31, table 4, Fig. 1), apparently infusoria, were phosphorescent; and fully half a century later, Pfaff noticed that the luminosity of the sea at Kiel was due to certain members of the group just mentioned. Subsequently both Michaelis and Ehrenberg met with phosphorescent infusoria in the Baltic, the latter describing them as species of *Peridinium* (now *Ceratium*) and *Prorocentrum*. The same fact, associated with the absence of *Noctiluca* at Kiel, has again more recently been brought forward by Stein. In our own seas I have been especially struck with this feature in July and August, the whole surface of the sea along the eastern shores of England and Scotland teeming with *Ceratium* and *Peridinium*, besides other Infusoria, which form a greenish scum on the interior of tow-nets in inshore water, and for many miles seaward. As the waves curl from the sides of the boat in quiet water, the crest of each sparkles with multitudes of luminous points, which gleam for a moment as the ripple stretches outward, and then disappear; or, still more vividly, when the plunging vessel sends the sparkling spray all around the bow. If, on removing the tow-net from such water at night it is suddenly jerked, the whole interior is beautifully lit up with a luminous lining, which glows brightly for a few seconds and then fades. I have been unable, nevertheless, to satisfy myself as to the phosphorescence of isolated examples of *Ceratium*, and Mr. Murray (who is inclined to follow Klebs in considering them algæ), tells me that he has not been more successful.

The most conspicuous member of the first group (viz. the Protozoa), however, is *Noctiluca*, which for a long time has been associated with luminosity in many seas. The minute size of this little transparent gelatinous sphere, which ranges from ⅙ to ¼ of a millimetre, probably gave origin to some of the ancient views that the phosphorescence of the sea originated from the water, and not from any visible organisms. Amongst the first who clearly made known the relationship of this minute body to the phenomenon we are examining was M. Rigaut, a French naval surgeon, who examined it off various parts of the French coasts as well as off the Antilles, and pointed out in a memoir communicated to the Academy that the luminosity of the sea was caused by an immense number of what he termed little spherical polyps, about a quarter of a line in diameter (*Journal des Savants*, tome xliii., February, 1770, pp. 554–61). The observations of this acute French surgeon were followed up by many subsequent authors, amongst whom may be mentioned Baker, Martin Slabber, Abbé Dicquemare, Suriray, Macartney, and Baird; while in more recent times Verhaege, De Quatrefages, and Giglioli have specially studied the phosphorescence of the sea caused by *Noctiluca*. The light given out by this form is occasionally spread over a large area, and is often evident along the margin of the beach, where the broad belts of Noctilucæ gleam in the broken water. It is not uncommon in summer on the southern shores of Britain, while it is rare in the northern; but it stretches into most of the great oceans, and is the cause of that diffused and silvery phosphorescence so well known to voyagers in the warmer seas. At Ostend, Verhaege found the maximum number in a given quantity of water in the warm months, few or none appearing in the winter. The observations of De Quatrefages ("Observations sur les Noctiluques," *Ann. des Sc. Nat.*, 3e Série, Zool., tom. xiv. p. 226) were made on the shores of France as well as those of Sicily, for he accompanied the distinguished Prof. Henri Milne-Edwards (whose loss science has had so recently to deplore), on his celebrated "Voyage en Sicile," and they were more extensive than those of the previous author. He attributes the emission of the clear bluish light in quiet water, or the white light with greenish or bluish touches in broken water, to any physical agent which produces contraction, the scintillations arising from the rupture and rapid contraction of the protoplasmic filaments in the interior. Thus, like Verhaege and others, he found no special luminous organ. Moreover, Ehrenberg and De Quatrefages observed that the light emitted by *Noctiluca*, though apparently uniform under a lens, was broken up into a number of minute scintillations when highly magnified. Mr. Sorby, in examining the light of this form, has been unable to obtain satisfactory spectroscopic results, apparently from its feebleness.

Besides *Noctiluca*, which was chiefly met with in inshore water, Mr. Murray, of the *Challenger*, describes various species of *Pyrocystis* (*Proc. Roy. Soc.*, vol. xxiv., p. 553, pl. xxi.; and *Narrative*, Zool., vols. i. and ii., pp. 935–38), a closely-allied form, and indeed some of which have been thought to be identical with the former. They abound in the open sea, and are the chief causes of its phosphorescence in the tropical and subtropical oceans. The light is stated to proceed from the nucleus, and in this respect diverges from that observed by De Quatrefages in *Noctiluca*. When shaken in a glass they give out, Sir Wyville Thomson observes ("Atlantic," vol. ii. p. 87), the uniform soft light of an illuminated ground-glass globe.

Dr. Giglioli, during the voyage of the Italian frigate *Magenta*, mentions (*Atti della R. Accad. delle Sc. di Torino*, vol. v., 1869-70, p. 492) that another group of the Protozoa, viz. the Radiolaria, show phosphorescent properties. In the Pacific the genera *Thalassicolla*, *Collozoum*, and *Sphærozoum* shone with an intermittent greenish light. It is possible that Dr. Baird (Loudon's *Mag. Nat. Hist.*, vol. iii. p. 312, Fig. 81, *c*, *d*), in his earlier paper, refers to the same group when describing an unknown phosphorescent pelagic organism.

No group of marine animals is more prominent in regard to phosphorescence than the Cælenterates. The Hydroida are familiar examples (even after many days and in impure water some of these retain this property, a shock to the stem sending off a crowd of luminous points from the trophosome), and, as Mr. Hincks observes, none excels the common *Obelia geniculata*, which forms pigmy forests on the broad blades of Laminariæ all around our shores. In the fresh specimen a touch during summer causes a large number of luminous points to appear on the zoophytes, the stems most irritated emitting beautiful flashes, which glitter like faintly-dotted lines of fire, the points not being harshly separated, but blending into each other, while the shock imparted by the instrument detaches the minute medusoids, which scintillate upward from the parent stem to the summit of the water. Mere blowing on the surface in July, where Laminariæ abound, suffices to produce the emission of light from the pelagic buds. Moreover, these minute bodies, along with the various species of *Ceratium* and minute larval forms of diverse kinds, are sometimes swept by the gales landward, and cause phosphorescence where least expected. In the same manner Vaughan Thompson ("Zoological Researches," vol. i. part i. mem. iii. p. 48, 1829) found luminous patches on the masts and windward yardarms on board ship, and they gradually mounted upward as the gale increased. Many of the free gonosomes of the Hydroids are as luminous as the polypites, and indeed have been described by some of the older naturalists as one of the main causes of the luminosity of the ocean. The light in these (*e.g. Thaumantias*) gleams around the margin and along the four radii.

The Ascraspedote Medusæ have also been signalised as factors in producing the phosphorescence of the sea, such forms as *Pelagia noctiluca* and *Pelagia cyanella* being especially prominent. Spallanzani, indeed, made an elaborate series of experiments on the luminosity of the Medusæ in his voyage to the Two Sicilies. Some of these, as *Dactylometra* (*Pelagia*) *quinquecirra*, Agass., are nocturnal in their habits. They are only occasionally found floating at the surface during the day, while at night, in the same localities, the bottom swarms with these large masses of dull phosphorescence, moving about with the greatest rapidity (Agassiz, "North American Acalephæ," p. 49, Cambridge, 1865). Species of *Rhizostoma* were likewise observed by Giglioli to have a pale bluish luminosity. The two most abundant Medusæ of our eastern shores, viz. *Aurelia aurita* and *Cyanea capillata* (both in its young purple and adult brown condition), so far as I can make out, exhibit no luminosity. This agrees with the views expressed long ago by Ehrenberg.

The oceanic Hydrozoa (*Siphonophora*) are likewise characterised by their phosphorescence. Thus Giglioli met with luminosity in *Abyla*, *Diphyes*, *Eudoxia*, *Praya* and *Aglaismoides*. Dr. Bennett ("Gatherings of a Naturalist," p. 69, 1860) has also observed luminosity amongst the Coralligenous Actinozoa, the grazing of a boat on a coral reef causing a vivid stream of phosphoric light. Similar observations were made on Madrepores by Giglioli (*Atti della R. Accad. d. Sc. di Torino*, vol. v. p. 502), the light in this case being bright greenish and enduring some minutes.

Amongst the Alcyonarians the luminosity of the common Sea-Pen (*Pennatula phosphorea*) has been long known, and was studied by Gesner, Bartholin, Adler, and others. In the earlier part of this century Grant made the well-known and oft-quoted description (*Brewster's Edin. Journ.* vol. vii. p. 330, 1827), in which he pictures a *Pennatula* "with all its delicate transparent polypi expanded and emitting their usual brilliant phosphorescent light, sailing through the still and dark abysses by the regular and synchronous pulsations of the minute fringed arms of the whole polypi." But it ought to be balanced by his concluding statement, that the sea-pens are probably stationary, or "lie at the bottom, and move languidly like Spatangi, Asteriæ or Actiniæ" (certainly the specimens in the St. Andrew's Marine Laboratory were very helpless). Edward Forbes again observed that the light proceeded from the irritated point to the extremity of the polypiferous portion, and never in the opposite direction. As Dr. George Johnston tells us, Forbes induced Dr. George Wilson to test, along with Professor Swan, the polyps during phosphorescence by a delicate galvanometer, but without result. He thought the luminosity was due to a spontaneously inflammable substance.

More recently a series of interesting observations were made by Panceri on the structure and physiology of the luminous organs of this form. His conclusions are (1) that the light emanates from the polyps and zoids; (2) that the phosphorescent organs are the eight white cords adhering to the outer surface of the stomach, and that these are chiefly composed of cells containing a substance of a fatty nature, the oxidation of which causes the light. Panceri's conclusions further considerably modify Forbes's views about the direction of the waves or points of light. He supposes that the elements which stand in the place of nerves are capable of producing in the luminous batteries of the polyps a momentary oxidation—more rapid and more intense—accompanied by phosphorescence. Like those examined by Professor Milnes Marshall ("Report on the Oban Pennatulidæ," p. 49, Birmingham, 1882), the specimens at St. Andrews, after irritation, show a series of brilliant coruscations which flash along the rows of polyps in a somewhat irregular manner.

Two other Alcyonarians, *Funiculina* and *Umbellularia*, are equally phosphorescent. Though the former is familiar enough to some of the long liners of the outer Hebrides and west coast, it is rare that either is procured for scientific investigation. *Funiculina quadrangularis*, according to Forbes (Johnston's *Brit. Zooph.* vol. i. p. 166), gives out a vivid bluish light, which comes from the bases of the polyps, and appears to be connected with the reproductive system. Wyville Thomson ("Depths of the Sea," p. 149) describes the specimens procured in the *Porcupine* as resplendent with a steady pale lilac phosphorescence like the flame of cyanogen; and always sufficiently bright to make every portion of a stem caught in the tangles distinctly visible. The same zoologist mentions that the stem and polyps of *Umbellularia* are so brightly phosphorescent, that Captain Maclear found it easy to determine the character of the light by the spectroscope. It gave a restricted spectrum sharply included between the lines *b* and D ("Atlantic," vol. i. p. 151).

Besides the foregoing Alcyonarians, *Isis* and *Gorgonia* have been indicated as likewise phosphorescent. Dr. Merle Norman and Dr. Gwyn Jeffreys (whose death since the last meeting of the British Association is a serious loss to science) mention a beautifully luminous *Isis* on board the French ship *Le Travailleur*; and Sir Wyville Thomson ("Atlantic," vol. i. p. 119), with the facile and genial pen which characterised the lamented naturalist, gives a fascinating picture of a long, delicate, simple Gorgonian which came up in immense numbers in the trawl from 600 fathoms off the Spanish coast. He conjures up this Gorgonian forest as an animated cornfield waving gently in the slow tidal current, and glowing with a soft diffused phosphorescence, scintillating and sparkling on the slightest touch, and now and again breaking into long avenues of vivid light, indicating the paths of fishes or other wandering denizens of these enchanted regions. Prof. Moseley thinks that this brilliant phosphorescence of the Alcyonarians may be regarded as an accidental production, but that it may be of occasional service. Further, that the deep sea is at any rate lighted up by these Alcyonarians, which would thus form luminous oases round which animals with eyes might possibly congregate ("Notes of a Naturalist on the *Challenger*," p. 590).

The last group of the Cœlenterates, the *Ctenophora*, are even more conspicuous than the foregoing in regard to luminosity. It is indeed long since the Abbé Dicquemare descanted on *Cydippe* (*Pleurobrachia*) and Suriray on *Beroë*, while subsequent authors have made it clear that the majority of this group are phosphorescent. In our own seas, as Prof. Allman observes, *Beroë* at various stages is one of the most prominent luminous forms during certain seasons. Their enormous numbers make their effects more striking, though the intensity of the phosphorescence is less than that of the Medusæ. Quiet seas like Bressay Sound and the Firth of Forth are occasionally covered by a dense layer of these animals. Prof. Allman found that *Beroë* did not phosphoresce if suddenly taken from light into darkness, but that after they had remained about twenty minutes in obscurity they became luminous. Considerable variety exists in this respect at St. Andrews, some emitting light at once, others showing none. It is probable that this uncertainty is connected with the hygienic condition of the individuals.

In foreign seas many brightly luminous species are met with. Thus Prof. A. Agassiz ("North American Acalephæ," p. 20, Cambridge, 1865) describes *Mnemiopsis Leidyi* as "exceedingly phosphorescent, and when passing through shoals of these Medusæ, varying in size from a pin's head to several inches in length, the whole water becomes so brilliantly luminous that an oar dipped up to the handle can plainly be seen on dark nights by the light so produced; the seat of the phosphorescence is confined to the locomotive rows, and so exceedingly sensitive are they that the slightest shock is sufficient to make them plainly visible by the light emitted from the eight phosphorescent ambulacra." The same author (*Op. cit.* p. 24) mentions that *Lesueuria* has a very peculiar bluish light of an exceedingly pale steel colour, but very intense. Giglioli, again, found that the beautiful riband-like *Cestus* shone with a reddish yellow light, but in *Eucharis* the latter was intensely blue (*Op. cit.* p. 495, 496).

While many of the preceding group are pelagic at all periods of their existence, the luminous star-fishes are in their adult condition members of the bottom fauna. The larval stages of the brittle-stars, however, are passed at the surface of the water, where it is probable they add their quota to swell the ranks of the phosphorescent types. Amongst the first to note this property in the brittle-stars was Prof. Viviani, who found on the shores of Genoa a little brittle-star which he termed *Asterias noctiluca*,[1] and which probably is identical with the *Amphiura elegans* of Leach. Péron likewise mentions the phosphorescence of his *Ophiura phosphorea*. Sir Wyville Thomson observed in the *Porcupine* that the light from *Ophiacantha spinulosa* was of a brilliant green, coruscating from the centre of the disk along the rays and illuminating the whole outline of the starfish ("Depths of the Sea," p. 98). More recently Prof. Panceri of Naples has re-examined the phosphorescence of the species described by Viviani, and he finds that though with the first momentary glow the whole ray is lit up with a greenish light, that the luminous points correspond with the bases of the pedicels and are ranged in pairs along the arms (*Atti della R. Accad. d. Sc. Fisiche e Mathem. di Napoli*, 1875, p. 17, pl. iv. figs. 1, 3). In deep water (between twenty and forty fathoms) off our eastern shores, *Ophiothrix* gleams all over the trawl-net with a pale greenish light; but the adults of the same form between tide-marks give no trace of luminosity.

The older authors were familiar with certain luminous annelids which they termed *Nereides*, such as *Nereis phosphorans*. Ehrenberg paid considerable attention to this group, specially referring to *Polynoë fulgurans* from the North Sea, *Nereis noctiluca*[2] and *Nereis* (*Photocharis*) *cirrigera*, the latter species having a photogenic structure in its cirri like the electric organ of the Torpedo. The latter form is probably related to the ubiquitous *Eusyllis*, which, under various names, has been noticed by many observers. Thus it is very likely the same species that is mentioned by Harmer, in Baker's "Employment for the Microscope," p. 400, as having been found on oyster shells; and also by Vianelli, who describes it as a caterpillar-like form amongst seaweeds. Indeed the Syllideans have been conspicuous in the literature of phosphorescence from the time of De la Voie (1665, *fide* Panceri), and Vianelli ("Nuove Scoperte intorno le Luci dell' Acqua Marina," Venezia, 1749), to the recent period of Claparède ("Glanures Zootomiques," p. 95) and Panceri (*Op. cit.* p. 8). The structure of the cirri of the phosphorescent forms, however, gives no support to the opinion of Ehrenberg that they possess a special photogenic structure.

The luminous annelids group themselves under five families, viz. the Polynoidæ, Syllidæ, Chætopteridæ, Terebellidæ, and Tomopteridæ, and the number may yet be extended to include other pelagic types.

In the first family one of the most abundant is *Harmothoë imbricata*, which lives both between tide-marks and deep water, and is cosmopolitan in geographical distribution. It discharges bright greenish scintillations from the point of attachment of each dorsal scale; and thus, under irritation, the flashes are arranged in pairs along the body, or in a double moniliform line. If severely pinched the worm wriggles through the water, emitting sparks of green light from the bases of the feet. The separated scales also continue to gleam for some time, chiefly at the surfaces of attachment (scars), near which, in each, a ganglion exists. The same phenomenon is readily produced in a fragment either of the anterior or posterior end of the body. No mucous secretion is emitted, but the light is clearly produced by the will of the animal, and by the agency of its nervous system. A recent writer, Dr. Jourdan (*Zoologischer Anzeiger*, March, 2 1885, No. 189, p. 133), has endeavoured to prove that this luminosity in another member of the Polynoidæ (viz., *Polynoë torquata*) is produced by cells secreting a phosphorescent mucus, but this view is by no means applicable in all cases.

Besides the species mentioned, various other forms in this family are equally luminous, such as *Polynoë scolopendrina*, *Achloë astericola*, *Polynoë lunulata*, and a Zetlandic *Eunoa*.

[1] "Phosphorescentia Maris," Genoa, 1805, p. 5, tab. i. figs. 1, 2. He observes: "Species hæc radiatæ instar stellæ scintillas in marinis aquis excitasse, quas electrico fluido adscripserunt, admodum probabile est."

[2] Supposed by some to refer to *Noctiluca miliaris*.

As an example of the Syllidæ, the common *Eusyllis*, so often mentioned by previous authors, may be taken. Under irritation a fine green light is emitted from the ventral aspect of each foot, and the scintillations seem to issue from many points at each space, flash along both sides of the worm posterior to the point of stimulation, and then disappear. Under severe irritation the animal remains luminous behind the injured part for nearly half a minute, while the surface of granular light on each segment is larger than usual, and in some instances those of opposite sides are connected on the ventral aspect by a few phosphorescent points. The body behind the irritated region has a paler pinkish hue immediately after the emission of light showing that the luminosity is diffused.

In the Chætopteridæ the phosphorescence is remarkably beautiful, bright flashes being emitted from the posterior feet; but the most vivid luminosity is at a point on the dorsum between the lateral wings of the tenth segment. Here the abundant mucus exuded by the animal can be drawn out as bluish-purple fire of great intensity, which, besides, now and then gleams along the edges of the wing-like processes, and illuminates the surrounding water. A very characteristic odour, somewhat resembling that produced by phosphorus in combustion, is given out by the animal during such experiments. In this connection it may be observed that Quoy and Gaimard mention that an odour similar to that around an electric machine is given out by luminous marine annelids.

Amongst the Terebellidæ, as first shown by Grube none excel the genus *Polycirrus* in the brightness of the phosphorescence and the ease with which it is elicited. Mere blowing on the water of the dissecting-trough suffices to cause in the British *Polycirrus* the most vivid pale bluish luminosity, which gleams for a moment along every one of the independent mobile tentacles. Long before Grube, however, had discovered the phosphorescence of *Polycirrus*, our patient and laborious countryman, Sir J. Graham Dalyell, had noticed it in the group ("Powers of the Creator," vol. ii. p. 210), for he mentions that when irritated *Terebella figulus* gave out the most copious blue refulgence, intermingled with a reddish flame. Another member of this family, viz. *Thelepus*, is only faintly phosphorescent in life, but when decomposition has made progress it gleams in the vessel with a pale lambent light, somewhat like phosphorus in air.

In the pelagic Tomopteridæ certain peculiar structures on the parapodia, formerly supposed by some to be eyes, and by others simply glandular organs, were lately found by Professor Greeff (*Zoologischer Anzeiger*, 1882, p. 384—87) to be luminous organs, which, though glandular, have a considerable nervous supply, including a ganglion.

Panceri's observations on the luminous annelids of Naples, and the peculiar type *Balanoglossus* (Enteropneusta) have recently added considerably to our knowledge of the subject. He specially describes, in *Chætopterus*, the structure of the phosphorescent glands in the great pinnules and other parts, which produce the luminous mucus. With some reason he concludes that two kinds of phosphorescence are present in annelids, viz., one which is the result of purely nervous action, and another which is due to this *plus* a luminous secretion.

A Turbellarian, viz., *Planaria retusa*, was mentioned by Viviani (*Op. cit.* p. 13) as luminous, but this feature appears to be rare in the group; and the same may be observed of phosphorescent Rotifers, one of which (*Synchæta baltica*) was described by Ehrenberg (*Op. cit.* p. 128). Giglioli (*Op. cit.* p. 498) again, records a *Sagitta* which showed a feeble luminosity in the posterior region of the body.

The minute forms amongst the Crustacea (chiefly Copepoda) were recognised as phosphorescent by Athanasius Kircher in 1640, and have been mentioned by most authors who have alluded to the subject since that date. Thus Viviani gives seven species from the shores of Genoa, and Tilesius no less than nineteen luminous crustaceans from Krusenstern's voyage. Dr. Baird describes the light given out by those met with in his cruises as brilliant in the extreme, and Vaughan Thompson added considerably to our knowledge of *Sapphirina* and of the luminous schizopods, an example of which had been discovered by Sir Joseph Banks, and described by Macartney (*Phil. Trans.* 1810, as "Cancer fulgens"). Most authors agree that the minute forms, such as the Copepods, give a sparkling appearance to the surface of the water. The light in these, according to Lesson, proceeds from glands placed on the sides of the thorax; while Giglioli found the luminous organ of the cosmopolitan *Sapphirina* in the anterior part of the thorax. On the other hand, Captain Chimmo (*Euplectella*, &c., 1878) thought it was decomposing food in the stomach, and Prof. Moseley (*Op. cit.* p. 574.—Naturalist on the *Challenger*) in certain cases entertained a similar opinion. The phosphorescence of the Euphausiidæ was a prominent feature in the voyage of the *Challenger*, brilliant flashes being emitted on capture from a series of spots along the trunk and tail. Mr. Murray also met with a diffused light in the Faröe channel when dredging in the *Triton*, and he attributed this to the phosphorescent organs of *Nyctiphanes norvegica*, M. Sars, one of the same group. Prof. G. O. Sars describes these organs as composed of a series of coloured globules, the lens-like body of which acts as a condenser, and thus enables the animal to produce at will a bright flash of light in a given direction ("*Challenger* Narrative," Zoology, I. part ii. pp. 740—43).

Marine phosphorescence has some of its most striking examples amongst the Tunicates. One of the best known instances is that of *Pyrosoma*, the light from which has been so graphically described by M. Péron, Prof. Huxley, and other naturalists who have had an opportunity of observing it. It proceeds in each member of the compound organism from two small patches of cells at the base of each inhalent tube. These cells contain a substance resembling fat. *Salpa* has frequently been mentioned as a luminous form by many authors, but Delle Chiaje found that in the Mediterranean *Salpa pinnata* was not phosphorescent; and amongst the multitudes of Salpæ which for some weeks abounded at Lochmaddy in North Uist, neither the former nor the *Salpa spinosa* of Otto exhibited this property, though a spark was occasionally seen in the nucleus in some specimens, probably from the food. Giglioli likewise is doubtful concerning them, but in one instance a brilliant rose-coloured light appeared in the nucleus. *Doliolum*, on the other hand, shone with a greenish tint, while examples of *Appendicularia* which he encountered in various seas were chameleon-like in their luminosity, and often gleamed with great brightness.

Various mollusks exhibit the property of phosphorescence. Fabricius ab Aquapendente mentions *Sepia*, Panceri *Eledone*, Adler *Chama* and "*Dactylus*." The best known, however, is *Pholas dactylus*, which possesses two wavy bands and triangular organs of ciliated epithelium on the inner surface of the mantle. These secrete a luminous substance, soluble in ether and alcohol, which light up the excurrent water. The light is also maintained for a long time during putrefaction, as in the case of *Thelepus*. Panceri found that carbonic acid extinguished the light, but that air re-illuminated it, just as Johannes Müller had previously observed in a vacuum and in air. The light is monochromatic, the bands having a constant place in connection with the solar spectrum (from line E to line F).

Several Pteropods likewise contribute to the phosphorescence of the sea. Thus Giglioli noticed that a *Cleodora* gave out a very reddish light, while a *Criseis* and a *Hyalæa* were luminous at the base of the shell. He mentions also a large unknown Heteropod (*Op. cit.* p. 497) in the Indian Ocean, which glowed with a reddish phosphorescence. Amongst the Dermatobranchs, *Phyllirrhoë* has the same property, Giglioli further found that *Loligo sagittatus* and a small *Octopus* gleamed all over with a whitish luminosity.

Phosphorescence in living fishes appears to have been accurately observed within a comparatively recent date, though the luminosity of dead fishes has been known from very early times, and has been the subject of many interesting experiments such as those of Robert Boyle on dead whitings (*Phil. Trans.* 1667, pp. 591-93), and Dr. Hulme on herrings (*Phil. Trans.* 1800, p. 161). I do not mean to say that the literature of the so-called phosphorescent fishes is scanty, for it extends from the days of Aristotle and Pliny to modern times, but that the writers have had little reliable evidence in regard to living fishes to bring forward. Thus of upwards of fifty fishes entered by Ehrenberg in his list it is hard to say that one is really luminous during life. In many cases it is probable that the supposed phosphorescence of large forms, such as sword-fishes and sharks, has arisen from the presence of multitudes of minute phosphorescent animals in the water, just as the herring causes a gleam when it darts from the side of a ship. Prof. Moseley, for instance, observed in the *Challenger* that when large fishes, porpoises, and penguins dashed through phosphorescent water, that it was brilliantly lit up, and their track marked by a trail of light. The same feature is observed in hooked fishes, and it is known that fishermen are doubtful of success when the sea is very phosphorescent, for the presence of the net in the water excites the luminosity and scares the herring.

One of the most striking instances of phosphorescence in living fishes is that of the luminous shark (*Squalus fulgens*) found by Dr. Bennett. This is a small dark-coloured shark, which was captured on two or three occasions at the surface of the sea. It emitted without irritation a vivid greenish luminosity as it swam about at night, and it shone for some hours after death. The phosphorescence appears to be due to a peculiar secretion of the skin. The eyes of the shark were more prominent than usual in such forms. (The Danish naturalist Reinwardt describes a phosphorescent fish (*Hemiramphus lucens*) from the Moluccas. *Fide* Giglioli, *Op. cit.* p. 503.) Little is known with regard to the luminosity of the "Pearl-sides" (*Maurolicus pennantii*, Cuv. and Val.) of our own shores, though from its wide distribution this lack of information seems to be remediable.

In recent times phosphorescence has generally been associated with deep-sea fishes. Thus in a narrative of the early part of the voyage of the *Challenger* (NATURE, August 28, 1873) Sir Wyville Thomson mentions ranges of spots or glands producing a phosphorescent secretion on the body of a fish pertaining to the Sternoptychidæ, a species of which is included by Dr. F. Day in the British list. Of a new *Echiostoma* (one of the Stomiatidæ) it is also noted that the two rows of probably phosphorescent dots along the body were red, surrounded by a circle of pale violet ("*Challenger* Narrative, Zoology," I. vol. ii. p. 42). Dr. Günther ("*Challenger* Narrative, Zoology, I. part ii. p. 905) observes that many deep-sea fishes have round, shining, mother-of-pearl bodies embedded in the skin. These are supposed to be producers of light, and they have been observed to be phosphorescent in two species of Sternoptychidæ. He further states that the whole muciferous system is dilated in deep-sea fishes, that is, fishes inhabiting 1000 fathoms or more, and that the entire body seems to be covered with a layer of mucus, the physiological use of which is unknown; it has been noticed to have phosphorescent properties in perfectly fresh specimens.

Having thus briefly reviewed the leading features of phosphorescence in marine animals, a glance may now be taken at the supposed causes and purposes of this provision.

I do not deem it necessary to go into detail with regard to the numerous views which have been advanced to account for the phosphorescence of marine organisms, for these range over a very wide area—from its production by electricity, the constant agitation of the water, by putrefaction, by luminous imbibition, to its manifestation as a vital action in the animals, or a secretion of a phosphorescent substance. Ehrenberg considered it a vital act similar to the development of electricity, and sometimes accompanied by the secretion of a mucilaginous humour which is diffused around; while others, such as Meyen, thought it only a superficial oxidation of the mucous coat, or a luminour secretion from certain glands. Some believed that a liquid containing phosphorus was secreted, and that this underwent slow combustion; while others explained that it was a nervous fluid modified by certain organs to appear as light. Coldstream thought it was due to an imponderable agent, and that phosphorus or an analogous substance might enter into the organs producing it. De Quatrefages, again, clearly affirms that it is produced in two ways: (1) by the secretion of a peculiar substance exuding from the entire body or a special organ; and (2) by a vital action independent of all material secretion. Panceri was strongly impressed with the importance of fatty matter in the forms he examined—such as *Pennatula*, the Medusæ, Beroïdes, Pholades, *Chætopteri*, and *Noctilucæ*—the phosphorescence arising from the slow oxidation of this substance; the nervous system of the living animal, however, being capable of producing a momentary oxidation more rapid and more intense, accompanied by light.

It will be observed that in the Protozoa the structure of the minute but often very abundant animals which furnish the luminosity clearly proves that the presence of a well-defined nervous system is not required for its manifestation, the protoplasm of their bodies alone sufficing for its development. There are neither glands for secreting it, and in some apparently no fatty matter for slow combustion. In the Cœlenterates the phenomena appear to be more nearly related to nervous manifestations, though in certain cases the luminous matter possesses inherent properties of its own. While in some annelids, such as *Chætopterus* and *Polyirrus*, there are glands which may be charged with the secretion of a luminous substance, it is otherwise with certain Polynoidæ, in which the emission of light appears to be an inherent property of the nervous system. The irritability in the phosphorescent examples of the latter family, however, varies considerably, some, *e.g. Polynoë scolopendrina*, being sluggish, while others, like *Harmothoë*, are extremely irritable. In the Crustaceans the luminosity seems to have the nature of a secretion, probably under the control of the nervous system. In *Pyrosoma* and *Pholas dactylus* a luminous secretion is also a prominent feature, and in both the latter and the annelids decay excites its appearance, as also is the case, to a limited extent, in fishes.

It is evident, therefore, that the causation of phosphorescence is complex. In the one group of animals it is due to the production of a substance which can be left behind as a luminous trail. The ease, for instance, with which in *Pennatula* and other Cœlenterates the phosphorescence can be repeatedly produced by friction on a surface having a minute trace of the material, clearly points to other causes than nervous agency. The action, moreover, clearly affects the organic chemical affinities of the tissues engaged. On the other hand again, as in certain annelids, it is purely a nervous action, probably resembling that which gives rise to heat.

With the exception of such as Macartney, the older authors, who in some cases took an imaginative view of the question, connected the emission of light with the special economy of the deep sea. The speculations to this effect are fairly summarised in "Brewster's Edinburgh Encyclopædia," published in 1830 (Chiefly the views of Dr. Macculloch). Thus it is supposed that total darkness exists at the depth of 1000 feet, and that the phosphorescence of marine animals is a substitute for the light of the sun. Moreover, that by these lights the animals on the one hand are guided for attack, and on the other their power of extinguishing them enables them to escape destruction. Fishes are known to prey chiefly at night, and the writer supposes that the phosphorescence of their prey guides them; for, he says, this luminosity is particularly brilliant in those inferior animals which from their astonishing powers of reproduction, and from a state of feeling little superior to that of vegetables, appear to have been in a great measure created for the food of the more perfect kinds. Dr. Coldstream at a later period (1847) reproduced the same views in his article on animal luminosity (Todd's "Cyclop. of Anat. and Phys.").

The same notion was brought forward in the "Report of the Cruise of the *Porcupine*" (*Proc. Roy. Soc.*, No. 121, 1870, p. 432), and special reference was made to the young of certain starfishes, which are stated to be more luminous than the adults, that being part of the general plan which provides an excess of the young of many species, apparently as a supply of food, their wholesale destruction being necessary for the due restriction of the multiplication of the species, while the parent individuals, on the other hand, are provided with special appliances for escape or defence. Thus phosphorescence, it is further asserted ("Depths of the Sea," p. 149), in very young Ophiacanthæ just rid of their plutei, in a sea swarming with predaceous crustaceans, such as *Dorynchus* and *Munida*, with great bright eyes, must be a fatal gift. Some naturalists still appear to hold a similar, though perhaps modified view. Much caution, however, is necessary in theorising on this head.

In the first place, phosphorescent animals do not appear to be more abundant in the depths of the sea than between tide-marks or on the surface, the latter perhaps presenting the maximum development of those exhibiting this phenomenon. Very many of the young that have been indicated as so brilliantly luminous become surface-forms soon after leaving the egg, and thus at their several stages more or less affect the three regions—of surface, mid-water, and bottom.

A survey of the life-histories of the several phosphorescent groups affords at present no reliable data for the foundation of a theory as to the functions of luminosity, especially in relation to food. No phosphorescent form is more generally devoured by fishes or other animals than that which is not; and, on the other hand, the possessor of luminosity, if otherwise palatable, does not seem to escape capture. An examination of the stomachs of fishes makes this clear, except perhaps in the case of the herring, which, however, is chiefly a surface-fish. Further, it is not evident that such animals are luminous at all times, for it is only under stimulation that many exhibit the phenomenon.

Moreover, the irregularity of its occurrence in animals possessing the same structure and habits in every respect, strengthens the view just expressed. Thus, while *Pholas dactylus* has been known from the days of Pliny to be luminous, the common *Pholas crispata* is not so endowed. Two annelids abound between tide-marks (*Harmothoë imbricata* and *Polynoë floccosa*), and closely resemble each other in habits and appearance; yet one is brightly luminous, while the other shows no trace. Instead of luring animals for prey, or affording facilities for being easily preyed upon, the possessors of phosphorescence in the annelids are often the inhabitants of tubes, or are commensalistic on starfishes. Indeed, every variety of condition accompanies the presence of phosphorescence in the several groups, so that the greatest care is necessary in making deductions, especially if these are to have a wide application.

In the foregoing brief outline of the remarkable phenomenon of phosphorescence as it affects marine animals, it is apparent that, though a considerable increase in our knowledge has taken place during the last quarter of a century, much more yet remains to be done. I, however, confidently look forward for further advances, in this as well as in other departments, to the marine laboratories of the country—I mean such institutions as those now in working order at Granton, St. Andrews, and Tarbet, as well as the larger establishment proposed to be erected by the Biological Association at Plymouth. These laboratories, it is true, have been tardily instituted, but it is satisfactory to think that at last the zeal and methods of the workers have, and will have, a better field for their exercise than formerly, and that the zoology of the fisheries will obtain that attention which its importance to the country necessitates.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY GENERAL J. T. WALKER, C.B., LL.D., F.R.S., F.R.G.S., PRESIDENT OF THE SECTION.

MY predecessors in this chair have claimed for geography a range of science which may be said to be practically unlimited; for it comprehends the history of the earth itself, and of all the life to be met with on the surface of the earth, from the first beginnings of things, and through their subsequent development onwards to their present conditional status; it is associated in a greater or less degree with every other department of knowledge and is a remarkable exemplification of the mutual interdependence and correlation of the physical sciences, for while all other branches of science are incomplete without some knowledge of geography, it is incomplete without some knowledge of each and all of them.

Such claims on behalf of geography would, not many years ago, have been considered extravagant and exaggerated; a popular encyclopædia which is still of some note defines geography to be simply the science which describes the surface of the earth, and somewhat querulously complains that geographical treatises contain matter not unfrequently taken from statistics, natural philosophy, and history which it declares to be irrelevant and not properly admissible into such treatises. And in a popular sense geography is still commonly suggestive only of such a knowledge of locality as may be acquired from maps and charts, with their graphical delineations of whatever exists on the surface of the earth, and of the various natural or artificial boundary lines of the peoples and states between whom the surface is divided. But the British Association and the Royal Geographical Society have successfully maintained that scientific geography is not restricted in its scope to a mere knowledge of locality—though that in itself is a very important factor in whatever appertains to the intercourse and mutual relations of mankind—but embraces all that relates to the structure and existing configuration of the earth, and takes cognisance of the varied conditions of all the life, both animal and vegetable, which is nurtured and supported by the earth; it studies the side lights which the general configuration of surface throws on the character of each locality as a home and support of life, and it examines with special interest the influence which that character has exerted on the social and political conditions of different races and peoples.

And geography does not merely devote its attention to the existing order of things as now displayed to our gaze; in alliance with geology it studies the history of a distant past, when the features of the earth's surface were not precisely as now, and lands which we see high above our horizon lay deep beneath the ocean, and life existed in other forms, whose mute records we possess in the fossils—the *Ilkha-kâni* or written stones as they are significantly called by the people of Afghanistan—which, after long lying entombed among the rocks, are presented to modern sight as revelations of life's early dawn; it investigates what Baron Richtofen describes as the reciprocal causal relations of the three kingdoms—land, water, and atmosphere; it seeks to determine the processes by which in some parts of the globe continents were built up with their varied sculpture of mountain and valley, of highly elevated plateau and low lying plain, of lakes and inland seas, and great river systems,—while in other parts land was depressed below the sea level, or broken up into the islands which are now dotting the surface of the ocean; and it endeavours to trace a process of continuous evolution of life from the primary and simplest types which perished in the early ages of the earth's history, to the latest and most highly developed types which are now flourishing around us. Going back still further it searches for evidence of the first beginnings of the material universe; it looks beyond the orbit of the most distant planet of the solar system, and scrutinises the boundless regions of stellar space to find, in the widely scattered particles of the nebulæ, the beginnings of new solar systems and new worlds such as ours; there it may be said to behold as in a mirror the formation of our own planet as a fluid igneous mass thrown off with great velocity from its sun, and rapidly revolving, and then becoming spheroidal, and slowly cooling and solidifying, and finally acquiring the crust which was to become an abode for life, the stage whereon man was to play out the drama of his planetary existence, and be held all the while fast imprisoned and out of touch with the surrounding universe.

More than this we would seek to know, but in vain; in passing from the early dawn of matter to that of life, science finds its career of wonderful achievement in the one direction exchanged for failure and disappointment in the other; it cannot discover the origin of life in any of its existing material forms, nor trace to its birthplace the spiritual life which exerts such an influence on what is material; it cannot ascertain whether man had a prior existence as different from his present existence as the first beginnings of his planet home differed from its present condition; it cannot gauge the truth of the poet's prescient conception that

> "Our birth is but a sleep and a forgetting;
> The soul that rises with us, our life's star,
> Hath had elsewhere its setting
> And cometh from afar."

It whispers faint suggestions regarding the possible future of the planet; but when questioned as to what is to follow the coming soul's setting of man, the planet's chief glory and dignity, it has nothing to reply, but is hopelessly dumb and inarticulate.

Scientific geography embraces a wide range of subjects, wider than can be claimed for any other department of science. Thus the President of this Section has a vast field from which to gather subjects for his opening address. I shall, however, restrict my address to the subject with which I am most familiar, and give you some account of the Survey of India, and more particularly of the labours of the trigonometrical or geodetic branch of that survey, in which the best years of my life have been passed.

I must begin by pointing out that the survey operations in India have been very varied in nature, and constitute a blending together of many diverse ingredients. Their origin was purely European, nothing in the shape of a general survey having been executed under the previous Asiatic Governments; lands had been measured in certain localities, but merely with a view to acquiring some idea of the relative areas of properties, in assessing on individuals the share of the revenue levied on a community; but other factors than area—such as richness or poverty of soil, and proximity or absence of water—influenced the assessment, and often in a greater degree, so that very exact measurements of area were not wanted for revenue purposes, and no other reason then suggested itself why lands should be accurately measured. The value of accurate maps of individual properties, with every boundary clearly and exactly laid down, was not thought of in India in those days, and indeed has only of late years begun to be recognised by even the British Government. The idea of a general geographical survey never suggested itself to the Asiatic mind. Thus when Englishmen came to settle in India, one of their first acts was to make surveys of the tracts of country over which their influence was extending; and as that influence increased, so the survey became developed from a rude and rapid primary delineation of the broad facts of general geography, to an elaborately executed and artistic delineation of the topography of the country, and in some provinces to the mapping of every field and individual property. Thus there have been three orders or classes of survey, and these may be respectively designated geographical, topographical, and cadastral; all three have frequently been carried on *pari passu*, but in different regions, demanding more or less elaborate survey according as they happened to be more or less under British influence. There is also the Great Trigonometrical or Geodetic Survey, by which the graphical surveys are controlled, collated, and co-ordinated, as I will presently explain.

Survey operations in India began along the coast-lines before the commencement of the seventeenth century, the sailors preceding the land surveyors by upwards of a century. The Directors of the East India Company, recognising the importance of correct geographical information for their mercantile enterprises, appointed Richard Hakluyt, Archdeacon of Westminster, their historiographer and custodian of the journals of East Indian voyages, in the year 1601, within a few weeks of the establishment of the company by Royal Charter. Hakluyt gave lectures to the students at Oxford, and is said by Fuller to have been the first to exhibit the old and imperfect maps and the new and revised maps for comparison in the common schools, "to the singular pleasure and great contentment of his auditory." The first general map of India was published in 1752 by the celebrated French geographer D'Anville, and was a meritorious compilation from the existing charts of coast-lines and itineraries of travellers. But the Father of Indian Geography, as he has been called, was Major Rennell, who landed in India as a midshipman of the Royal Navy in 1760, distinguished himself in the blockade of Pondicherry, was employed for a time in making surveys of the coast between the Paumben Passage and Calcutta, was appointed Surveyor of the East India Company's dominions in Bengal in 1764, was one of the first officers to receive a commission in the Bengal Engineers on its formation, and in 1767 was raised to the position of Surveyor-General. Bengal was not in those days the tranquil country we have known it for so many years, but was infested by numerous bands of brigands who professed to be religious devotees, and with whom Rennell came into collision in the course of one of his surveying expeditions, and was desperately wounded; he had to be taken 300 miles in an open boat for medical assistance, the natives meanwhile applying onions to his wounds as a cataplasm. His labours in the survey of Bengal lasted over a period of nineteen years, and embraced an area of about 300,000 square miles, extending from the eastern boundaries of Lower Bengal to Agra, and from the Himalayas to the borders of Bandelkand and Chota Nagpur. Ill-health then compelled him to retire from the service on a small pension and return to England; but not caring, as he said, to eat the bread of idleness, he immediately set himself to the utilisation of the large mass of geographical materials laid up and perishing in what was then called the India House; he published numerous charts and maps, and eventually brought out his great work on Indian Geography, the "Memoir of a map of Hindostan," which went through several editions; this was followed by his Geographical System of Herodotus, and various other works of interest and importance. His labours in England extended over a period of thirty-five years, and their great merits have been universally acknowledged.

Rennell's system of field-work in Bengal was a survey of routes checked and combined by astronomical determinations of the latitude and the longitude, and a similar system was adopted in all other parts of India until the commencement of the present century. But in course of time the astronomical basis was found to be inadequate to the requirements of a general survey of all India, as the errors in the astronomical observations were liable materially to exceed those of the survey, if executed with fairly good instruments and moderate care. Now this was no new discovery, for already early in the eighteenth century the French Jesuits who were making a survey of China—with the hope of securing the protection of the Emperor, which they considered necessary to favour the progress of Christianity—had deliberately abandoned the astronomical method and employed triangulation instead. Writing in the name of the missionaries who were associated with him in the survey, Père Regis enters fully into the relative advantages of the two methods, and gives the trigonometrical the preference, as best suited to enable the work to be executed in a manner worthy the trust reposed in them by a wise prince, who judged it of the greatest importance to his State. "Thus," he says, "we flatter ourselves we have followed the surest course, and even the only one practicable in prosecuting the greatest geographical work that was ever performed according to the rules of art."

What was true in those days is true still; points whose relative positions have been fixed by any triangulation of moderate accuracy present a more satisfactory and reliable basis for topographical survey than points fixed astronomically. Though the lunar theory has been greatly developed since those days by the labours of eminent mathematicians, and the accuracy of the lunar tables and star catalogues is much increased, absolute longitudes are still not susceptible of ready determination with great exactitude; moreover, all astronomical observations, whether of latitude or longitude, are liable to other than intrinsic errors, which arise from deflection of the plumb-line under the influence of local attractions, and which of themselves materially exceed the errors that would be generated in any fairly executed triangulation of a not excessive length, say not exceeding 500 miles.

Thus at the close of the last century Major Lambton, of the 33rd Regiment, drew up a project for a general triangulation of Southern India. It was strongly supported by his commanding officer—Colonel Wellesley, afterwards the Duke of Wellington—and was readily sanctioned by the Madras Government; for a large accession of territory in the centre of the peninsula had been recently acquired, as the result of the Mysore campaign, by which free communication had been opened between the east and west coasts of Coromandel and Malabar; and the proposed triangulation would not merely furnish a basis for new surveys, but connect together various isolated surveys which had already been completed or were then in progress. The Great Trigonometrical Survey of India owes its origin as such, and its simultaneous inception as a geodetic survey, to Major Lambton, who pointed out that the trigonometrical stations must needs have their latitudes and longitudes determined for future reference just as the discarded astronomical stations, not however by direct observation, but by processes of calculation requiring a knowledge of the earth's figure and dimensions. But at that time the elements of the earth's figure were not known with much exactitude, for all the best geodetic arcs had been measured in high latitudes, the single short and somewhat questionable arc of Peru being the only one situated in the vicinity of the equator. Thus additional arcs in low latitudes, as those of India, were greatly needed and might be furnished by Lambton. He took care to set this forth very distinctly in the programme which he drew up for the consideration of the Madras Government, remarking that there was thus something still left as a desideratum for the science of geodesy, which his operations might supply, and that he would rejoice indeed should it come within his province "to make observations tending to elucidate so sublime a subject."

Lambton commenced operations by measuring a base line and a small meridional arc near Madras, and then, casting a set of triangles over the southern peninsula, he converted the triangles on the central meridian into a portion of what is now known as the Great Arc of India, measuring its angles with extreme care, and checking the triangulation by base lines measured at distances of two to three degrees apart in latitude. His principal instruments were a steel measuring chain, a great theodolite, and a zenith sector, each of which had a history of its own before coming into his hands. The chain and zenith sector were sent from England with Lord Macartney's Embassy to the Emperor of China, as gifts for presentation to that potentate, who unfortunately did not appreciate their value and declined to accept them; they were then made over to Dr. Dinwiddie, the astronomer to the embassy, who took them to India for sale. The theodolite was constructed in England for Lambton, on the model of one in use on the Ordnance Survey; on its passage to India it was captured by the French frigate, the *Piemontaise*, and landed at Mauritius, but eventually it was forwarded to its destination by the chivalrous French Governor, De Caen, with a complimentary letter to the Governor of Madras.

Lambton was assisted for a short time by Captain Kater, whose name is now best known in connection with pendulum experiments and the employment of the seconds' pendulum as a standard of length; but for many years afterwards he had no officer to assist him. At first he met with much opposition from advocates of the discarded astronomical method, who insisted on its being sufficiently accurate and more economical than the trigonometrical. But he was warmly supported by Maskelyne, the Astronomer-Royal in England; and soon had an opportunity of demonstrating the astronomical method to be fallacious, for its determination of the breadth of the peninsula in the latitude of Madras was proved by the triangulation to be forty miles in error. Still, for several years he never received a word of sympathy, encouragement, or advice either from the Government or from the Royal Society. A foreign nation was the first to recognise the importance of his services to science, the French Institute electing him a corresponding member in 1817. After this, honours and applause quickly followed from his own countrymen. In 1818 the Governor-General of India—then the Marquis of Hastings—decided that the survey should be withdrawn from the supervision of a local Government and placed under the Supreme Government, with a view to its extension over all India, remarking at the same time that he was "not aware that with minds of a certain order he might lay himself open to the idle imputation of vainly seeking to partake the gale of public favour and applause which the labours of Colonel Lambton had recently attracted;" but as the survey had reached the northern limits of the Madras Presidency, its transfer to the Supreme Government, if it was to be further extended, had become a necessity. He directed the transfer to be made, and the survey to be called in future the Great Trigonometrical Survey of India. Noticing that the intense mental and bodily labour of conducting it was being performed by Lambton alone, that his rank and advancing age demanded some relief from such severe fatigue, and farther, that it was not right that an undertaking of such importance should hang on the life of a single individual, the Governor-General appointed two officers to assist him—Captain Everest, as chief assistant in the geodetic operations; and Dr. Voysey, as surgeon and geologist. Five years afterwards Lambton died, at the age of seventy. The happy possessor of an unusually robust and energetic constitution and a genial temperament, he seems to have scarcely known a day's illness, though he never spared himself nor shrank from subjecting himself to privations and exposure which even Everest thought reckless and unjustifiable. These he accepted as a matter of course, saying little about them, and devoting his life calmly and unostentatiously to the interests of science and the service of his country.

Everest's career in the survey commenced disastrously. He was deputed by Lambton to carry a triangulation from Hydrabad, in the Nizam's territory, eastwards to the coast, crossing the forest-clad and fever-haunted basin of the Godavery river, a region which he described as "a dreadful wilderness, than which no part of the earth was more dreary, desolate, and fatal." Indignant at being taken there, his escort, a detachment of the Nizam's troops, mutinied, and soon afterwards he and his assistants, and almost all the men of his native establishment, were stricken down by a malignant fever; many died on the spot, and the survivors had to be carried into Hydrabad, whence litters and vehicles of all descriptions, and the whole of the public elephants, were despatched to their succour. To recover his health Everest was compelled to leave India for a while and proceed to the Cape of Good Hope, where he remained for three years. He availed himself of the opportunity to inspect Lacaille's meridional arc, which, when compared with the arcs north of the equator, indicated that the opposite hemispheres of the globe were seemingly of different ellipticities. He succeeded in tracing this anomaly to an error in the astronomical amplitude of the arc, which had been caused by deflection of the plumb-line at the ends of the arc, under the influence of the attraction of neighbouring mountains. Thus he became aware of the necessity of placing the astronomical stations of the Indian arcs at points where the plumb-line would not be liable to material deflection by the attraction of neighbouring mountain ranges. Shortly after his return to India Lambton died, and Everest succeeded him, and immediately concentrated his energies on the extension of the Great Arc northwards. He soon came to the conclusion that his instrumental equipment, though good for the time when it was procured, and amply sufficient for ordinary geographical purposes, was inadequate for the requirements of geodesy, and generally inferior to the equipments of the geodetic surveys then in progress in Europe. He therefore proceeded to Europe to study the procedure of the English and French surveys, and also to obtain a supply of new instruments of the latest and most improved forms. The Court of Directors of the Honourable East India Company accorded a most liberal assent to all his proposals, and gave him *carte blanche* to provide himself with whatever he considered desirable to satisfy all the requirements of science.

Everest returned to India with his new instrumental equipment in 1830, a year that marks the transition of the character of the operations from an order of accuracy which was sufficient as a basis for the graphical delineation of a comparatively small portion of the earth's surface, to the higher precision and refinement which modern geodesists have deemed essentially necessary for the determination of the figure and dimensions of the earth as a whole. He immediately introduced an important modification of the general design of the principal triangulation, which up to that time had been thrown as a network over the country on either side of the Great Arc, as in the English survey and many others; but he abandoned this method, and, adopting that of the French survey instead, he devised a system of meridianal chains to be carried at intervals of about 1° apart, and tied together by longitudinal chains at intervals of about 5°, the whole forming, from its resemblance to the homely culinary utensil with which we are all familiar, what has been called the gridiron system in contradistinction to the network. The entire triangulation was to rest on base-lines to be measured with the new Colby apparatus of compensation bars and microscopes which had been constructed to supersede the measuring chain the Emperor of China had rejected; the base-lines were to be placed at the intersections of the longitudinal chains of triangles with the central meridional or axial chain, and also at the further angles of the gridirons on each side. Latitudes were to be measured at certain of the stations of the central chain, with new astronomical circles in place of the old zenith sector, to give the required meridional arcs of amplitude. Two radical improvements on all previous procedure were introduced in the measurement of the principal angles, one affecting the observations, the other the objects observed. The great theodolites were manipulated in such a manner as not merely to reduce the effects of accidental errors by numerous repetitions in the usual way, but absolutely to eliminate all periodic errors of graduation by systematic changes of the position of the azimuthal circle relatively to the telescope, in the course of the complete series of measures of every angle. The objects formerly observed had been cairns of stones or other opaque signals; for these Everest substituted luminous signals, lamps by night, and, by day, heliotropes which were manipulated to reflect the sun's rays through diaphragms of small aperture, in pencils appearing like bright stars, and capable of penetrating a dense atmosphere through which distant opaque objects could not be seen.

Everest's programme of procedure furnished the guiding principles on which the operations were carried out during the period of half a century which intervened between their commencement under his superintendence and the completion of the principal triangulation under myself. The external chains have necessarily been taken along the winding course of the frontier and coast lines instead of the direct and more symmetrical lines of the meridians and the parallels of latitude. The number of the internal meridional chains has latterly been diminished by widening the spaces between them, and in two instances a principal chain has been dispensed with because, before it could be taken in hand, a good secondary triangulation had been carried over the area for which it was intended to provide. But these are departures from the letter rather than the spirit of Everest's programme which has been faithfully followed throughout, first by his immediate successor, Sir Andrew Waugh, and afterwards by myself, thus affording an instance of the impress of a single mind on the work of half a century which is probably unique in the annals of India; for there, as is well known, changes of personal administration are frequent, and are not uncommonly followed by changes of procedure.

The physical features of a country necessarily exercise a considerable influence on the operations of any survey that may be carried over it, and more particularly on those of a geodetic survey, of which no portion is allowed to fall below a certain standard of precision. Every variety of feature, of scenery, and of climate that is to be met with anywhere on the earth's surface between the equator and the arctic regions has its analogue between the highlands of Central Asia and the ocean, which define the limits of the area covered by the Indian survey. Thus in some parts the operations were accomplished with ease, celerity, and enjoyment, while in others they were very difficult and slow of progress, always entailing great exposure, and at times very deadly. In an open country, dotted with hills and commanding eminences, they advanced as on velvet; in close country, forest-clad or covered with other obstacles to distant vision, they were greatly retarded, for there it became necessary either to raise the stations to a sufficient height to overlook all surrounding obstacles, or to render them mutually visible by clearing the lines between them; and both these processes are more or less tedious and costly. There are many tracts of forest and jungle which greatly impeded the operations, not merely because of the physical difficulties they presented, but because they teemed with malaria, and were very deadly during the greater portion of the year, and more particularly immediately after the rainy seasons, when the atmosphere is usually clearest and most favourable for distant observations. At first tracts of forest, covering extensive plains, were considered impracticable; thus Lambton carried his network over the open country, and stopped it whenever it reached a great plain covered with forest and devoid of hills; but Everest's system would not permit of any break of continuity, nor the abandonment of any chain which was required to complete a gridiron; it has been carried out in all its integrity, often with much sacrifice of life, but never with any shrinking on the part of the survey officers from carrying out what it had become a point of honour with them to accomplish, and the accomplishment of which the Government had come to regard as a matter of course. We have already seen how the progress of Everest's first chain of triangles was suddenly arrested because he and all his people were struck down by malaria in the pestilential regions of the Godavery basin. That chain remained untouched for fifty years; it was then resumed and completed, but with the loss of the executive officer, Mr. George Shelverton, who succumbed when he had not yet reached, but was within sight of, the east coast line, the goal towards which his labours were directed. Many regions, as the basin of the Mahanaddi, the valley of Assam, the hill ranges of Tipperah, Chittagong, Arracan, and Burma, and those to the east of Moulmein and Tennasserim, which form the boundary between the British and the Siamese territories, are covered with dense forest, up to the summits of the peaks which had to be adopted as the sites of the survey stations. As a rule the peaks were far from the nearest habitation, and they could not be reached until pathways to them had been cut through forests tangled with a dense undergrowth of tropical jungle; not unfrequently large areas had to be cleared on the summits to open out the view of the surrounding country. Here the physical difficulties to be overcome were very considerable, and they were increased by the necessity that arose, in almost every instance, of importing labourers from a great distance to perform the necessary clearances. But the broad belt of forest tract known as the Terai, which is situated in the plains at the feet of the Nepalese Himalayas, was the most formidable region of all, because the climate was very deadly for a great portion of the year, and more particularly during the season when the atmosphere was most favourable for the observations, though the physical difficulties were not so great as in the hill tracts just mentioned, and labour was more easily procurable. Lying on the British frontier, at the northern extremities of no less than ten of the meridional chains of triangles, it had necessarily to be operated in to some extent, and Everest wished to carry the several chains across it, on to the outer Himalayan range, and then to connect them together by a longitudinal chain running along the range from east to west, completing the gridiron in this quarter. But the range was a portion of the Nepalese territories, and all Europeans—excepting those attached to the British embassy at Khatmandu—were debarred from entering any part of Nepal, by treaty with the British Government. Everest hoped that the rulers of Nepal might make an exception in his favour for the prosecution of a scientific survey; and when he found they would not, he urged the Government to compel them to give his surveyors access, at least, to their outlying hills; but he urged in vain, for the Government would not run the risk of embarking in a war with Nepal for purely scientific purposes. Thus the connecting chain of triangles—now known as the N.E. Longitudinal Series—had to be carried through the whole length of the Terai, a distance of about 500 miles, which involved the construction of over 100 towers—raised to a height of about 30 feet to overlook the earth's curvature—and the clearance of about 2,000 miles of line through forest and jungle to render the towers mutually visible. It required no small courage on Everest's part to plunge his surveyors into this region; he endeavoured to minimise the risks as much as possible by taking up the longitudinal chain in sections, bit by bit, on the completion of the successive meridional chains, and thus apportioning it between several survey parties, each operating in the Terai for a short time, instead of assigning it to a single party to execute continuously from end to end, as all the other chains of triangles. But notwithstanding these precautions, the peril was great, and the mortality among both officers and men was very considerable; greater than in many a famous battle, says Mr. Clements Markham, in an eloquent passage in his Memoir of the Indian Surveys, in which he claims for the surveyors who were employed on these operations—with no hope of reward other than the favourable notice of their immediate chief and colleagues—merit for more perilous and honourable achievement than much of the military service which is plentifully rewarded by the praises of men and prizes of all kinds.

Everest retired in 1843, and was succeeded by Waugh, who applied himself energetically to the completion of the several chains of triangles exterior to the Great Arc, for which he obtained a substantial addition to the existing equipment of great theodolites. It was under him that the formidable longitudinal series through the Terai, which had been begun by Everest, was chiefly carried out. He personally initiated the determination of the positions and heights of the principal snow peaks of the Himalayan ranges; and he did much for the advancement of the general topography of India, which had somewhat languished under his predecessor, who had devoted himself chiefly to the geodetic operations. He retired in 1861, and I succeeded to the charge of the Great Trigonometrical Survey. The last chain of the principal triangulation was completed in 1882, shortly before my own retirement.

Of the general character of the operations, it may be asserted without hesitation that a degree of accuracy and precision has been attained which has been reached by few and surpassed by none of the great national surveys carried out in other parts of the world, and which leaves nothing to be desired even for the requirements of geodesy; a very considerable majority of the principal angles have been measured with the great 24-inch and 36-inch theodolite, and their theoretical probable error averages about a quarter of a second; of the linear measurements the probable error, so far as calculable, may be taken as not exceeding the two-millionth part of any measured length. And as regards the extent of the triangulation, if we ignore the primary network in Southern India, and all secondary triangulation, however valuable for geographical purposes, we still have a number of principal chains—meridional, longitudinal, and oblique—of which the aggregate length is 17,300 miles, which contain 9,230 first-class angles all observed, and rest on eleven base-lines measured with the Colby apparatus of compensation bars and microscopes. This prodigious amount of field-work furnishes an enormous mass of interdependent angular and linear measures; and each of these is fallible in some degree, for, great as was the accuracy and care with which they had severally been executed, perfect accuracy of measurement is as yet beyond human achievement; thus every circuit of triangles, every chain closing on a base-line, and even every single triangle, presented discrepancies the magnitude of which was greater or less according as derived from a combination of many, or only of a few, of the fallible facts of observation. Thus, when the field operations were approaching their termination, the question arose as to how these facts were to be harmonised and rendered consistent throughout, which was a very serious matter considering their great number. The strict application of mathematical theory to a problem of this nature requires the adjustment to be effected by the application of a correction to every fact of observation, not arbitrarily, but in such a manner as to give it its proper weight, neither more nor less, in the final investigation, and in this the whole of the facts must be treated simultaneously. That would have involved the simultaneous solution of upwards of 4,000 equations between 9,230 unknown quantities, by what is called the method of minimum squares, and I need scarcely say that it is practically impossible to solve such a number of equations between so many unknown quantities by any method at all. Thus a compromise had to be made between the theoretically desirable and the practically possible. It would be out of place here to attempt to describe the method of treatment which was eventually adopted, after much thought and deliberation; I will merely say that the bulk of the triangulation was divided into five sections, each of which was treated in succession with as close approximation to the mathematically rigorous method as was practically possible; but even then the mass of simultaneous interdependent calculation to be performed in each instance was enormous, I believe greatly exceeding anything of the kind as yet attempted in any other survey. But the happy result of all this labour was that the final corrections of the angles were for the most part very minute, less than the theoretical probable errors of the angles, and thus fairly applicable without taking any liberties with the facts of observation. If the attribute of beauty may ever be bestowed on such things as small numerical quantities, it may surely be accorded to these notable results of very laborious calculations, which, while in themselves so small, were so admirably effective in introducing harmony and precision throughout the entire triangulation.

If now we turn once more to what Lambton calls "the sublime science of geodesy," which was held in such high regard by both him and Everest, we shall find that the great meridional arc between Cape Comorin and the Himalayas, on which they laboured with so much energy and devotion, is not the only contribution to that science to which the Indian triangulation is subservient, but every chain of triangles—meridional, longitudinal, or oblique—may be made to throw light either on geodesy, the science of the figure of the earth, or on geognosy, the science of the earth's interior structure, when combined with corresponding astronomical arcs of amplitude. Thus each of the several meridional chains of triangles may be utilised in this way, as their prototype has been, by having latitude observations taken at certain of their stations to give meridional arcs; and the several longitudinal chains of triangles may also be utilised—in combination with the main lines of telegraph—by electro-telegraphic determinations of differential longitudes to give arcs of parallel. When the stations of the triangulation which are resorted to for the astronomical observations are situated in localities where the normal to the surface coincides fairly with the corresponding normal to the earth's figure, the result is valuable as a contribution to geodesy; when the normal to the surface is sensibly deflected by local attraction, the result gives a measure of the deflection which is valuable as a contribution to geognosy.

Having regard to these circumstances, I moved the Government to supply the Trigonometrical Survey with the necessary instruments for the measurement of the supplemental astronomical arcs; and as officers became available on the gradual completion of the successive chains of triangles, I employed some of them in the required determinations of latitude and differential longitude. It so happened that about the same time geodesists in Europe began to recognise the advantages to science to be acquired by connecting the triangulations of the different nationalities together, and supplementing them with arcs of amplitude. The "International Geodetic Association for the Measurement of Degrees in Europe" was formed in consequence, and it has been, and is still, actively employed in carrying out this object; in India, however, the triangulation was complete and connected throughout, so that only the astronomical amplitudes were wanting. They are still in progress, but already meridional chains, aggregating 1,840 miles in length, and lying to the west of the Great Arc, have been converted into meridional arcs; and the three longitudinal chains, from Madras to Mangalore, from Bombay to Vizagapatam, and from Kurrachee *via* Calcutta to Chittagong, of which the aggregate length is 2,600 miles, have been converted into arcs of parallel. In the former the operations follow the meridional course of the chains of triangles; in the latter they follow the principal lines of the electric telegraph, which sometimes diverge greatly from the direction of the longitudinal chains of triangles, the two only intersecting at occasional points; the astronomical stations are therefore placed at the trigonometrical points which may happen to be nearest the telegraph lines, whether on the meridional or on the longitudinal chains, and their positions are invariably so selected as to form self-verificatory circuits which are usually of a triangular form, presenting three differential arcs of longitude; each of these arcs is measured independently as regards the astronomical work—though for the third arc there is usually no independent telegraph line, but only a coupling of the lines for the first and second arcs—and this has been proved to give such an excellent check on the accuracy of the operations, that it is not too much to say that no telegraphic longitude operations are entirely reliable which have not been verified in some such manner.

Through the courtesy of Colonel Stotherd, Director-General of the Ordnance Survey, I am enabled to exhibit two charts, one of the triangulation of India, the other of that of Europe, which have recently been enlarged to the same scale in the Ordnance Survey Office at Southampton for purposes of comparison. The first is taken from the official chart of the Indian Survey, and shows the great meridional and longitudinal chains and Lambton's network of principal triangles, the positions of the base-lines measured with the Colby apparatus, the latitude and the differential longitude stations, the triangular circuits of the longitudinal arcs, the stations of the pendulum and the tidal operations which will be noticed presently, and the secondary triangulations to fix the peaks of the Himalayan and Sulimani ranges, and the positions of Bangkok in Siam and Kandahar in Afghanistan, the extreme eastern and western points yet reached. The chart of the European triangulation has been enlarged from one published by the International Geodetic Association of Europe; in it special prominence is given to the Russian meridional arc, which extends from the Danube to the Arctic Ocean, and is 25° 20′ in length, and to the combined English and French meridional arc, 22° 10′ in length, which extends from the Balearic Island of Formentera in the Mediterranean, to Saxavord in the Shetland Islands. The aggregate length of the meridional arcs already completed in India is about equal to that of the English, French, and Russian arcs combined; but the longest in India is about $1\frac{1}{2}°$ shorter than the Russian. As regards longitudinal arcs, I believe the two which were first measured in India, and were employed shortly afterwards by Colonel Clarke in his last investigation of the figure of the Earth, are the only ones which have as yet been deemed sufficiently accurate to be made use of in such investigations, though arcs of much greater length have been measured in Europe. It would be interesting, if time permitted, to set forth the salient points of divergence between the systems of the Indian and the European surveys; I will only mention that in the southern part of the Russian arc, for a space of about 8° from the Duna to the Dneister, a vast plain, covered with immense and almost impenetrable forests, presented great obstacles to the prosecution of the work; the difficulty was overcome by the erection of a large number of lofty stations of observation, wooden scaffoldings which were 120 and even as much as 146 feet high, to overlook the forests. In Indian forests, as the Terai on the borders between British and Nepalese territories, the stations were rarely raised to a greater height than 30 feet, or just sufficient to overtop the curvature, and all trees and other obstacles were cleared away on the lines between them; this was found the most expeditious and economical process. The stations were very substantial, with a central masonry pillar, for the support of a great theodolite, which was isolated from the surrounding platform for the support of the observer. The lofty Russian scaffoldings only sufficed for small theodolites, and they were so liable to shake and vibration, that the theodolites had to be fitted with two telescopes to be pointed simultaneously by two observers at the pair of stations, the angle between which was being measured.

All the modern geodetic data of the Indian survey that were available up to the year 1880 were utilised by Colonel A. R. Clarke, C.B., of the Ordnance Survey, in the last of the very valuable investigations of the Figure of the Earth which he has undertaken from time to time. It will be obvious that new data tend to modify in some degree the conclusions derived from previous data, for the figure of so large a globe as our earth is not to be exactly determined from measurements carried over a few narrow belts of its superficies. Thus thirty years ago it was inferred that the equator was sensibly elliptic—and not circular, as had been generally assumed—with its major axis in longitude 15° 34′ east of Greenwich; but later investigations indicate a far smaller ellipticity, and place the major axis in west longitude 8° 15′. More significant evidence of the influence of new facts of observation in modifying previous conclusions is furnished by the French national standard of length, the metre, which was fixed at the ten-millionth part of the length of the earth's meridional quadrant, as deduced from the best geodetic data available up to the end of the last century; but it is now found to be nearly $\frac{1}{5000}$th part less than the magnitude which it is supposed to represent, the difference being about a hundred times greater than what would now be considered an allowable error in an important national standard of measure.

The Indian survey has also made valuable contributions to geodesy and geognosy in an elaborate series of pendulum observations for determining variations of gravity, which throws light both on the grand variation from the poles to the equator that governs the ellipticity, and on the local and irregular variations depending on the constitution of the interior of the earth's crust. They were commenced in 1865 by Captain J. P. Basevi, on the recommendation of General Sabine and the Council of the Royal Society, with two pendulums, one of which the General had swung in his notable operations which extend from a little below the equator to within 10° of the pole. Captain Basevi had nearly completed the operations in India, and had taken swings at a number of the stations of the Great Arc and at various other points near mountain ranges and coast lines, when he died of exposure in 1871 at a station on the high table-lands of the Himalayas, while investigating the force of gravity under mountain ranges. Major Heaviside swung the pendulums at the remaining Indian stations, then at Aden and Ismailia on the way back to England, and finally at the base station, the Kew Observatory. Afterwards they and a third pendulum were swung at Kew and Greenwich by Lieutenant-Colonel Herschel, who took all three to America, swung them at Washington, and then handed them over to officers of the United States Coast Survey, by whom they have been swung at San Francisco, Auckland, Sydney, Singapore, and in Japan.

The pendulum operations in India have been successful in removing from the geodetic operations the reproach which had latterly been cast on them, that their value has become much diminished since the discovery that the attraction of the Himalayan mountains is so much greater than had previously been suspected, that it may have materially deflected the plumb-line at a large number of the astronomical stations of the Great Arc, and injuriously influenced the observations. Everest considered the effects of the Himalayan attraction to be immaterial at any distance exceeding sixty miles from the feet of the mountains; but in his days the full extent and elevation of the mountain masses was unknown, and their magnitude was greatly underestimated. Afterwards, when the magnitude became better known, Archdeacon Pratt of Calcutta, a mathematician of great eminence, calculated that they would materially attract the plumb-line at points many hundred miles distant; he also found that everywhere between the Himalayas and the ocean, the excess of density of the land of the continent as compared with the water of the ocean would combine with the Himalayan attraction and increase the deflection of the plumb-line northwards, towards the great mountain ranges, and that under the joint influence of the Himalayas and the ocean the level of the sea at Kurrachee would be raised 560 feet above the level at Cape Comorin.

But as a matter of fact the Indian arc gave a value of the earth's ellipticity which agreed sufficiently closely with the values derived from the arcs measured in all other quarters of the globe, to show that it could not have been largely distorted by deflections of the plumb-line; thus it appeared that whereas Everest might have slightly underestimated the Himalayan attraction, Pratt must have greatly overestimated it. His calculations were however based on reliable data, and were indubitably correct. For some time the contradiction remained unexplained, but eventually Sir George Airy put forward the hypothesis that the influence of the Himalayan masses must be counteracted by some compensatory disposition of the matter of the earth's crust immediately below them, and in which they are rooted; he suggested that the bases of the mountains had sunk to some depth into a fluid lava which he conceived to exist below the earth's crust, and that the sinking had caused a displacement of dense matter by lighter matter below, which would tend to compensate for the excess of matter above. Now Pratt's calculations had reference only to the visible mountain and oceanic masses, and their attractive influences—the former positive, the latter negative—in a horizontal direction; he had no data for investigating the density of the crust of the earth below either the mountains on the one hand, or the bed of the ocean on the other. The pendulum observations furnished the first direct measures of the vertical force of gravity in different localities which were obtained, and these measures revealed two broad facts regarding the disposition of the invisible matter below; first, that the force of gravity diminishes as the mountains are approached, and is very much less on the summit of the highly elevated Himalayan table-lands than can be accounted for otherwise than by a deficiency of matter below; secondly, that it increases as the ocean is approached, and is greater on islands than can be accounted for otherwise than by an excess of matter below. Assuming gravity to be normal on the coast lines, the mean observed increase at the island stations was such as to cause a seconds' pendulum to gain three seconds daily, and the mean observed decrease in the interior of the Continent would have caused the pendulum to lose $2\frac{1}{2}$ seconds daily at stations averaging 1,200 feet above the sea level, 5 seconds at 3,800 feet, and about 22 seconds at 15,400 feet—the highest elevation reached—in excess of the normal loss of rate due to height above the sea.

Pratt was strongly opposed to the hypothesis of a substratum, or magma, of fluid igneous rock beneath the mountains; he assumed the earth to be solid throughout, and regarded the mountains as an expansion of the invisible matter below, which thus becomes attenuated and lighter than it is under regions of less elevation, and more particularly in the depressions and contractions below the bed of the ocean. And certainly we seem to have more reason to conclude that the mountains emanate from the subjacent matter of the earth's crust than that they are as wholly independent of it as if they were formed of stuff shot from passing meteors and asteroids; any severance of continuity and association between the visible above and the invisible below appears, on the face of it, to be decidedly improbable.

The hypothesis of sub-continental attenuation and sub-oceanic condensation of matter is supported by the two arcs of longitude on the parallels of Madras and Bombay; for at the extreme points of these arcs, which are situated on the opposite coast lines, the horizontal attraction has been found to be not landwards, as might have been anticipated, but seawards, showing that the deficient density of the sea as compared with the land is more than compensated by the greater density of the matter under the ocean than of that under the land.

While on the subject of the constitution of the earth's crust, I may draw attention to the circumstance that the tidal observations which have been carried on at a number of points on the coasts of India, as a part of the operations of the Survey, tend to show that the earth is solid to its core, and that the geological hypothesis of a fluid interior is untenable. They have been analysed by Prof. G. H. Darwin, with a view to the determination of a numerical estimate of the rigidity of the earth, and he has ascertained that whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and the effective rigidity is very considerable, not so great as that of steel, as was at first surmised, but sufficient to afford an important confirmation of the justice of Sir William Thomson's conclusion as to the great rigidity.

The Indian pendulum observations have been employed by Colonel Clarke, in combination with those taken in other parts of the globe, to determine the earth's ellipticity. Formerly there was wont to be a material difference between the ellipticities which were respectively derived from pendulum observations and direct geodetic measurements, the former being somewhat greater than $\frac{1}{290}$, the latter somewhat less than $\frac{1}{300}$; but as new and more exact data became available, the values derived from these two essentially independent sources became more and more accordant, and they now nearly agree in the value $\frac{1}{293}$.

As a part of the pendulum operations, a determination of the length of the seconds' pendulum was made at Kew by Major Heaviside, with the pendulum which had been employed for the same purpose by Kater early in the present century, when leading men of science in England believed that in the event of the national standard yard being destroyed or lost, the length might be reproduced at any time with the aid of a reversible pendulum. In consequence of this belief an Act of Parliament was passed in 1824 which defined the relations between the imperial and the seconds' pendulum, the length of the former being to that of the latter—swung in the latitude of London, in a vacuum and at the level of the sea—in the proportion of 36 inches to 39·1393 inches. Thus, while the French took for their unit of length the ten-millionth part of the earths' meridional quadrant, the English took the pendulum swinging seconds in the latitude of London. In case of loss the yard is obviously recoverable more readily and inexpensively by reference to the pendulum than the metre by reference to the quadrant; it is also recoverable with greater accuracy; still the accuracy is not nearly what would now be deemed indispensable for the determination of a national standard of length, and it is now generally admitted that every pendulum has certain latent defects, the influence of which cannot be exactly ascertained. Thus the instrument cannot be relied on as a suitable one for determinations of absolute length; but, on the other hand, so long as its condition remains unaltered, it is the most reliable instrument yet discovered for differential determinations of the variations of gravity. In truth, however, the pendulum is a very wearisome instrument to employ even for this purpose, for it has to be swung many days and with constant care and attention to give a single satisfactory determination; thus if such a thing can be invented and perfected as a good differential gravity meter, light and portable, with which satisfactory results can be obtained in a few hours, instead of many days, the boon to science will be very great.

The trigonometrical operations fix with extreme accuracy two of the co-ordinates—the latitude and longitude—which define the positions of the principal stations; but the third co-ordinate, the height, is not susceptible of being determined by such operations with anything like the same degree of accuracy, because of the variations of refraction to which rays of light passing through the lower strata of the atmosphere are liable, as the temperature of the surface of the ground changes in the course of the day. In the plains the apparent height of a station ten to twelve miles from the observer has been found to be upwards of 100 feet greater in the cool of the night than in the heat of the day, the refraction being always positive when the lower atmospheric strata are chilled and laden with dew, and negative when they are rarefied by the heat radiated from the surface of the ground. At hill stations the rays of light usually pass high above the surface of the ground, and the diurnal variations of refraction are comparatively immaterial, and very good results are obtained by the expedient of taking the vertical observations between reciprocating stations at the same hour of the day, and as nearly as possible at the time of minimum refraction; but in the plains this expedient does not usually suffice to give reliable results. The hill ranges of central and those of northern India are separated by a broad belt of plains, which embraces the greater portion of Sind, the Punjab, Rajputana, and the valley of the Ganges, and is crossed by a very large number of the principal chains of triangles, on the lines where the chart shows stretches of comparatively small triangles, which are in most instances of considerable length. Thus it became necessary to run lines of spirit levels over these plains, from sea to sea, to check the trigonometrical heights. The opportunity was taken advantage of to connect all the levels which had been executed for irrigation and other public works, and reduce them to a common datum; and eventually lines of level were carried along the coast and from sea to sea to connect the tidal stations. The aggregate length of the standard lines of level executed up to the present time is nearly 10,000 miles, and an extensive series of charts of the levels derived from other departments of the public service and reduced to the survey datum has already been published.

The survey datum which has been adopted for all heights, whether deduced trigonometrically or by spirit-levelling, is the mean sea level as determined, either for initiation or verification, by tidal observations at several points on the coast lines. At first the observations were restricted to what was necessary for the requirements of the survey, and their duration was limited to a lunar month at each station. In 1872 more exact determinations were called for, to ascertain whether gradual changes in the relative level of land and sea were taking place at the head of the Gulf of Cutch, as had been surmised by the geological surveyors, and observations were taken for over a year at three tidal stations on the coasts of the gulf, to be repeated hereafter when a sufficient period had elapsed to permit of a measurable change of level having taken place. Finally, in 1875, the Government intimated that as "the great scientific advantages of a systematic record of tidal observations on Indian coasts had been frequently urged and admitted," such observations should be taken at all the principal ports and at such points on the coast lines as were best suited for investigations of the laws of the tides. In accordance with these instructions, five years' observations have been made at several points, and new stations are taken up as the operations at the first ones are completed.

The initiation of the later and more elaborate operations is due in great measure to the recommendations of the Tidal Committee of the British Association, of which Sir William Thomson was President. The tidal observations have been treated by the method of harmonic analysis advocated by the Committee. The constants for amplitude and epoch are determined for every tidal component, both of long and of short periods, and with their aid tide-tables are now prepared and published annually for each of the principal ports; and further, it is with them that Prof. G. H. Darwin made the investigations of the effective rigidity of the earth, which I have already mentioned. The very remarkable waves which were caused by the earthquake on December 31, 1881, in the Bay of Bengal, and by the notable volcanic eruptions in the island of Krakatoa and the Straits of Sunda on August 27 and 28, 1883, were registered at several of the tidal stations, and thus valuable evidence has been furnished of the velocities of both the earth-wave and the ocean-wave which are generated by such disturbances of the ordinarily quiescent condition of the earth's crust.

I must not close this account of the non-graphical, or more purely scientific, operations of the great Trigonometrical Survey of India without saying something of the officers who were employed thereon, under the successive superintendence of Everest, Waugh, and myself. A considerable majority were military, from all branches of the army—the cavalry and infantry, as well as the corps of engineers and artillery; the remainder were civilians, mostly promoted from the subordinate grades. Prominent shares in the operations were taken by Lieutenant Renny, Bengal Engineers, afterwards well known in this neighbourhood as Colonel Renny Tailyour, of Borrowfield in Forfarshire, of whom and his contemporary, Lieutenant Waugh, Everest, retiring, reported in terms of the highest commendation; by Reginald Walker, of the Bengal Engineers, George Logan, George Shelverton, and Henry Beverley, all of whom fell victims to jungle fever; by Strange, F.R.S., of the Madras Cavalry, whose name is associated with the construction of the modern geodetic instruments of the Survey; by Jacob—afterwards Government Astronomer at Madras—Rivers and Haig, all of the Bombay Engineers; Tennant, C.I.E., F.R.S., Bengal Engineers, afterwards Master of the Mint in Calcutta; Montgomerie, F.R.S., of the Bengal Engineers, whose name is best remembered in connection with the Trans-Himalayan geographical operations; James Basevi, of the Bengal Engineers, who so sadly died of exposure while engaged on the pendulum operations in the higher Himalayas; Branfill, of the Bengal Cavalry; Thuillier, Carter, Campbell, Trotter, Heaviside, Rogers, Hill, and Baird, F.R.S., all engineer officers; also Hennessey, C.I.E., F.R.S., M.A., Herschel, F.R.S., and Cole, M.A., whose names are intimately associated with the collateral mathematical investigations and the final reduction of the principal triangulation.

The Trigonometrical Survey owes very much to the liberal and even generous support which it has invariably received from the Supreme Government, with the sanction and approval, first of the Directors of the East India Company, and afterwards of the Secretary of State for India. In times of war and financial embarrassment the scope of the operations has been curtailed, the establishments have been reduced, and some of the military officers sent to join the armies in the field; but whatever the crisis, the operations have never been wholly suspended. Even during the troubles of 1857-58, following the mutiny of the native army, they were carried on in some parts of the country, though arrested in others; and the then Viceroy, Lord Canning, on receiving the reports of the progress of the operations during that eventful period, immediately acknowledged them to the Surveyor-General, Colonel Waugh, in a letter from which the following extract is taken:

"I cannot resist telling you at once with how much satisfaction I have seen these papers. It is a pleasure to turn from the troubles and anxieties with which India is still beset, and to find that a gigantic work, of permanent peaceful usefulness, and one which will assuredly take the highest rank as a work of scientific labour and skill, has been steadily and rapidly progressing through all the turmoil of the last two years."

The operations have been uninfluenced by changes of *personnel* in the administration of the Indian Empire, as Governor-Generals and Viceroys succeeded each other, but have met with uniform and consistent support and encouragement. It may well be doubted whether any similar undertaking, in any other part of the world, has been equally favoured and as munificently maintained.

In conclusion I must state that I have purposely said nothing of the graphical operations executed in the Trigonometrical and other branches of the Survey of India, because they are more generally known, their results appear in maps which speak for themselves, and time would not permit of my attempting to describe them also. They comprise, *first*, the general topography of all India, mostly on the standard scale of 1 inch to the mile; *secondly*, geographical surveys and explorations of regions beyond the British frontier, notably such as are being carried on at the present time on the Russo-Afghan frontier, by Major Holdich and other officers of the Survey; *thirdly*, the so-called Revenue Survey of the British districts in the Bengal Presidency, which is simply a topographical survey on an enlarged scale—4 inches to the mile—showing the boundaries and areas of villages for fiscal requirements; and *fourthly*, the Cadastral Survey of certain of the British districts in the Bengal Presidency, showing fields and the boundaries of all properties, on scales of 16 to 32 inches to the mile. There are also certain large scale surveys of portions of British districts in the Madras and Bombay Presidencies, which, though undertaken originally for purely fiscal purposes by revenue and settlement officers working independently of the professional survey, have latterly been required to contribute their quota to the general topography of the country. And of late years a survey branch has been added to the Forest Department, to provide it with working maps constructed for its own requirements on a larger scale than the standard topographical scale, but on a trigonometrical basis, and in co-operation with the Survey Department. But this brief capitulation gives no sort of idea of the vast amount of valuable topographical and other work for the requirements of the local Administrations and the public at large—always toilsome, often perilous—which has been accomplished, quite apart from and in quantity far exceeding the non-graphical and more purely scientific work which I have been describing. Its magnitude and variety are such that a mere list of the officers who have taken prominent shares in it, from first to last, would be too long to read to you. Three names, however, I must mention: *first*, that of General Sir Henry Thuillier, who became Surveyor-General on the same day that I succeeded to the superintendence of the Great Trigonometrical Survey, and with whom I had the honour of co-operating for many years; under his administration a much larger amount of topography was executed than under any of his predecessors, and a great impetus was given to the lithographic, photographic, engraving and other offices in which the maps of the survey are published; *secondly*, that of Colonel Sconce, who became Deputy Surveyor-General soon after my accession in 1878 to the Survey-Generalship, and with whom I was associated for some years, much to my gratification and advantage, in various matters, but more particularly in the establishment of cadastral surveys on a professional basis at a moderate cost, to render them more generally feasible, which was a matter of the utmost importance for the administration of the more highly populated portions of the British provinces; and *thirdly*, that of Lieutenant-Colonel Waterhouse, who has for many years superintended the offices in which photography is employed, in combination with zincography and lithography, for the speedy reproduction *en masse* of the maps of the Survey, and has done much to develop the art of photogravure, whereby drawings in brushwork and mezzotint may be reproduced with a degree of excellence rivalling the best copperplate engraving, and almost as speedily and cheaply as drawings in pen and ink work are reproduced by photo-zincography.

Mr. Clements Markham's Memoir on the Indian Surveys gives the best account yet published of the several graphical surveys up to the year 1878. In that year the Trigonometrical, Topographical, and the Revenue branches, which up to that time had constituted three separate and almost independent departments, were amalgamated together into what is now officially designated "the Survey of India." In the same year the chronicle so well commenced by Mr. Markham came to an end on his retirement from the India office—unfortunately, for it is a work of excellence in object and in execution, and most encouraging to Indian surveyors, who find their labours recorded in it with intelligent appreciation and kindly recognition.

During the present meeting, several papers by officers of the Survey will be read—one by Colonel Barron, in person, on the cadastral surveys in the organisation of which he has taken a leading share; by Major Baird, on the work of spirit-levelling, which he superintends conjointly with the tidal observations; by Colonel Godwin Austen, on Lieutenant-Colonel Woodthorpe's recent journey from Upper Assam to the Irawadi river; by Colonel Branfill, on the physical geography of Southern India; and by Colonel Tanner, on portions of the Himalayas, and on recent explorations in Southern Tibet. Major Bailey will also read a paper on the forest surveys.

SECTION G

MECHANICAL SCIENCE

Opening Address by B. Baker, M.Inst.C.E., President of the Section

Two hundred and fifty-seven Presidential Addresses of one kind and another have been delivered at meetings of the British Association since the members last mustered at Aberdeen. I need hardly say that the candid friend who informed me of this interesting fact most effectually dispelled any illusion I may have previously entertained as to the possibility of preparing an address of sufficient novelty and suggestiveness to be worthy of your attention, and I can only hope that any shortcomings will be dealt with leniently by you. One compensating advantage obviously belongs to my late appearance in the field—I have 257 models of style upon which to frame my address. My distinguished predecessor, Sir Frederick Bramwell, has a style of his own, in which wit and wisdom are combined in palatable proportions; but were I to attempt this style I should doubtless incur the rebuke which a dramatic critic of Charles the Second's time administered to a too ambitious imitator of a popular favourite: "He's got his fiddle, but not his hands to play on't." I must search further back than last year, therefore, for a model of style, and the search reminds me that I labour under a double disadvantage: firstly, that only two addresses intervene between the present one and that of my partner, Mr. John Fowler, with whom I have so long had the honour of being associated, and whose professional experiences, as set forth in his address, are necessarily so largely identical with my own; and, secondly, that within the same period I have read before this Section two somewhat lengthy papers on the work which is at present chiefly engaging the attention of Mr. Fowler and myself—the great Forth Bridge.

Although, for the reasons aforesaid, I am conscious that my address may fail in novelty, I cannot honestly profess to feel a difficulty in preparing an address of some kind, for the subjects embraced under the head of "Mechanical Science" are so inexhaustible that even the youngest student might safely accept the responsibility of speaking for an hour on some of them. Prof. Rankine, addressing you thirty years ago, said it was well understood that questions of pure or abstract mechanics form no part of the subjects dealt with in this Section. With characteristic clearness of conception and precision of language he told you what the term "mechanical science" meant, and, after thirty years' interval, his words may be recalled with advantage to every one proposing to prepare an address or report for this Section. "Mechanical science," said Prof. Rankine, "enables its possessor to plan a structure or machine for a given purpose without the necessity of copying some existent example; to compute the theoretical limit of the strength and stability of a structure or the efficiency of a machine of a particular kind; to ascertain how far an actual structure or machine fails to attain that limit, and to discover the cause and the remedy of such shortcoming; to determine to what extent, in laying down principles for practical use, it is advantageous for the sake of simplicity to deviate from the exactness required by pure science; and to judge how far an existing practical rule is founded on reason, how far on custom, and how far on error." There is thus an ample text for many discourses; but, as I am not writing a treatise on engineering, but merely delivering a brief address, I will confine my attention at present to a particular case of the branch of mechanical science referred to in the last clause of Prof. Rankine's definition, and will ask you to consider how far the existing practical rules respecting the strength of metallic bridges are "founded on reason, how far on custom, and how far on error."

The first question obviously is, What are the rules adopted by engineers and Government departments at the present time?—and it is one not easily answered. I have for some time past been receiving communications from leading Continental and American engineers, asking me what is my practice as regards the admissible intensity of stress on iron and steel bridges, and in replying I have invited similar communications from themselves. As a result I am able to say that at the present time absolute chaos prevails. The old foundations are shaken, and engineers have not come to any agreement respecting the rebuilding of the structure. The variance in the strength of existing bridges is such as to be apparent to the educated eye without any calculation. If the wheels of a miniature brougham were fitted to a heavy cart the incident would excite the derision even of our street boys, and yet equal want of reason and method is to be found in hundreds of bridges in all countries. It is an open secret that nearly all the large railway companies are strengthening their bridges, and necessarily so, for I could cite cases where the working stress on the iron has exceeded by 250 per cent. that considered admissible by leading American and German bridge-builders in similar structures.

In the case of old bridges the variance in strength is often partly due to errors in hypothesis and miscalculation of stresses. In the present day engineers of all countries are in accord as to the principles of estimating the magnitude of the stresses on the different members of a structure, but not so in proportioning the members to resist those stresses. The practical result is that a bridge which would be passed by the English Board of Trade would require to be strengthened 5 per cent. in some parts and 60 per cent. in others before it would be accepted by the German Government or by any of the leading railway companies in America. This undesirable state of affairs arises from the fact that in our own and some other countries many engineers still persistently ignore the fact that a bar of iron may be broken in two ways—namely, by the single application of a heavy stress or by the repeated application of a comparatively light stress. An athlete's muscles have often been likened to a bar of iron, but, if "fatigue" be in question, the simile is very wide of the truth. Intermittent action—the alternative pull and thrust of the rower, or of the labourer turning a winch—is what the muscle likes and the bar of iron abhors. Troopers dismount to rest their horses, but to relieve a bar of iron temporarily of load only serves to fatigue it. Half a century ago Braithwaite correctly attributed the failure of some girders, carrying a large brewery vat, to the vessel being sometimes full and sometimes empty, the repeated deflection, although imperceptibly slow and wholly free from vibration, deteriorating the metal, until, in the course of years, the girders broke. These girders were of cast-iron; but it was equally well known that wrought-iron was similarly affected, for in 1842 Nasmyth called the attention of this Section to the fact that the "alternate strain" in axles rendered them weak and brittle, and suggested annealing as a remedy, he having found that an axle which would snap with one blow when worn would bear eighteen blows when new or after being annealed.

So important a matter as the action of intermittent stresses could not escape the attention of the Royal Commissioners appointed in 1849 to consider the application of iron to railway structures, and some significant and sufficiently conclusive experiments were made by Capt. Douglas Dalton and others. Cast-iron bars 3 inches square and 13 feet 6 inches span between the supports were deflected, both by the slow action of a cam and the percussive action of a swinging pendulum weight. When the deflection was that due to one-third of the breaking weight, about 50,000 successive bendings by the cam broke one of the bars, and about 1000 blows from the pendulum another. When the deflection was increased from one-third to one-half, about 500 applications of the cam, and 100 blows, sufficed to rupture two of the specimens. Slow-moving weights on bars and on a small wrought-iron box girder gave analogous results; and the deduction drawn by the experimenters at the time was that "iron bars scarcely bear the reiterated application of one-third the breaking weight without injury, hence the prudence of always making beams capable of bearing six times the greatest weight that could be laid upon them."

Although these experiments were entirely confirmatory of all previous experience, they would appear to have little influenced the practice of engineers, since Fairbairn, more than ten years later, in a communication to this Section, said that opinions were still much divided upon the question whether the continuous change of load which many wrought-iron structures undergo has any permanent effect upon their ultimate powers of resistance. To assist in settling the question he communicated to the Association the results of some experiments carried out by himself and Prof. Unwin on a little riveted girder 20 feet span and 16 inches deep. Once more the same important but disregarded facts were enforced on the attention of engineers. About 5000 applications of a load equal to four-tenths of the calculated breaking load fractured the beam with the small ultimate deflection of three-eighths of an inch, and subsequently, when repaired, the beam broke with one-third of the load and a deflection of but a quarter of an inch, which sufficiently indicated how small a margin the factor of safety of four, when currently adopted, allowed for defective manufacture, inferior material, and errors in calculation. Still nothing was done, and the general practice of engineers and the Board of Trade regulations continued unaltered.

Soon after the introduction of wrought-iron bridges on railways, the testimony of practical working was added to that of experiments. In 1848 several girder bridges of unduly light proportions were erected in America, and one of 66 feet span broke down under the action of the rolling load in the same manner as Fairbairn's little experimental girder. Again, in early American timber bridges the vertical tie-rods were often subject to stresses oscillating between 1 ton and 10 tons per square inch and upwards. Many of these broke, as did also the suspension bolts in platforms subjected to similar stresses. In my own experience, dozens of broken flange-plates and angle-bars, and hundreds of sheared rivets, have been the silent witnesses of the destructive action of a live load. Like evidence was afforded by early constructed iron ships deficient in girder strength. Under the alternating stresses due to the action of the waves weaknesses not at first apparent would, in the course of time be developed, and additional strength, in the way of stringers and otherwise, become imperative.

If none of the preceding evidence had been forthcoming, the results of the historical series of experiments carried out by Wöhler for the Prussian Ministry of Commerce would alone be conclusive. For the first time a truly scientific method of investigation was followed, and an attempt was made to determine the laws governing the already proved destructive action of intermittent stresses. In previous experiments the bar or girder was alternately fully loaded and wholly relieved of load. Wöhler was not satisfied with this, but tested also the result of a partial relief of load. The striking fact was soon evidenced on testing specimens under varying tensions, that the amount of the variation was as necessary to be considered as that of the maximum stress. Thus, an iron bar having a tensile strength of 24 tons per square inch broke with about 100,000 applications of a stress varying from *nil* to 21 tons, but resisted 4,000,000 applications of the 21 tons when the minimum stress was varied from *nil* to 11½ tons. The alternations of stress in the case of some test pieces numbered no less than 132,000,000; and too much credit cannot be bestowed by engineers upon Wöhler for the ingenuity and patience which characterised his researches. As a result, it is proved beyond all further question that any bar or beam of cast iron, wrought iron, or steel may be fractured by the continued repetition of comparatively small stresses, and that, as the differences of stress increase, the maximum stress capable of being sustained diminishes.

Various formulæ based upon the preceding experiments have been proposed for the determination of the proper sectional area of the members of metallic structures. These formulæ differ in some essential respects, and doubtless many experiments are still required before any universally accepted rules can be laid down. Probably at the present time the engineers who have given the most attention to the subject are fairly in accord in holding that the admissible stress per square inch in a wrought-iron girder subject to a steady dead load would be one and a half times as great as that in a girder subject to a wholly live load, and three times that allowable in members subject to alternate tensile and compressive stresses of equal intensity, such as the piston-rod of a steam-engine or the central web-bracing of a lattice girder. If the alternations of stress to be guarded against are not assumably infinite in number, but only occasional —as in wind bracing for hurricane pressures, or in a vessel amongst exceptionally high waves—then the aforesaid ratio of 3, 2, and 1 would not apply, but would more nearly approach the ratios 6, 5, and 4.

Hundreds of existing railway bridges which carry twenty trains a day with perfect safety would break down quickly under twenty trains per hour. This fact was forced on my attention nearly twenty years ago by the fracture of a number of iron girders of ordinary strength under a five-minute train service. Similarly, when in New York last year I noticed, in the case of some hundreds of girders on the "Elevated Railway," that the alternate thrust and pull on the central diagonals from trains passing every two or three minutes had developed weaknesses which necessitated the bars being replaced by stronger ones after a very short service. Somewhat the same thing had to be done recently in this country with a bridge over the Trent, but the train service being small the life of the bars was measured by years instead of months. If ships were always amongst great waves the number going to the bottom would be largely increased, for, according to Mr. John, late of Lloyd's, "many large merchant steamers afloat are so deficient in longitudinal strength that they are liable under certain conditions of sea to be strained in the upper works to a tension of from 8 to 9 tons per square inch, and to a compression of from 6 to 7 tons—stresses which the experiments already referred to proved would cause failure after a definite number of repetitions. Similarly, on taking ground or being dry-docked with a heavy cargo on board, it has been shown that vessels are liable to stresses of over 11 tons per square inch on the reverse frames, but no permanent injury results from such high stresses, because the number of repetitions is necessarily very limited.

It appears natural enough to every one that a piece even of the toughest wire should be quickly broken if bent backward and forward to a sharp angle; but, perhaps, only to locomotive and marine engineers does it appear equally natural that the same result would follow in time if the bending were so small as to be quite imperceptible to the eye. A locomotive crank axle bends but 1-34th of an inch, and a straight driving axle the still smaller amount of 1-64th of an inch under the heaviest bending stresses to which they are subject, and yet their life is limited. During the year 1883 one iron axle in fifty broke in running, and one in fifteen was renewed in consequence of defects. Taking iron and steel axles together, the number then in use on the railways of the United Kingdom was 14,848, and of these, 911 required renewal during the year. Similarly, during the past three years no less than 228 ocean steamers were disabled by broken shafts, the average safe life of which is said to be about three or four years. In other words, experience has proved that a very moderate stress alternating from tension to compression, if repeated about one hundred million times, will cause fracture as surely as a sharp bending to an angle repeated perhaps only ten times.

I have myself made many experiments with a view to elucidate the laws affecting the strength of iron- and steel-work subject to frequent alternations of stress. Perhaps the most suggestive series was one in which I subjected flat steel bars about 3 feet long, in pairs, to repeated bendings until one bar broke, and then testing the surviving bar under direct tensile and compressive stresses to ascertain to what extent the metal had deteriorated. It had come under my notice, as a practical engineer, that if the compression members of a structure were unduly weak the fact became quickly evident, perhaps under the test load; but if, on the other hand, the tension members were weak, no evidence might appear of the fact until frequent repetition of stresses during several years had caused them to fracture without any measurable elongation of the metal. In the case of crank-shafts, also, the fracture is invariably due to a tearing and not a crushing action. It appeared to me, therefore, eminently probable that repetition of stresses might be far more prejudicial to tension than to compression members, and, if so, the fact ought to be taken account of in proportioning a structure.

This proved to be the case in my experiments. For example, the companion bars to those which had broken with 18,000 reversals of a stress less than half the original breaking weight behaved, when tested as columns thirty diameters in length, precisely the same as similar bars which had done no work at all, whereas when tested in tension the elongation was reduced from the original 25 per cent. to 2·5 per cent., and the fracture appeared to indicate that the bars had been made of three different kinds of steel imperfectly welded together. With a stress reduced by one-fourth the number of bendings required to break the bars was increased to 1,200,000. In this instance the calculated maximum working stress on the extreme fibres was 43 per cent. of the direct ultimate tensile resistance of the steel, and about 30 per cent. of the stress the bar was capable of sustaining as a beam under the single application of a load. Of course, the bars failed by tension, and the extreme fibres had thus deteriorated as regards tensile stresses to the extent indicated by the above percentages. Tested as a column, however, the injury the bar had received from the 1,200,000 bendings was inappreciable. The ductility was of course very largely reduced, but ductility is a quality of comparatively little importance when a material is in compression. There is no ductility in the slender Gothic stone columns of our cathedrals, which, though heavily stressed, have carried their loads for centuries. As I found repeated bendings raised the limit of elasticity, I rather anticipated finding an increased resistance from this cause in long columns. This did not prove to be the case, nor did I find any difference in short columns four diameters in length.

In addition to the preceding experiments with rectangular bars, I have tested the endurance of many revolving shafts of cast iron, wrought iron, and steel, with similar results. About 5000 reversals of a stress equal to one-half the static breaking weight sufficed generally to cause the snapping of a shaft of any of the above materials. When the stress was reduced and the number of applications increased, I found the relative endurance of solid beams to be more nearly proportional to the tensile strength of the metal than to the breaking weight of the beam, a distinction of great importance where axles, springs, and similar things are concerned. Many of my experiments were singularly suggestive. Thus, it was instructive to see a bar of cast iron loaded with a weight which, according to Fairbairn's experiments, it should have carried for a long series of years, broken in two minutes when set gently rotating. Also to find a bar of the finest mild steel so changed in constitution by some months of rotation as to offer no advantages either in strength or toughness over a new cast-iron bar of the same section.

Although, as already stated, many more experiments are required before universally acceptable rules can be laid down, I have thoroughly convinced myself that, where stresses of varying intensity occur, tension and compression members should be treated on an entirely different basis. If, in the case of a tension member, the sectional area be increased 50 per cent. because the stress, instead of being constant, ranges from *nil* to the maximum, then I think 20 per cent. increase would be a liberal allowance in the case of a compression member. I have also satisfied myself that if a metallic railway bridge is to be built at a minimum first cost, and be free from all future charges for structural maintenance, it is essential to vary the working stress upon the metal within very wide limits, regard being had not merely to the effect of intermittent stresses, but also to the relative limits of elasticity in tension and compression members even under a steady load.

Why an originally strong and ductile metal should become weak and brittle under the frequent repetition of a moderate stress has not yet been explained. Lord Bacon touched upon the subject two or three centuries ago, but you may consider his explanation not wholly satisfactory. He said, "Of bodies, some are fragile, and some are tough and not fragile. Of fragility, the cause is an impotency to be extended, and the cause of this inaptness is the small quantity of spirits." I am sorry to have no better explanation to offer, but whatever may be the immediate cause of fragility, no doubt exists that it is induced in metals by frequent bendings, such as a railway bridge undergoes. This fact, however, is not recognised in our Board of Trade Regulations, which remain as they were in the dark ages, as do those of the Ministry of Public Works of France and other countries. With us it is simply provided that the stress on an iron bridge must not exceed 5 tons per square inch on the effective section of the metal. In France it is still worse, as the limiting stress of rather under 4 tons per square inch is estimated upon the gross section, regardless of the extent to which the plates may be perforated by rivet holes. In neither case is any regard had in the rules to intermittent stresses or the flexure of compression members. In Austria the regulations make a small provision for these elements; and American specifications make a large one, the limiting stresses, instead of being constant at 5 tons, as with us, ranging from about 2½ tons to 6¾ tons per square inch, according to circumstances. It is hardly necessary that I should say more to justify my statement that, as regards the admissible intensity of stress on metallic bridges, absolute chaos prevails.

Engineers must remember that if satisfactory rules are to be framed, they, and not Governmental departments, must take the initiative. In former days the British Association did much to direct the attention of engineers to this important matter, but, so far as I know, the subject has been dropped for the past twenty years, and I have ventured, therefore, to bring it before you again in some detail. We are here avowedly for the advancement of science, and I have not been deterred by the dryness of the subject from soliciting your attention to a branch of science which is sadly in need of advancement.

Had I been addressing a less scientific audience I might have been tempted rather to boast of the achievements of engineers than to point out their shortcomings. The progress in many branches of mechanical science during the past fifty years has exceeded the anticipation of the most far-seeing. Fifty years ago the chairman of the Stockton and Darlington Railway, when asked by a Parliamentary committee if he thought any further improvements would be possible on railways, replied that he understood in future all new railways would have a high earthwork bank on each side to prevent engines toppling over the embankments, and to arrest hot ashes, which continually set fire to neighbouring stacks, but in other respects he appeared to think perfection was attained. Shortly before the introduction of locomotives it was also thought perfection was attained when low trucks were attached to the trains to carry the horses over the portions of the line where descending grades prevailed, and all the newspapers announced, with a great flourish of trumpets, that a year's experience showed the saving in horseflesh to be fully 33 per cent.

Although these views seem childlike enough from our present standpoint, I have no doubt that as able and enterprising engineers existed prior to the age of steam and steel as exist now, and their work was as beneficial to mankind, though different in direction. In the important matter of water supply to towns, indeed, I doubt whether, having reference to facility of execution, even greater works were not done 2000 years ago than now. Herodotus speaks of a tunnel 8 feet square, and nearly a mile long, driven through a mountain in order to supply the city of Samos with water; and his statement, though long doubted, was verified in 1882 through the abbot of a neighbouring cloister accidentally unearthing some stone slabs. The German Archæological Society sent out Ernst Fabricius to make a complete survey of the work, and the record reads like that of a modern engineering undertaking. Thus, from a covered reservoir in the hills proceeded an arched conduit about 1000 yards long, partly driven as a tunnel and partly executed on the "cut and cover" system adopted on the London underground railway. The tunnel proper, more than 1100 yards in length, was hewn by hammer and chisel through the solid limestone rock. It was driven from the two ends like the great Alpine tunnels, without intermediate shafts, and the engineers of 2400 years ago might well be congratulated for getting only some dozen feet out of level and little more out of line. From the lower end of the tunnel branches were constructed to supply the city mains and fountains, and the explorers found ventilating shafts and side entrances, earthenware socket-pipes with cement joints, and other interesting details connected with the water-supply of towns.

In the matter of masonry bridges, also, as great works were undertaken some centuries ago as in recent times. Sir John Rennie stated, in his presidential address at the Institute of Civil Engineers, that the bridge across the Dee at Chester was the "largest stone arch on record." That is not so. The Dee Bridge consists of a single segmental arch 200 feet span and 42 feet rise; but across the Adda, in Northern Italy, was built, in the year 1377—more than 500 years ago—a similar segmental arch bridge of no less than 237 feet span and 68 feet rise. Ferario not long since published an account of this, for the period, colossal work, from which it would appear that its life was but thirty-nine years, the bridge having been destroyed for military reasons on December 21, 1416. I believe our American cousins claim to have built the biggest existing stone arch bridge in the world—that across the Cabin Johns Creek; but the span, after all, is only 215 feet, or 10 per cent. smaller than the 500-year-old bridge. In timber bridges, doubtless, the Americans will ever head the list, for the bridge of 340 feet span built across the Schuylkill three-quarters of a century ago will probably never be surpassed. Our ancestors were splendid workers in stone and timber, and, if they had been in possession of an unlimited supply of iron and steel I fear there would have been little left for modern bridge-builders to originate.

The labours of the present generation of engineers are lightened beyond all estimate by labour-saving appliances. To prove how much the world is indebted to students of this branch of mechanical science, and how rapid is the development of a really good mechanical notion, it is only necessary to refer to the numerous hydraulic appliances of the kind first introduced forty years ago by a distinguished past-President, Sir W. G. Armstrong. Addressing you in 1854, Sir William Armstrong explained that the object he had in view from the first was "to provide, in substitution of manual labour, a method of working a multiplicity of machines, intermittent in their action and extending over a large area, by means of transmitted power, produced by a steam-engine and accumulated at one central point." The number of cases in which this method of working is a desideratum, or even indispensable, would appear to be limitless. I should be sorry, indeed, to have anything to do with building the Forth Bridge if hydraulic appliances were not at hand to do a giant's work. Let me shortly describe to you what we are doing there at the present time. More than 42,000 tons of steel plates and bars have to be bent, planed, drilled, and riveted together before or after erection, and hydraulic appliances are used throughout. The plates are handled in the shops by numerous little hydraulic cranes of special design, without any complication of multiplying sheaves, the whole arm being raised with the load by a 4-inch direct-acting ram of 6 feet stroke. A total length of no less than 60 miles of steel plates, ranging in thickness from 1¼ inches to ⅜ inch, have to be bent to radii of from 6 feet to 9 inches, which is done in heavy cast-iron dies squeezed together by four rams of 24 inches in diameter, and the same stroke. With the ordinary working pressure of 1000 lbs. per square inch, the power of the press is thus about 1750 tons. Some 3000 pieces, shaped like the lid of a box, 15 inches by 12 inches wide, with a 3-inch deep rim all round, were required to be made of ½-inch steel plate, and this was easily effected in two heats by a couple of strokes of a 14-inch ram. In numberless other instances steady hydraulic pressure has been substituted by Mr. Arrol, our able contractor, for the usual cutting and welding under the blacksmith's hammer.

Hydraulic appliances are also an indispensable part of the scheme for erecting the great 1700 feet spans. Massive girders will be put together at a low level, and be hoisted as high as the top of St. Paul's Cathedral by hydraulic power. Continuous girders, nearly a third of a mile in length, will be similarly raised. Not only the girders, but workmen, their sheds, cranes, and appliances will be carried up steadily and imperceptibly as the work of erection proceeds, on platforms weighing in some instances more than 1000 tons. It is hardly necessary to say that every rivet in the bridge will be closed up by hydraulic power, the machines being in many instances of novel design, specially adapted to the work. Thus the bed-plates, which in ordinary bridges are simple castings, in the Forth Bridge are necessarily built up of numerous steel plates, the size of each bed-plate being 37 feet long by 17 feet 6 inches wide. To grip together the 47 separate plates into a solid mass, 3800 rivets 1⅛ inches in diameter with countersunk heads on both sides are required, and, remembering that the least dimension of the bed-plate is 17 feet 6 inches, it will be seen that the ordinary "gap"-riveter would not be applicable. A special machine was therefore designed by Mr. Arrol, consisting of a pair of girders and a pair of rams, between which the bed-plate to be riveted together lies. A double ram machine had for like reasons to be devised for riveting up the great tubular struts of the bridge.

Not merely in the superstructure, but in the construction of the foundations, were hydraulic appliances of a novel character indispensable at the Forth Bridge. Huge wrought-iron caissons or cylinders, 70 feet diameter and 72 feet high, were taken up and set down as readily as a man would handle a bucket. In sinking these caissons through the mud and clay of the Forth compressed air was used. When the boulder-clay was reached the labour of excavating the extremely hard and tenacious material in the compressed-air chamber proved too exhausting, pick-axes were of little avail, and the Italian labourers who were chiefly employed lost heart over the job altogether. But a giant power was at hand, and only required tools fit for the work. Spades with hydraulic rams in the hollow handles were made, and, with the roof of the compressed air-chamber to thrust against, the workmen had merely to hold the handle vertically, turn a little tap, and down went the spade with a force of three tons into the hitherto impracticable clay as sweetly as a knife into butter. Probably, when addressing you thirty years ago, Sir William Armstrong never anticipated that a number of hydraulic spades would be digging away in an electrically lighted chamber or diving-bell, 70 feet diameter and 7 feet high, 90 feet below the waves of the sea; but still the spades come strictly within the definition of the class of machines, intermittent in their action and extending over a large area, which it was his aim to introduce. It would be possible, indeed, with the appliances at the Forth Bridge, to arrange that the simple opening of a valve should start digging at the bottom of the sea, riveting at a height of nearly 400 feet above the sea, and all the multifarious operations of bending, forging, and hoisting, extending over a site a mile and a half in length.

It would not only be impossible to build a Forth Bridge, but it would be equally impossible to fight a modern ironclad without the aid of hydraulic appliances. Most of the Presidents of this Section have referred in the course of their addresses to our navy, and certainly the subject is a tempting one, for the progress of mechanical science in recent years could not be better illustrated than by a description of the innumerable appliances which go to the making and working of a modern ironclad. Let me quote a single passage from a pamphlet by a naval officer, which caused a great stir a few years before the Crimean war, that I may recall to your minds what was the speed and what the armament of our fleet at that comparatively recent period. "Conceive," said Capt. Plunkett, R.N., "a British and French fleet issuing simultaneously from Spithead and

Cherbourg; seven hours' steaming at the rate of six miles an hour will bring them together. A single glance at the heavy and well-appointed tiers of a line-of-battle ship's guns will satisfy any one that they are no toys to be placed in the hands of novices. Formidable batteries of the heaviest ordnance are there—not a gun under a 32-pounder, and many 68-pounder shell guns." In little more than a quarter of a century engineers have changed all that, and advanced to 20-knot vessels and 120-ton guns. Archæologists tell us that our predecessors in mechanical science of the Stone Age were apparently a thousand or more years in finding out that the best way of fitting an axe was to slip the handle through the axe and not the axe through the handle. Engineers of the present day may be excused, therefore, for occasionally illustrating the rapidity of the advance of their science by contrasting the ships of thirty years ago with our modern ironclads.

The latest type of battle-ship weighs, fully equipped, about 10,000 tons. There are about 3400 tons of steel in her hull, apart from armour, which, with its backing, will weigh a further 2800 tons. The machinery, largely of steel, is about 1400 tons; the armament, including ammunition, 1100 tons; the coals, 1100 tons; and general equipment, 270 tons. A detailed description bristles with the word "steel," and enthusiastic newspaper reporters sent down to Chatham Dockyard can no more "spin out their copy" with Cowper's oft-quoted lines on the "Launch of a First-Rate":—

"Giant oaks of bold expansion
O'er seven hundred acres fell,
All to build thy noble mansion,
Where our hearts of oak do dwell."

A latter-day poet might boast of 700 acres being exhausted by a single vessel, but it would be a coal-field and not a forest. Accepting Prof. Phillips's estimate of the average rate of formation of coal, it may be shown that a hard-worked American liner during her lifetime burns as much coal as would be produced on the area of 700 acres in a period of 2000 years. We are thus with our steel ships using up our primeval forests at a far more extravagant rate than that at which our immediate forefathers cleared the oak forests. Coal is the great stimulant of the modern engineer. Pope Pius the Second has left on record an expression of the astonishment he felt when visiting Scotland, in the fifteenth century, on seeing poor people in rags begging at church doors, and receiving for alms pieces of black stone, with which they went away contented. To such early familiarity with coal may, however, be due the fact that Scotland has ever led the way in the development of the steam-engine, and that at the date of the battle of Waterloo she had built and registered seven steam-vessels, whilst England could boast of none.

Probably none but a poet or a painter would wish for a return to our old oak sailing ships. Some few people still entertain the illusion that the picturesque old tubs were better sea-boats than our razor-ended steamers; but, speaking of them in 1846, Admiral Napier said: "The ships look very charming in harbour, but to judge of them properly you should see them in a gale of wind, when it would be found they would roll 45° leeward and 43° windward." Even our first ironclads were not so bad as that, for although, according to the *Times*, when the squadron was on trial in the Bay of Biscay, the ships rocked wildly to the rising swell and the sea broke in great hills of surf, yet the maximum roll signalled by the worst roller of the lot—the *Lord Warden*—was but 35° leeward and 27° windward—a total range of 62° as compared with 88° in the old line-of-battle ships.

We have heard much about the state of the navy during the past twelve months. A dip into the publications of the British Association—which in this, as in other respects, afford a fair indication of what is uppermost in people's minds—will show that similar discussions have recurred periodically, at any rate since 1830. If we consult Hansard, as I had occasion to do recently, we find the same remark applies to periods long antecedent to 1830.

It amounts almost to a religious conviction in the mind of a Briton that Providence will not be on his side unless his fleet is at least equal to that of France and Russia united. What would be said now of a Minister who met an attack on the administration of the navy by demonstrating that we had *half* as many line-of-battle ships as Russia: and yet that was literally done less than fifty years ago. Speaking in the House of Commons on March 4, 1839, the Secretary of the Admiralty said: "For the last six months unceasing attacks have been made upon our naval administration, describing our navy as in a state of the utmost decrepitude, and Tory papers say that shameful reductions have been made in the navy by the present Government. It will be a consolation to my honourable friends to be assured that we have for years lived unharmed through dangers as great as that to which we are now exposed. In 1817 we had 15 sail-of-the-line in commission, and Russia had 30; in 1823 we had 12, and Russia 37; in 1832 we had 11, and Russia 36; and now we have 20, and the Russians 43, having raised our ships to nearly half the number of those of Russia.

Now as to our guns. The past twelve months is by no means the first occasion on which the armament of our navy has been attacked. Three years subsequent to the speech of the Secretary of the Admiralty just referred to, Sir Charles Napier made a statement from his place in Parliament of so extraordinary a character that I make no apology for quoting his exact words, as a reminder of the past and a warning for the future: "At the end of the last war the guns were in such a bad state that, when fired, they would scarcely hit an enemy, and during the latter period of the American war a secret order was issued that British ships of war should not engage American frigates, because the former were in such an inefficient state." As for himself, said the plain-spoken old admiral, when he got the order he put it in "the only place fit to receive it, the quarter-galley."

Happily, from our insular position, the change which the progress of mechanical science has wrought in military operations has not been brought home to the people of this country in the same vivid manner that it has to the people of the continents of Europe and America. In the American war, the Franco-German war, and the Russo-Turkish war the construction and equipment of railway works by engineers was an essential part of all great movements. The Russians, in 1877, constructed a railway from Bender to Galatz, 180 miles in length, in fifty-eight working days, or at the rate or more than three miles per day. Altogether, in the three latter months of that year they laid out and built about 240 miles of railway, and purchased and stocked the line with 110 locomotives and 2200 waggons. They also built numerous trestle bridges, together with an opening bridge and a ferry across the Danube.

We have had recent experience of the slowness of primitive modes of transport in the tedious advance of Lord Wolseley's handful of men in whale-boats up the Nile. It was the intention of the late Khedive, partly from military and partly from commercial considerations, to construct a railway exactly on the line of advance subsequently followed by Wolseley. My partner, Mr. Fowler, had the railway sent out in 1873, and the works were shortly after commenced. The total length was 550 miles, and the estimated cost, including rolling-stock and repairing-shops, 4,000,000*l*. Owing to financial difficulties the works were abandoned, but the 64 miles constructed by Mr. Fowler, and the recent extensions of the same by the military, proved of great service to the expedition, even some of the steam-launches being taken by railway to save delays at the cataracts.

During the siege of Paris the German forces were dependent upon supplies drawn from their base, and the army requirements were fully met by one line of railway running twelve to fourteen trains per day. Military authorities state that a train load of about 250 tons is equal to two days' rations and corn for an army corps of 37,000 men and 10,000 horses. The military operations in Egypt have proved that, even in the heart of Africa, railways, steamboats, electric lights, machine guns, and other offspring of mechanical science, are essential ingredients of success.

Members of this Section who visited the United States last year not for the first time could hardly have failed to notice that American and European engineering practice are gradually presenting fewer points of difference. Early American iron railway bridges were little more than the ordinary type of timber bridge done into iron, and the characteristic features, therefore, were great depth of truss, forged links, pins, screw-bolts, round or rectangular struts, cast-iron junction pieces, and, in brief, an assemblage of a number of independent members more or less securely bolted together, and not, as in European bridges, a solidly riveted mass of plates and angle-bars. At the present moment the typical American bridge is distinctly derived from the grafting of German practice on the original parent stock. Pin connections are still generally used in bridges of any size, but the top members and connections are more European than

American in construction, whilst for girders of moderate span, such as those on the many miles of elevated railway in New York, riveted girders of purely European type are admittedly the cheapest and most durable. From my conversations with leading American bridge builders, I am satisfied that their future practice and our own will approach still more nearly. We should never think of building another Victoria tubular bridge across the St. Lawrence, or repeat the design of the fallen Tay Bridge, nor would they again imitate in iron an old timber bridge, or repeat the design of the fallen Ashtabula bridge. In one respect the practice in America tends to the production of better and cheaper bridges than does our own practice, and it is this: each of the great bridge-building firms adopts by preference a particular type design, and the works are laid out to produce bridges of this kind. It is an old adage that practice makes perfect, and by adhering to one type, and not vaguely wandering over the whole field of design, details are perfected and a really good bridge is the result. Engineers in America therefore need only specify the span of their bridge, and the rolling load to be provided for, with certain limiting stresses, and they can make sure of obtaining a number of tenders from different makers of bridges, varying somewhat in design, but complying with all the requirements. With us, on the other hand, it is too often the privilege of a pupil to try his 'prentice hand on the design for a bridge, and it is no wonder, therefore, that many curious bits of detail meet the eye of an observant foreigner inspecting our railways.

The magnificent steel wire rope suspension bridge of 1600 feet span built by Roebling across the East River at New York well marks the advanced state of mechanical science in America as regards bridge-building. It is worthy of note that, at the second meeting of the British Association, held so long back as 1832, there was a paper on suspension bridges, and the author entreated the attention of the scientific world, and particularly of civil engineers, to the serious consideration of the question: "How far ought iron to be hereafter used for suspension bridges, since a steel bridge of equal strength and superior durability could be built at much less cost?" "I earnestly call upon the ironmasters of the United Kingdom," said he, "to lose no time in endeavouring to solve this question." In this, as in many other engineering matters, America has given us a lead. America, is indeed, the paradise of mechanics. When the British Association was inaugurated, years ago, there was, I believe, no intention to have a section for the discussion of mechanical science. Possibly it may have been considered too mean a branch. Even the usually generous Shakespeare speaks contemptuously of "mechanic slaves, with greasy aprons, rules, and hammers;" and our old friend Dr. Johnson's definition of "mechanical" is "mean, servile." We have lived down this feeling of contempt, and the world admits that the "greasy apron" is as honourable a badge as the priest's cassock or the warrior's coat of mail, and has played as important a part in the great work of civilising humanity and turning bloodthirsty savages into law-abiding citizens.

As I have had occasion to refer to Canada and America in the course of my remarks, I cannot refrain from expressing the high appreciation which I am sure every member of this Section entertains of the cordiality and warmth of our reception on the other side of the Atlantic last year. Such incidents make us forget that differences have ever existed between the two countries. I was amused the other day, on reading in Dr. Doran's "Annals of the Stage," that, in the year 1777, the theatrical company from Edinburgh was captured on its voyage to Aberdeen by an American privateer, and taken off Heaven knows where, for it did not turn up again. This, you will say, was a long time ago; but, if you glance through the speeches of our present gracious Sovereign, you will find one in which her Majesty speaks with "deep concern" of insurrection in Lower Canada, and of hostile incursions into Upper Canada by certain "lawless inhabitants" of the United States of North America.

This is strange reading, after our last year's experience. Gentlemen, I may not have carried you with me in some things I have said, but I think you will all agree with me in this: that the statesman who should suffer any slight difference of opinion to develope into a serious breach between ourselves and our brethren in Canada and cousins in America would, to quote the words of Burke, "far from being qualified to be directors of the great movements of this empire, be not fit even to turn a wheel in the machine."

NOTES

THE new gallery of fishes at the Natural History Museum is now open to the public, and an addition has been made to the Osteological Gallery by throwing open the pavilion at the west end, in which are exhibited skeletons and skulls of elephants, the giraffe, &c.

A REPORT is current in Rome that the members of the Italian Expedition to Central Africa, under the leadership of Signor Alfredo Massari, have been massacred.

THE natural history collections made by the late Dr. Nachtigal, in the course of his tour of annexation on the west coast of Africa, have arrived at Berlin in twenty cases, and the greater part of their contents will be assigned to the new ethnological museum.

AN astronomical-mathematical section, under the presidency of Profs. Reye and Christoffel, of Strassburg, has been formed in the Scientific Congress at Strassburg.

M. BOUQUET, a mathematician of some eminence and a Sorbonne professor, died on the 10th instant at the age of sixty-six.

THE death is announced of Mr. W. A. Guy, M.B., F.R.S., on the 10th inst., in the seventy-sixth year of his age. He was for a number of years Dean of the Medical Department in King's College, and Professor of Hygiene. He was admitted a Fellow of the Royal College of Physicians in 1844, held office as censor in 1855, 1856, and 1866, and as examiner in 1861–3, and in 1861, 1868, and 1875 was appointed Croonian, Lumleian, and Harveian lecturer. Mr. Guy also held a number of other appointments, among which were—honorary secretary to the Statistical Society in 1845, and President in 1873, examiner in forensic medicine at the University of London in 1862, Swiney Prizeman, 1869, and Vice-President of the Royal Society in 1876-7. Mr. Guy devoted much attention for many years to questions of sanitary reform and social science, and in 1878 was appointed one of the Royal Commissioners to inquire into the working of the Penal Servitude Acts; also in 1879 a member of the Criminal Lunatic Commission. He was the author of many essays on physiology and kindred subjects, and also of works of a more general character. Among his principal publications may be mentioned "Principles of Forensic Medicine," "Public Health," "The Factors of the Unsound Mind," "John Howard's Winter's Journey," and his last work, "The Claims of Science on Public Recognition and Support." It may be added that Mr. Guy was likewise editor of Hooper's "Physician's Vade-Mecum."

COL. PRJEVALSKY has sent the following message, dated July 1, from his camp in Chinese Turkestan:—"It is impossible to penetrate into Tibet by the Keria Mountains, the passes through them being impracticable for our beasts of burden, and the Chinese having obstructed the paths with rocks, and having also destroyed the bridges. The native population has given us everywhere a good reception, and, despite the interference of the Chinese, their sympathies with the Russians are openly pronounced. We shall pass the present month among the snow-covered mountains between the rivers of Keria and Khoten. About the middle of August we shall go to Khoten, and then by the course of the river of the same name to Aksu. All is well."

THE inaugural address at the commencement of the medical session 1885-86 will be delivered at St. Thomas's Hospital on October 1, at 3 p.m., by A. O. MacKellar, M.Ch., F.R.C.S., in the theatre of the hospital.

AT the request of the Batavian Society of Arts and Sciences, the Government of the Netherlands' Indies has taken a step which might be imitated by other Governments with advantage. It has distributed fifty copies of Prof. de Hollander's "Handleiding bij de Beoefening der Land- en Volkenkunde von Neder. Oost Indië" to its officials in all parts of its colonies, and has instructed them to compare their own observations with the statements in the work, and to report the result.

THE German Government has despatched a mission under Baron Pring to the Cheshire salt districts, charged with an investigation of the local industry, and especially of the phenomenon of land subsidence through brine pumping, Prince Bismarck being about to propose certain legislation affecting similar landslips in Germany.

WITH reference to Mr. G. J. Symons's letter last week on the subject of the trees in Richmond Park struck by lightning, Mr. Percy Smith writes to the *Times* that "the most probable cause of the liability of certain trees to be struck by lightning is that they are bad conductors of electricity. The suggestion that oak trees are struck because they contain iron is both erroneous and absurd. If oak did contain iron it would in all probability increase its conducting power and act as a preservative. If oak contained an estimable quantity of that metal the wood would turn black on exposure to air, on account of the tannin which is present. This blackening may be seen surrounding the iron nails in any oak fence. The contour of the ground, nature of the soil, and the presence or absence of water has more influence in deciding the locality of an electric discharge than the height of a tree. Add to this the difference in conductibility between various woods and we have at once an explanation of the apparent peculiarity of tall trees escaping unharmed while shorter trees are destroyed."

ONE of the proofs commonly advanced for the theory that the cold in northern regions has increased in historic times is that there is an increase of ice on the eastern shores of Greenland; another is that barley, which was successfully grown in Iceland from its first settlement in 870 down to the middle of the fifteenth century, is no longer cultivated there. It is, therefore, of much interest to learn from *Globus* that the Icelandic Government lately attempted to grow barley in the island on a considerable scale, and that the results were very favourable. Norwegian barley from Altenfjord, which is on the extreme north of the barley-growing zone, was planted and was fit for cutting down in eighty-nine days. The decline in the cultivation of barley in Iceland was really due, not to an increase in the cold, but to the fact that cattle-breeding paid better. Attempts are being made to grow other plants: at Reikjavik a botanical garden has been established, and the seeds of 382 kinds of plants which occur around Christiania have been planted there. It is probable, therefore, that the scanty garden flora of Iceland will be increased in the near future.

AT the recent meeting of the French Association at Grenoble, M. de Mortillet read a paper on Tertiary man before the anthropological section. The question, he said, was not to know whether man already existed in the Tertiary epoch as he exists at the present day. Animals varied from one geological stratum to another, and the higher the animals the greater was the variation. It was to be inferred, therefore, that man would vary more rapidly than the other mammals. The problem was to discover in the Tertiary period an ancestral form of man, a predecessor of the man of historical times. M. de Mortillet affirmed that there were unquestionably in the Tertiary strata objects which implied the existence of an intelligent being. These objects have, in fact, been found at two different stages of the Tertiary epoch—in the lower Tertiary at Thenay, and in the Upper Tertiary at Otta, in Portugal, and at Puy Courny, in Cantal. These objects proved that at these two distant epochs there existed in Europe animals acquainted with the use of fires and able more or less to cut stone. During the Tertiary period, then, there lived animals less intelligent than existing man, but much more intelligent than existing apes. M. de Mortillet gives the name of *anthropitheque*, or ape-man, to the species, which, he maintains, was an ancestral form of historic man, whose skeleton has not yet been discovered, but who has made himself known to us in the clearest manner by his works. A number of flints were exhibited from the strata in question, which had been intentionally chipped and exposed to fire. The general opinion of the *savants* assembled at Grenoble was that there can be no longer any doubt of the existence in the Tertiary period of an ancestral form of man.

AN ingenious instrument for ascertaining the distances of accessible and inaccessible points from the observer and from each other has been invented by Dr. Luigi Cerebotani, a Professor of the University of Verona. This apparatus consists mainly of a pair of telescopes mounted on a stand and fixed on a tripod for use. The telescopes are both brought to bear on the object, and a reading is then taken from a graduated scale on the instrument, which, compared with a set of printed tables, gives the distance. By this means the inventor obviates the necessity for the base line, which has hitherto had to be laid down in these operations, and he dispenses with all trigonometrical calculations. Distances can be measured between far-off objects, and, by means of a sheet of paper fixed on a drawing-board, a rough plan of the country under measurement can be sketched. In the same way the distances of ships at sea or of moving objects on land can be determined. The apparatus appears to be well adapted for land-surveying, and particularly for military purposes. In fact, it is stated to have been already adopted in the German army in the latter connection, and it is about to be tried by the authorities of our own War Department. A practical trial was made with this instrument on the Thames Embankment on the 11th inst., when its varied usefulness was demonstrated.

WE have received from the Director of the Batavia Observatory a volume containing statistics of the rainfall in the East Indian Archipelago for the year 1884. Rainfall observations were made during the year at 145 stations without interruption, although at the end of the year there were 172 stations, 94 of which were on the islands of Java and Madura.

IT is stated that the Physical and Mathematical Society of Tokio has decided in future to print its official proceedings in Japanese written in Roman letters instead of Chinese characters, although the authors of papers may employ any style or language they please. A similar step is in contemplation by the Japanese Chemical Society.

IN a note in a late issue of the *Bulletin* of the United States Fish Commission, Prof. Verrill discusses the question how long oysters will live out of water. In a fishmonger's in New Haven his attention was drawn to a large cluster of oysters attached to an old boot which hung in the window from about December 10 to February 25, when he found several of the larger oysters still alive. Most of the smaller and many of the larger ones were dead and dried up; in the case of the latter the edges of the shells had been broken or chipped. Those that were alive had all been hung up with the front edge of the shell downward and the hinge upward. They had been hanging in the show window, attached to a gas burner, freely exposed to the air and light. The place was doubtless cool, but the air must have been dry, and temperature variable. The remarkable duration of the lives of these oysters he attributes to two causes: first, the perfect condition of the edges of the shells, which allowed them to close up very tightly; secondly, the position—suspended as they were with the front edge downward—is the most favourable one possible for the retention of water within the gill-cavity, for in this position the edges of the mantle would closely pack against the inner edges of the shell, effectually closing any small leaks, and the retained water would also be in the most favourable position to moisten the gills, even after part had evaporated. It is also possible that when in this position the oyster instinctively keeps the shell tightly closed, to prevent the loss of water. This incident, says Prof. Verrill, may give hint of the best mode of transporting oysters and clams long distances. Perfect shells should be selected, and they should be packed with the front edge downward, and kept moderately cool, in a crate or some such receptacle which will allow a free circulation of air. Under such favourable conditions selected oysters can doubtless be kept from eight to twelve weeks out of water. Mr. Ryder, of Washington, adds that he has had oysters live in the shell for two weeks, where the temperature ranged from 30° to over 80° F., lying on shelves in the cases in his work-room, exposed the whole time to the air, without showing the slightest tendency to decompose.

THE schooner *Rosario*, at New York, reports than on June 23, in lat. 29° 14′ N. and long. 133° 25′ W., at 11 a.m., two heavy shocks of submarine earthquake were experienced. These were about one minute apart, and the last was much heavier than the first, causing the vessel to tremble violently. The sky was overcast, and the sea remarkably smooth.

THE Russian Geographical Society is said by the St. Petersburgh journals to contemplate sending a scientific expedition to the Amour for the purpose of studying the surrounding region with regard to its geographical, historical, and commercial features, as well as its mineral resources.

IT is announced in Brussels that the German Lieutenant Weissmann, who is in the service of the African Association, has discovered that the River Kassaï, which was always believed to join the Congo above the equator station, forms a curve and falls into Lake Leopold II.

ON the night of August 31 to September 1 temperature fell to a lower point in several districts than is known to have ever before happened so early in the season. Over upper and middle Strathspey in particular the frost was very severe. At Kingussie the protected thermometer fell to 24°·9 and the exposed to 18°·0, while at Grantown the exposed thermometer fell to 15°·0, these being all compared instruments and in good order. At Kingussie ice an inch thick was found on the water supplying the hygrometer. In this large district the potato crop is completely destroyed, not only in low-lying situations but also on the high-lying slopes. On the other hand, on crossing from Inverness-shire into Perthshire, the potato crop is safe, the tops being only slightly blackened. At the Ben Nevis Observatory on the same night, with a sky equally clear and cloudless as was over Strathspey, the protected thermometer fell only to 32°·9 and the exposed thermometer to 24°·6, being respectively 8°·0 and 6°·6 higher than occurred at Kingussie on the same night.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus inuus*) from North Africa, presented by Miss Bedford; at Bank Vole (*Arvicola pratensis*) from Essex, presented by Mr. E. Rosling; a Common Hedgehog (*Erinaceus europæus*), British, presented by Master C. Hanrott; a Common Polecat (*Mustela putorius*), British, presented by Mr. W. Buckley; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, presented by Mdlle. de Nujac; a Smooth Snake (*Coronella lævis*) from Dorsetshire, presented by the Rev. O. P. Cambridge, C.M.Z.S.; two Douglass's Horned Lizards (*Phrynosoma douglassi*) from New Mexico, presented by Dr. R. W. Shufeldt; two Common Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Mr. F. Bland.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, SEPTEMBER 20-26

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on September 20

Sun rises, 5h. 44m.; souths, 11h. 53m. 16·2s.; sets, 18h. 2m.; decl. on meridian, 0° 56′ N.: Sidereal Time at Sunset, 18h. 1m.

Moon (Full on Sept. 24) rises, 16h. 21m.; souths, 21h. 21m.; sets, 2h. 27m.*; decl. on meridian, 12° 12′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	4 1	10 50	17 39	8 51 N.
Venus	9 12	14 7	19 2	13 11 S.
Mars	0 23	8 21	16 19	20 42 N.
Jupiter	4 52	11 23	17 54	5 21 N.
Saturn	22 27*	6 35	14 44	22 20 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Occultations of Stars by the Moon

Sept.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
20	18 Aquarii	6	18 47	19 55	49 305
21	B.A.C. 7774	6	22 8	23 22	136 283
24	B.A.C. 8365	6½	5 12	6 5	124 350
25	μ Piscium	5	20 12	21 9	94 233
26	B.A.C. 741	6½	21 19	22 3	26 299

The Occultations of Stars are such as are visible at Greenwich.

Sept.	h.	
20	8	Mercury at least distance from the Sun.
22	–	Sun in equator.
24	–	Partial eclipse of the Moon, but the Moon will set at Greenwich at about sunrise whilst partly obscured by the penumbra and before entering the shadow.

SCIENTIFIC SERIALS

The Proceedings of the Royal Society of Queensland, 1884, vol. i. parts 2, 3, 4.—We are glad to see that this new Society in one of our leading colonies is advancing rapidly. In the parts before us Mr. Tryon describes certain rock-drawings of the aborigines of Queensland, of a class hitherto undescribed (with plates). Mr. C. W. de Vis, who is one of the most indefatigable contributors, writes on new Australian lizards; on a new form of the genus Therapon; on new Queensland lizards; on a new species of Hoplocephalus; on an apparently new species of Halmaturus; on a new species of Hyla; a description of new snakes with a synopsis of the genus Hoplocephalus; on the fauna of the Gulf of Carpentaria, and a conspect of the genus Heteropus. Mr. Bailey gives instalments of his contributions to Queensland Flora. Mr. Broadbent writes on the migrations of birds at the Cape York peninsula, which is a peculiarly favourite spot for observing the migrations of birds from and to New Guinea, for the passage is shortest here. Ethnology is well represented in the numbers before us, for, besides the paper by Mr. Tryon mentioned above, we have one by Dr. Bancroft on the food of the aborigines of Central Australia, and one by Mr. Duffield on the inhabitants of New Ireland and its archipelago, their fine and industrial arts, customs, and language, especially their tattooing. Mr. Knight describes a new species of Parmelia, and Baron von Müller, the *Dendrobium cincinnatum*, sp. nov. Mr. Bernays describes exotic fruits new to Queensland. Mr. Pink pleads for the practice of hybridisation of plants; and Dr. Bancroft describes experiments with Indian wheats in Queensland. There are numerous other minor contributions.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 31.—M. Bouley, President, in the chair.—On the cyclonic character of the solar spots, in reply to M. Tacchini's objection, by M. Faye. In their normal state the spots, like terrestrial cyclones, are described as of circular form, with funnel-shaped penumbra, concentric circumferences, and vertical axis, varying in size from almost imperceptible pores to abysses large enough to engulph the earth. The mechanical identity of the two phenomena is thus established, while the absence of this special disposition in the penumbra of certain spots proves nothing against the author's theory, which accounts both for the development and occasional disappearance of the cyclonic form.—Note respecting M. Bochefontaine's experiment on the origin of cholera, by M. Trécul. A pill containing the comma bacillus having been swallowed by M. Bochefontaine with impunity, the author infers that Koch's germ may not after all be the active principle of cholera. In any case he protests against the ridicule cast upon the experimenter, whose courageous act is worthy rather of admiration and reward.—On the part played by the bacilli in the ravages of the vine attributed to *Phylloxera vastatrix*, by M. Luiz de Andrade Corvo. From his experiments the author concludes that the disease, to which he gives the name of "tuberculosis," is quite distinct from, and independent of, Phylloxera, that it is constitutional and hereditary, and may also be transmitted by contagion, the insect merely playing a secondary part in its propagation.—Octahedrons of sulphur with square base, which is physically a rhombus, by M. Ch. Brame.—On certain points in the physiological action of tanguin, the poison used at ordeals in Madagascar, by M. Ch. E. Quinquand.—Influence of the sun on the vegetation, the vegetable functions and virulence of the cultivated virus of *Bacillus anthracis*, by M. S. Arloing.—A letter was read by the Perpetual Secretary from King Oscar of Sweden, to the effect that on attaining his sixtieth year, in 1889, he proposes offering a prize of 2500 francs, with a gold medal valued at 1000 francs, to the author of the most important contribution to mathematical science. The already nominated judges are a German, a Swiss, and M. Hermite of the Academy. —Experiments with various kinds of wheat, with a view to ascertain the most productive variety under normal conditions, by M. P. P. Dehérain. Five varieties yielded the following returns per hectare (2½ acres):—

	Corn		Straw
	Quintals	Hectolitres	(Tons)
Scholey ...	40·7	49·8	7·323
Scotch red	40·2	48·7	7·687
Berwick	37·7	44·8	6·281
Bordeaux	32·3	39·8	5·630
Noé Blue	29·6	35·6	5·491

—Account of a meteor observed at Fontainebleau, by M. E. P. Mounier. This meteor was noticed at 7.20 a.m. in a clear sky, describing a parabolic curve from north to south at a velocity much inferior to that of a shooting star. It emitted an intensely white light like that produced by a magnesium wire in combustion. Before disappearing it broke into three fragments, which for an instant flared with a still more vivid light, and then suddenly became extinguished.

Berlin

Physiological Society, July 3.—Prof. Waldeyer reported on an investigation carried out in his institute by Herr Pischelis into the development of the thyroid gland. The oldest observers, Remak, Kölliker, and, quite recently, His, had found that the thyroid gland was developed medianly from the stomodærum, a thickening of the wall and then a buttonlike eminence arising thereon, which afterwards became hollow and got transformed into the gland. Seeing the gland was composed of two lateral lobes united by an intermediate piece, Herr His assumed that two protrusions arose from the anterior wall of the stomodærum, coalescing towards the middle. Herren Stieda and Wölfler had afterwards given an entirely different description of the development of this organ. According to them the thyroid gland was developed from two lateral buds emanating from the branchial cleft, probably from the fourth fissure. In view of this contradiction of authors Herr Born had quite recently resumed this investigation, and had come to the highly surprising conclusion that the thyroid gland originated both medianly and laterally, the middle part of the gland originating from the uppermost part of the stomodærum, the lateral portions from the branchial clefts. This fact having no analogy in embryology, Herr Pischelis had scrutinisingly traced the development of the thyroid gland, not only in swine, which had been examined by Herr Born, but also in rabbits and birds. The result was the complete confirmation of Herr Born's conclusions. Thus was all the ground taken from under the feet of phylogenetic speculators regarding the derivation of the thyroid gland. This organ, which was a complete riddle both physiologically and histologically, remained inexplicable phylogenetically as well. In the discussion which followed, the effects of the excision of the thyroid gland in men and animals were copiously enlarged on.—Prof. Eulenburg spoke on a communication concerning the influence of the cortex of the cerebrum on the temperature of the body, which had been lately laid before the Society by Dr. Raudnitz, and sought to refute the arguments which had been brought forward by the latter in opposition to the conclusions at which, in conjunction with Herr Landois, he (Prof. Eulenburg) had arrived. The speaker maintained both the exactness of his thermo-electric measurements and the accuracy of his statements in reference to phenomena he had observed regarding the influence of certain parts of the cortex cerebri on the temperature of the part of the body lying opposite. His statements were supported not only by experiments on animals by means of stimulation and cutting, but likewise by a large number of clinical experiences. —Dr. Müllenhoff spoke of the different methods of investigating the locomotion of animals, and discussed the advantages afforded in this study by the photographic representation of a large number of individual moments on the part of animals in the act of movement. A rather large series of photographs prepared by Herr Anschütz in Lissa were shown. They reproduced the movements of men and horses, of storks dropping into their nests, lying there, and issuing from them, and of pigeons.—Dr. Salomon next exhibited some beautiful preparations of paraxanthine crystals which he had obtained from urine, and set forth some further qualities and reactions of this xanthine body discovered by him a year ago in the urine. Paraxanthine occurred very sparely; one thousand litres of urine contained but one grain of paraxanthine. In just as small quantity was another xanthine body present in urine, a body which he had now discovered and had called provisionally "heteroxanthine." This body was precipitated amorphously in the form of powder or in the shape of poppy-seeds, and with soda formed beautiful crystals. Certain reactions served to discriminate it from paraxanthine and to range it under the head of xanthine bodies. Of quite peculiar interest was its chemical composition. So far as the elementary analysis had yet gone, heteroxanthine was a methylxanthine, while paraxanthine was a dimethylxanthine, isomeric with theobromine. Seeing, as was known, that coffeine was a trimethylxanthine, by the discovery of the simply methylated xanthine the gap in the series of methylxanthines was filled up. We had now xanthine, methylxanthine = heteroxanthine, dimethylxanthine = paraxanthine and theobromine, trimethylxanthine = coffeine.

CONTENTS

THURSDAY, SEPTEMBER 24, 1885

PUBLIC OPINION AND STATE AID TO SCIENCE

ALTHOUGH Sir Lyon Playfair's address was probably listened to by a large number of members of the British Association as that of a man of science, there can be no doubt that to the vast majority of people outside it came as the utterance of a practical statesman. It was the Chairman of Committees of the House of Commons, the member of Parliament, the man of affairs who spoke, and the address was largely in keeping with these characters, for, as one writer has expressed it, it smells not so much of the laboratory as of the House of Commons. The subject of the endowment of research, of State aid to science, has been before the public for many years, and has been discussed under various circumstances, but it has never attracted at any one time the same earnest and general attention that it has since Sir Lyon Playfair's address. This is due not less to the pedestal on which the speaker was placed, than to the character and career of the speaker himself. The result has been that the guides and instructors of public opinion all over the country have felt it necessary to address themselves to the subject, and it is therefore possible now to gain some idea of the general drift of the public mind on the question of the claims of science on the State, and of the manner in which these claims should be met. Happily it is a question which men of all shades of opinion can consider without having their vision obscured by party passion and prejudice. As we go on it will be seen that the advocates of the doctrine of *laissez faire* are not absent; but, on the whole, those who have for so long maintained that the country, for the sake of its own happiness and prosperity and in order to maintain its place amongst other nations, must bring the teachings of science to its aid, have every ground for satisfaction.

To gauge public opinion on this question, in some measure, we have taken many of the leading journals of the metropolis, and propose to state briefly their views on this particular part of the Presidential Address. As will be seen, all shades of opinion are represented.

The *Times* acknowledges the reproach that countries less wealthy than our own make efforts to encourage science, by the side of which the encouragement afforded in England to science by the State sinks into insignificance; but it urges that, after all, the State is very much what the individuals who compose it choose to make it. Until public opinion exists in an organised and effective shape, the demand for the encouragement of science by the State will be addressed, for the most part, to a faithless and unbelieving generation. It points, as do a large number of other writers, to our ancient endowments for the benefit of education, and says that, although it may be conceded that they are still largely misapplied, they could be almost indefinitely increased, without direct assistance from the State, if vested interests and lack of intelligent initiative did not so often stand in the way. Until these obstacles are removed by the pressure of an active and enlightened public opinion, the State itself can hardly be expected to do much more than it does. The *Times*, therefore, acknowledges the need, and suggests that it should be met by the proper application of our existing educational endowments.

The *Standard* is as anxious as the President to see our Universities fully, and even lavishly, equipped for the prosecution of research; but it will not allow that they are so miserably starved as he would lead us to believe:—

"Sir Lyon Playfair falls into the vulgar error of reckoning as national expenditure on a given object only the outlay provided from taxation. Our Universities have resources which ought to be set against the State provision made in other countries for the same purposes. We are not, therefore, disposed to join in the outcry against the results of our English system. We believe that private benefactions and private enterprise have done much and are capable of doing more, and doing it better, than the State can do. We are not ashamed of the condition of scientific studies in England, and we claim for our countrymen a leading place among those who have built up the fabric of knowledge and promoted the well-being of man."

The *Daily Telegraph* likewise refers to private munificence which in the past has done in this country what State aid has to do at present in Continental countries, and it urges that scientific people should set before themselves, as their proper aim, to convince public opinion that the teaching of a far greater amount of science is necessary in our schools which are richly enough endowed.

The *Morning Post* maintains that Sir Lyon Playfair has conclusively demonstrated that we do not in respect to scientific education keep abreast of other countries, and in the same proportion as we allow ourselves to be distanced do we deny ourselves the means and the opportunities of developing our industrial and physical resources The money laid out in the manner indicated by Dr. Playfair, it says, would be well expended, and would in time be returned a hundredfold to the Imperial Exchequer.

The *Daily News* regards the address as singularly interesting and practical. It is a powerful and, as many will think, a conclusive plea for giving science a larger and a better place in modern life. Sir Lyon Playfair is a practical statesman, and suggests only practical measures. We must not only greatly enlarge our educational machinery, but must at the same time modernise it and bring it into direct relation to modern needs.

The *Morning Advertiser* eulogises the address because every word of it is directed to the one moral, "Educate, educate, educate." Never has the cause of scientific education been urged in a manner which commends itself more to common sense and conviction than in the singularly well-reasoned monologue wherein Sir Lyon Playfair, from the platform of the British Association, hits a national danger at the same time that he shows the means of correcting it.

The *Pall Mall Gazette* pronounces a verdict in favour of Sir Lyon Playfair as clearly and decidedly as the *Morning Post*. It says:—

"No one will be surprised that Sir Lyon Playfair should have selected for the subject of his address the 'Relation of Science to the State,' and when that is once explained it goes without saying that he made a very cogent plea for an establishment and endowment of science. This plea, it is perfectly certain, cannot be much longer refused. The Laissez-faire Society must add a new section to it betimes, for it is inevitable that the liberty of ignorance, which is impoverishing the life of the country at home and letting its trade slip through its fingers abroad, should soon be very rudely interfered with by the State. At present it is a case in this matter of Great Britain *contra mundum*. Every other civilised country has come to the conclusion by this time that the competition of the world is now a competition of intellect, and has taken steps accordingly. Either we or they must be wrong; and that it is we is now being brought home to us by the conclusive 'argument to the pocket.' John Bull's one ambition, according to Mr. *Punch*, is to 'guard his pudding;' but then he is beginning to find out that he can only fill his stomach by first filling his head. From the recognition of the vital importance of science to its establishment by the State—in a much less half-hearted fashion than at present—is in these days a short and inevitable step. The same considerations by which State interference has been justified elsewhere—its greater certainty, its ampler resources, its wider range—are all equally applicable here, and will come to be equally applied."

The *Globe* says the "argument" of the address may be conceded. Science deserves from the State all that the State can do for her. Minerva is a sort of alien deity in our intellectual Pantheon, and it is certain that the tendency and pressure of modern conditions impose upon all civilised States, an increasing obligation to learn or to lag. But it questions whether we really are in the evil plight depicted by the President, and points to "the magnificent private endowments of our insular foundations"—a source of revenue comparatively non-existent abroad, which, it states, Sir Lyon Playfair strangely ignores.

The *St. James's Gazette* thinks that reformers might bend some of their energies to seeing that more technical science and more arts likely to be useful to the craftsman and the mechanic, were brought within the curriculum of the Board Schools. For them we could easily spare some of the literary subjects:—

"With the moral of Sir Lyon Playfair's scientific sermon, and the journalistic lectures based on it, most people will agree. This is an age of science, and you can do nothing effectual in the practical way, from building ironclads to catching mussels, without a knowledge of what are called 'the laws of nature.' If you do not want your ironclads to be sunk by those of other navies, or your mussel trade to be ruined by foreign competition, you will do well to see that the 'laws of nature' are properly studied in your schools and colleges. That technical education in this country is not so good as it might be, and as it possibly is elsewhere, may be admitted."

But it does not think that this is due to superabundance of classics in our system of middle and higher-class education.

The *Guardian*, at the conclusion of a lengthy article devoted to the address, sums up its conclusions on the subject of the relations of the State to science thus:—

"On the whole we are inclined to think that the best service the State can render to education is to continue to help it in the unsystematic and irregular way which has hitherto proved so useful, considering each case as it arises, and adapting its measures to the particular needs which are brought before it. Much more may, no doubt, be done for Science, but it may be done in the same way as before, by grants for special purposes, by expeditions fitted out for costly investigations, perhaps by the foundation of professorships and scholarships. But it would be a misfortune if the free action of individual thought were repressed by being obliged to conform to the rules of a State-imposed system, or if individual exertion and private munificence were discouraged by the habit, already growing upon us too much, of looking to the State rather than to ourselves for the removal of every difficulty and the promotion of every useful end."

The *Athenæum*, refers to what has been done by the State for science since the last meeting of the British Association at Aberdeen twenty years ago, and instances the Science and Art Department, the Natural History Museum, grants to the Royal Society, &c., proceeds:—

"All this—and much more might be added—shows that British statecraft is not altogether disposed to frown coldly upon science and its devotees. And yet, after all, how little—how miserably little—has been officially done for the promotion of science compared with the magnitude of our scientific interests and the wealth of our country! It is only by looking abroad and observing what has been accomplished in other lands that we realise our own shortcomings. Germany and France, Switzerland, and some of the other small continental States, have displayed a zeal for scientific progress and a liberal recognition of science which strikingly contrast with our own parsimony. Even when we have undertaken a good work our heart has often failed us in carrying it through with dignity and liberality. As a striking and recent example we may refer to the *Challenger* expedition. Here was an expedition splendidly equipped for scientific work at the expense of the nation; and yet, when the results of the expedition come to be published as voluminous reports, they are distributed with so sparing a hand, and are published at so high a price, as to be practically inaccessible to most men of science."

The *Saturday Review* says that Sir Lyon Playfair's words are tempered by the consciousness that he may some day be called upon to make them good, and this adds the greater force to the adverse verdict which he is compelled to give, the censure which he cannot help pronouncing on the action of the State towards science in England. The reply to the question, What has the State done directly for science? the answer is, But little compared with the need, and that little often in the wrong way. As the pocket is said to be the most sensitive part of our race, it is to be hoped that when the British Association next meets in Aberdeen its future president will not be forced to repeat Sir Lyon Playfair's assertion: "English Governments alone fail to grasp the fact that the competition of the world has become a competition in intellect."

The *Spectator* speaks of the address as like a sermon preached by a popular clergyman on behalf of science, and wants to know why this branch of thought needs help so much more than art, literature, or pursuits like archæology, or the study of the historic past. It doubts whether in science, as in an army, honourable poverty does not conduce to the highest efforts; and whether richly endowed schools will produce the most successful professors, even in the inferior domain of applied science Wheatstone was great, and was paid? but how much a year, it asks, did Friar Bacon get? or did any body ever pay that early expert in natural science who discovered fire?

"And remembering what the history of thought has been, we cannot but deprecate that spirit of sordidness in which for some years past the claims of science have been pressed—the desire for salaries which has been so conspicuous whenever professors have descanted on the merits of research. We have not the slightest objection to scientific departments, and quite agree with Sir Lyon Playfair that if the State wants fishes it could learn how to get them better by inquiring of the fishes—who, at least, tell no lies—than of the fishermen, who often do; but still the picture he draws of the United States Government, with its dozen departments of inquiry into geology, palæontology, ichthyology, chemistry, and the rest, does not inspire us with enthusiasm. It is all very excellent, no doubt; but it was all consistent with slavery. France may be handed over to Paul Berts and its judges still take bribes."

The *Glasgow Herald* pronounces Sir Lyon Playfair's address a signal success. Those pedantic persons who fail to see the uses of science might find in the address an admirable lesson against the perpetual sneering at what they are pleased to term the abstractions of scientific teaching. Sir Lyon, in a word, has emphasised the teaching that the safety and the progress of every country are one with scientific advance and the growth of scientific precision.

On the whole, then, it may be pronounced that the movement in favour of State aid to science, in the interest of the State itself rather than of any particular branch of human knowledge, has advanced and has taken a hold of the public mind. The need is universally acknowledged; in many quarters it is proposed to meet it by the application of endowments, ancient and modern, to the changed requirements of the present day; in others—and these amongst the influential—it is boldly declared that the State must link itself, at whatever cost, with science if this country is to hold its high place amongst nations. "The same considerations by which State interference has been justified elsewhere—its greater certainty, its ampler resources, its wider range—are all equally applicable here, and will come to be equally applied."

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The New Star in Andromeda

On seeing the report in yesterday's *Standard* of the remarkable change in the nucleus of the nebula of Andromeda, I decided to write to you to mention that, accidentally noticing the nebula on Sunday evening, the 6th, I was struck by its conspicuousness, and set wondering how the ancients came to overlook an object so prominent. As frequent watching for meteors has made that region very familiar to me, it seems likely that an increase in general brightness has occurred, and made me specially notice its appearance.

What is of far more interest, however, I have learnt this morning that one of our scholars, Lawrence Richardson, noted and *recorded* an apparent change in the nebula, as he saw it in our 4¼ inch Cooke's refractor, about 9 p.m. September 1. I append a *verbatim* copy from his diary of what is perhaps the first English observation of this remarkable phenomenon.

J. Edmund Clark

Friends' School, Bootham, York, September 9

(Copy) "Sept. 1 . . . As a beginning [of the season's work] looked at Polaris, ϵ Lyræ and the great nebula of Andromeda. Noticed a small star in the centre of the latter which I do not remember having seen before, and which is not down in a small drawing I made on September 15, 1884.

Norwegian Testimony to the Aurora-Sound

How widespread in our days is the belief in the sound of the Aurora in Norway, the following may show. In March, 1885, I despatched some thousand circulars to all parts of the country containing different queries regarding the aurora, and amongst these also the following:—Have you or your acquaintances ever heard any sound during aurora, and, in this case, when and in what manner? Up to this date I have received answers to these queries from 144 persons in different parts of the country. Of these there are not less than 92, or 64 per cent., who believe in the existence of the aurora-sound, and 53 (36 per cent.) of these again state they have heard it themselves, whilst the other 39 cite testimonials from other people; only 21 (15 per cent.) declare they never have heard the sound or know anything about it, and the other 31 (22 per cent.) have not noticed the query at all. There are thus 92 affirmations against 21 negations.

The sound is described in these answers in the following manner:—

Sizzling (3)
Creaking or sizzling
An intermediate sound between sizzling and whizzing, sometimes as if a piece of paper were torn
A kind of sound as when you tear silk
Sizzling, th—ss
Soft whizzing, alternative with sizzling
Soft crackling, sizzling
Hissing and crackling
Partly hissing, partly as a kind of rushing whiz
Whispering and glistering
Strong whiz (3)
Whiz or whispering
Whiz, or distant, soft, continuous whizzing
A rather heavy rush, as from a distant waterfall
Quiet whizzing, hissing
Hissing, or hoy! hoy! hoy!
Whiz (2)
Rush, as from a stream
Soft but distant crackling, as from a lighted match-cord
Whizzing (5)
Whizzing in the air
Rush, as when sheep are chased
Soft whiz or hissing
Soft whiz
Soft hissing, soft whiz
Whizzing or whistling
Rippling
Crackling (4)
Hissing
Hissing noise in the air
Crack in the air
Din in the air
Continuous sounding, rolling din in the air
Clashing
Flapping, as a flag before the wind
Partly as rustling or flapping of sails hanging loose fore the wind, partly as hissing from fire
Like the noise from a distant, before the wind-flapping flag, which now and then sends out a creaking sound
Like the sound from sails of a ship hanging loose in stormy weather
Monotonous whizzing and creaking, as when a sheet flaps before the wind
Like burning juniper-boughs
Brustling or crackling as if burning juniper
As from a feeble burning flame
Like burning dried juniper
As from the flames of a conflagration
Cutting, hissing as from flames
Crackling and creaking, a noise as from a large fire-flame—as, for instance, burning dried boughs
Like the sound from a flight of birds
Noise as when a bird flaps in the air
Strong flapping noise, as when a bird passes very near you
Crackling from fire and flapping from wings
As of a bird flying through the air with great velocity
Whizzing noise, as when striking the air with a whip
Noise as from the dart of an arrow
Like the buzzing of a bee
Roaring noise, as when strong gushes of wind dart through the tree-tops of the wood
Creaking sound as from the blowing of the wind
Distant roar, as from a storm
Roaring as from a storm
Roaring as from a whirlwind
As from a soft-blowing wind
Soft breeze
Like the soft breeze through a wood
Whipping with whisk-brooms
Fanning
Soft noise, as when fanning with a piece of paper from a distance
Soft flapping with a piece of cloth
Roaring of the sea
Heavy, hollow roar from the sea
Sweeping sound, as when dry snow is sweeping over an ice-field
As when one holds a cloth by two corners and flaps with it

Creaking, at other times, as when a sail strikes against the mast or flaps before the wind	As when a thunder-clap passed over us from west to east
Partly whizzing, partly as when a sail flaps before the wind	Soft crackling, as from electric sparks from an electrical machine
As when a sail flaps before the wind	As when stroking a cat's back against the hairs

Christiania, September 16 SOPHUS TROMHOLT

A White Swallow

DURING our walk to-day on the Kendal Road, near Heversham, my brother and I were very much surprised to see a white swallow amongst a number of the ordinary kind. The bird's plumage was entirely white, except the lower part of the breast, which was greyish.

We are quite sure of its identity, as it flew around us several times.

Can you tell us whether a white swallow is really an uncommon sight? MARY BRIGGS

Sandside, near Milnethorpe, Westmoreland, September 4

THE HUME COLLECTION OF ASIATIC BIRDS

FOR some time past the interest of ornithologists has been aroused by the rumour that Mr. A. O. Hume, of Simla, had offered, or intended to give, his celebrated collection of Asiatic Birds to the Trustees of the British Museum; and I am glad to be able to inform the readers of NATURE that the whole of this collection is now safely housed in the Natural History Museum, the second half having been delivered by the P. and O. Company on the 18th of last month.

Those of our readers who are not ornithologists may wish to learn something in the first place about the collection itself and its generous donor.

Mr. A. O. Hume, C.B., occupied formerly a high position in the Bengal Civil Service, and devoted for many years his leisure hours to the study of ornithology, and especially of the birds of India. His aim was to form a collection of birds of every part of the British Asian Empire, in which every species should be represented by a complete series of specimens illustrating its range and its variations of colour according to age, season, or locality. For this purpose he organised a system under which a great number of local observers and collectors (in some years numbering nearly 100) worked for and with him. He fitted out expeditions with a staff of collectors and taxidermists, under his own leadership or that of his able former curator, Mr. Davison, into Scinde, Coorg, Manipur, the Malayan Peninsula, Tennasserim, and the Andaman and Nicobar Islands; he acquired by purchase or donation the Mandelli collection from Sikkim and Tibet, Brook's beautiful series from North-Western and Central India, Adam's Sambhur birds, Bingham's collections from Delhi and Tennasserim, Scully's collection from Turkestan. The expense incurred in forming this collection was in proportion to the enthusiasm with which Mr. Hume worked. He had built at Simla a museum for the reception of the collection which should finally form the basis for the preparation of a comprehensive work on the avifauna of the vast region which he was exploring. But whilst thus engaged Mr. Hume, with his wonderful activity and ready pen, which had rendered him *facile princeps* in all matters regarding Indian ornithology, published numerous papers in an ornithological periodical, *Stray Feathers*, which he founded and conducted for ten or eleven years, as well as several separate works — viz. "Notes on the Indian Raptores," "Nests and Eggs of Indian Birds," "List of the Birds of India," "Game Birds of India, Burmah, and Ceylon," and others.

However, during the last few years naturalists, to their great regret, became aware that Mr. Hume's interest in ornithology began to yield to other important matters of social and political nature; and finally, the grievous loss by theft of an enormous mass of ornithological manuscripts, comprising his materials for "The Birds of the British Asian Empire," and the whole of his Museum Catalogue, contributed to his determination to abandon his intention of working out his collection, and to present it to some museum where others might utilise the materials he had collected.

It is very gratifying that Mr. Hume, "considering the British Museum as the one that has most claims upon him, and Mr. Sharpe as the man most capable in Europe of doing justice to the collection," offered to present it to the Trustees of that institution. The Trustees, fully aware of the scientific importance of the collection, had no hesitation in accepting the offer. Still, before actually transferring the collection, Mr. Hume was desirous of completely rearranging and placing it in thorough good order, and also of preparing at the same time a Catalogue of the Birds of the Indian Empire containing the results of his long and careful studies. Unfortunately this project could not be carried out owing to the difficulty of finding a competent coadjutor in the work, or rather of obtaining the means of properly remunerating such a person. And as there was great risk in leaving the collection without due curatorial supervision exposed to the deteriorating influences of another rainy season in India, the Trustees obtained Mr. Hume's consent to transmitting the collection without further delay to England.

Mr. Sharpe, who is always ready to sacrifice his personal comfort to duty, started for Simla almost at a moment's notice, and although, unseasoned as he was, he had to travel and work during the hottest part of the year, he seems to have infused his energy into all who had to help him in the gigantic task of packing the collection. He started on April 25, arrived in Simla on May 21, completed his work by the end of June, and returned to the Museum on August 15, having the satisfaction to find on his return the half of the collection which had preceded him safely lodged in the Museum, while the other half was delivered a week later without loss of, or damage to, any of the cases.

The collection comprises about 400 skins of mammals, 63,000 skins of birds, 300 nests, and 18,500 eggs. It was packed in eighty-two cases, the majority with a capacity of 30 cubic feet. Even to those who are used to the inspection of large collections, these figures can hardly convey a correct idea of the magnitude of this addition to the National Museum. Mr. Hume may truly say that such a collection has never been made before; and such will probably never be made again. Each specimen is enveloped in a brown paper wrapper with the name of the species and locality written on the outside, proper labels being, besides, attached to the specimen. The skins themselves are in excellent condition, and, thanks to the precautions taken by Mr. Sharpe, they are not likely to harbour or to develop destructive inmates. Specimens which had suffered from damp or insects and to which no special interest was attached, were eliminated during packing.

The scientific value of the collection, of course, is not to be measured by the number of specimens only, but by the judgment which determined their selection, by the history attached to many of them, and by the completeness of the series. We may reasonably assume that it contains about 2000 species, so that on an average each species is represented by some thirty specimens, which number in the majority of the cases would not go beyond a fair illustration of its range and variation. Therefore the number of duplicates which will be eliminated by Mr. Sharpe during the progress of the examination will probably be much smaller than one might anticipate on a superficial inspection; and I need not say that Mr. Hume's earnest wish that the series which he has brought together with so much discrimination and care should remain intact, will be strictly carried out. No doubt a considerable number of duplicates will be eliminated, and, according to the wish of the donor, of these a complete set has to be transmitted to the Museum of Comparative Zoology of Harvard College, whilst the remainder are to be utilised for the benefit of the ornithological collection generally.

Ornithologists need not go many years back in recalling to their memory the extent of the collection which the late Mr. G. R. Gray had arranged in such a handy fashion in and about his study in the old building at Bloomsbury. What was then regarded a good reference collection has since been enriched by the addition of the Wallace collection from the Indian Archipelago, Capt. Pinwill's Malayan birds, Sharpe's African collection, the Gould collection, Salvin and Godman's European, Australian, and American collections, the Sclater collection, and now by this immense collection from every part of the Indian Empire. Years of unremitting labour will be required to get these vast materials into order and to work them out in a manner which will satisfy the aims of so advanced a branch of science as ornithology is at the present day.

ALBERT GÜNTHER

THE FORSTER HERBARIUM

BOTANISTS will learn with pleasure that this herbarium, a portion of the collections of Cook's second voyage, has been acquired by exchange from the Liverpool Corporation for the Kew Herbarium; and it will be incorporated in the general collection. From the introduction to the "Catalogue of Plants" in the Botanic Gardens at Liverpool, published in 1808, it appears that the proprietors of that establishment possessed, at that date, about 3000 specimens of dried plants, "collected by the late Dr. Forster in his voyages to the South Seas, with large and valuable contributions from his friends and correspondents." How these plants came into their possession is uncertain, but they could hardly have been presented to them by Mr. Shepherd, the Curator, as stated by Sir Joseph Hooker in the introductory essay to his "Flora Novæ-Zealandiæ," or his name would almost certainly have been mentioned as the donor. At least this may be inferred, because on the very next page a very high tribute is paid to Mr. John Shepherd for his services to the Garden. Be that as it may, the collection will shortly be accessible to botanists generally, thanks to the perseverance of Sir Joseph Hooker and the sensible view of the matter taken by the present members of the Corporation when it was represented to them that these dried plants were practically useless where they were, but would be valuable at a botanical establishment like Kew. This act of the Corporation deserves to be recorded, because some thirty years ago, when Sir Joseph Hooker was engaged writing his "Flora Novæ-Zealandiæ," he applied to the then custodians of the collection to transmit it temporarily to Kew for comparison and publication, and his request was refused.

Botanical investigations in connection with the *Challenger* expedition again brought to mind the existence of this interesting collection at Liverpool, and it was determined to make another effort to rescue it from oblivion, which was fortunately successful. A few words respecting the botanical collections of Cook's voyages generally, and of this one in particular, will be welcome to those interested in botany. Sir Joseph Banks and Dr. Solander accompanied Capt. Cook on his first voyage round the world; John Reinhold Forster and George Forster, father and son, were the botanists of the second voyage (1772-75), and Mr. Anderson, the surgeon of the expedition, collected a little on the third voyage. From a statement in Sparmann's "Travels in South Africa," it seems that Forster the elder undertook the duties of naturalist to the expedition for the sum of 4000*l.*, and he took his son with him, then only seventeen years old, as an assistant. On arriving at the Cape of Good Hope they fell in with Sparmann, who, at the instance and expense of Forster, was added to the scientific staff, and continued with them until the return to the Cape in 1775. Considerable collections of plants were made in New Zealand, many parts of Polynesia, and the extreme south of America, and smaller collections in some of the Atlantic Islands, including St. Helena, Cape Verd Islands, and Canaries. On returning to England the Forsters soon commenced publishing the botanical results of the expedition, and an authenticated set of all the published plants at least was deposited in the British Museum. The Cape plants, however, which they did not publish, are apparently not represented there. The first botanical work, "Characteres Genera Plantarum," appeared in 1776, and the title-page bears the names of both father and son, and this was the only one published in England. For the rest, the botany was done by the son alone. His "Florula Insularum Australium Prodromus" appeared at Göttingen in 1786, and "De Plantis Esculentis Insularum Oceani Australis" at Berlin in the same year, followed by "De Plantis Magellanicis et Alanticis" at Göttingen in 1787.

These works, we believe, constitute the whole of the published botany of the expedition, and, though very meagre, are extremely interesting, being the foundation of our knowledge of New Zealand, Antarctic, and Polynesian vegetation. The collection now acquired for Kew is excellently preserved, and the plants mostly named and localised. It comprises altogether 1359 species, 785 of which were collected on the voyage with Cook, and the rest, from various parts of the world, are probably some of those alluded to above as having been presented to Forster by his friends. The collection includes a large proportion of the plants published by the Forsters, but it is not complete. Roughly, there are 187 species from Polynesia, 119 from New Zealand, 21 from the extreme south of America, 23 from the Atlantic Islands, including all those described by Forster from St. Helena, and 9 from Australia. Besides the foregoing, which are all phanerogams, there are 36 ferns, but they include only a small portion of the species described by Forster.

In addition to this botanical work George Forster's name appears on the second title-page of the Narrative of the second voyage as joint author with James Cook. He died, a violent death, we believe, at Paris in 1794, four years before the decease of his father. The philosophical writings of the latter, entitled "Observations made during a Voyage round the World," London, 1778, deserve special mention

W. BOTTING HEMSLEY

THE INTERNATIONAL METEOROLOGICAL COMMITTEE

THIS Committee held its third meeting in Paris at the Ministry of Public Instruction on September 1 to 8. The Meeting was attended by the President, Prof. Wild (Russia); the Secretary, Mr. R. H. Scott; Profs. Buys Ballot (Holland), Hann (Austria), Mascart (France), Mohn (Norway), Dr. Neumayer (Germany), and Prof. Tacchini (Italy). M. de Pinto Capello (Portugal), the only remaining member, was unfortunately unable to be present.

In addition certain gentlemen were present by invitations at some of the meetings, among these we may mention Brigadier-General Hazen (Chief Signal Officer, U.S.A.), Prof. Hildebrandsson (Upsala), and M. Leon Teisserenc de Bort.

The following is a brief notice of the most important subjects discussed, with the action taken on each.

A valuable report on cirrus observations by the Committee appointed at Copenhagen (1882), MM. Capello, Hildebrandsson, and Ley, was submitted, and will be printed.

The subject of Atlantic telegrams was discussed with General Hazen. It was decided to maintain the present system of reports from ships' logs which has been carried on since Christmas by the Meteorological Offices of France and this country, and to endeavour to improve it.

At the same time a proposal made by M. L. Teisserenc de Bort for the telegraphic transmission of a daily *résumé* of the weather in the New England States was considered. General Hazen expressed perfect readiness to furnish such reports, and it was resolved to procure such telegrams provided the cost of the service could be guaranteed by the European offices which would participate in it.

It was decided to recommend that barometrical observations should be corrected for the force of gravity at lat. 45°.

A letter from General Hazen respecting the reduction of barometer readings to sea-level, which has been lately circulated, was considered, and two memoranda on the subject from Hamburg and St. Petersburg respectively were handed in and will be printed.

It was considered *desirable*, as absolute synchronism in weather observations appears to be unattainable in Europe, that the same hours of local time should be adopted in each country (which would mean a change from 8 a.m. to 7 a.m. in this country).

It was decided that each of the International Reduction Tables (proposed by the Committee at its meeting at Berne in 1880) as did not involve any question which is still in an undecided state (such as, *e.g.*, hygrometrical tables, or tables of sea-level reduction) should be published.

It was decided to recommend that the next Congress should not take place till 1889, and Prof. Mascart stated that probably the French Government would propose that it should be held in Paris.

THE BRITISH ASSOCIATION

JUDGED by the quantity of work which the sections have put through their hands the Aberdeen meeting has been successful almost beyond precedent. Moreover much of this work has been of the best quality. The addresses come up to a very high standard, and in the first four sections, at least, not a few of the papers were really important original contributions to science, while the discussions in Sections A and B on certain great questions in physics and chemistry were a marked and commendable feature—a feature which, it is hoped, will in time become common to all the sections. Mr. Murray's lecture on deep-sea research has been justly considered one of the leading events of the meeting; a full report will appear in our columns.

At the concluding general meeting a deservedly hearty vote of thanks was accorded to the Aberdonians for their abundant hospitality. Birmingham seems determined to make next year's meeting a memorable one; and we may remind our readers that Sir William Dawson, of McGill College, Montreal, will be the President.

The total number of persons who attended the Aberdeen meeting was 2203.

The following is a synopsis of grants of money appropriated to scientific purposes by the General Committee at the Aberdeen meeting. The names of the members who would be entitled to call on the General Treasurer for the respective grants are prefixed:—

A—*Mathematics and Physics*

*Foster, Prof. G. Carey—Electrical Standards	£40
*Stewart, Prof. Balfour—Solar Radiation	20
*Stewart, Prof. Balfour—Meteorological Observations at Chepstow	25
Darwin, Prof. G. H.—Instructions for Tidal Observations	50
*Stewart, Prof. Balfour—Comparing and Reducing Magnetic Observations	40
*Forbes, Prof. G.—Standards of Light	20
*Brown, Prof. Crum—Ben Nevis Observatory	100
*Armstrong, Prof.—Physical and Chemical Bearings of Electrolysis	20

B—*Chemistry*

M'Leod, Prof.—Silent Discharge of Electricity into Atmosphere	£20
*Williamson, Prof. A. W.—Chemical Nomenclature ...	5

C—*Geology*

*Blanford, Mr. W. T.—Fossil Plants of the Tertiary and Secondary Bed	20
Hughes, Prof. T. McK.—Caves of North Wales ...	25
*Etheridge, Mr. R.—Volcano Phenomena in Japan ...	50
*Grantham, Mr. R. B.—Erosion of Sea Coasts	20
*Bannerman, Mr. H.—Volcanic Phenomena of Vesuvius	30
*Evans, Dr. J.—Geological Record	100
*Etheridge, Mr. R.—Fossil Phyllopoda	15

D—*Biology*

*Stanton, Mr. H. T.—Zoological Record	100
*Murray, Mr. J.—Marine Biological Station at Granton..	75
*Lankester—Prof. Ray—Zoological Station at Naples ...	50
Cleland, Prof.—Researches in Food Fishes at St. Andrew's	75
*Cordeaux, Mr. J.—Migration of Birds	30
Cleland, Prof.—Mechanism of Secretion of Urine ...	10

E—*Geography*

Walker, General J. T.—New Guinea Exploration ...	150
Walker, General J. T.—Investigation into Depth of Permanently Frozen Soil in Polar Regions	5

F—*Economic Science and Statistics*

Sidgwick, Prof.—Regulation of Wages under Sliding Scales	10

G—*Mechanics*

Barlow, Mr. W. H.—Effect of Varying Stresses on Metals	10

H—*Anthropology*

Garson, Dr.—Investigation into a Prehistoric Race in the Greek Islands	20
*Tylor, Dr. E. B.—Investigation into North-Western Tribes of Canada	50
*Galton, Mr. F.—Racial Characteristics in British Isles..	10
	£1195

* Reappointed.

REPORTS

Report of the Committee, consisting of Mr. Robert H. Scott (Secretary), Mr. J. Norman Lockyer, Prof. G. G. Stokes, Prof. Balfour Stewart, and Mr. G. J. Symons, appointed for the purpose of co-operating with the Meteorological Society of the Mauritius in their proposed publication of Daily Synoptic Charts of the Indian Ocean from the year 1861. *Drawn up by Mr. R. H. Scott.*—The Committee forward, for the inspection of the members of the Association, a copy of the charts for the month of March, 1861, with some specimens for January of the same year, and the complete number for February which appeared some years ago. These documents have recently arrived from the Mauritius. As the work has now made decided progress the Committee have applied for and obtained the grant of 50*l*. placed at their disposal by the General Committee. As soon as the requisite documents are received from Dr. Meldrum the Committee will submit a formal account of their expenditure with the necessary vouchers.

Second Report of the Committee, consisting of Prof. Schuster (Secretary), Prof. Balfour Stewart, Prof. Stokes, Mr. G. Johnstone Stoney, Prof. Sir H. E. Roscoe, Capt. Abney, and Mr. G. J. Symons, appointed for the purpose of considering the best methods of recording the direct Intensity of Solar Radiation.—The Committee have come to the following conclusions:—(1) It seems desirable to construct an instrument which would be a modification of Prof. Stewart's actinometer adapted for self-registration—the quantity to be observed being, not the rise of temperature of the enclosed thermometer after exposure for a given time, but the excess of its temperature when continuously exposed over the temperature of the envelope. (2) As the grant to the Committee will not admit of the purchase of a heliostat, it will no doubt be possible to procure the loan of such n instrument, and, by making by its means sufficiently numerous comparisons of the instrument proposed by the Committee with an ordinary actinometer, to find whether the arrangement suggested by the Committee is likely to succeed in practice. The Committee would therefore confine their action for the present to the carrying out of such a series of comparisons. (3) The size of the instrument might be the same as that of Prof. Stewart's actinometer. (4) The instrument should have a thick metallic enclosure, as in the actinometer above-mentioned, and in this enclosure there should be inserted a thermometer to record its temperature. Great pains should therefore be taken to construct this enclosure so that its temperature shall be the same throughout. (5) The interior thermometer should be so constructed as to be readily susceptible of solar influences. It is proposed to make it of green glass (a good absorber), and to give it a flattened surface in the direction perpendicular to the light from the hole. (6) It seems desirable to concentrate the sun's light by means of a lens upon the interior thermometer, as in the ordinary instrument. For if there were no lens the hole would require to be large, and it would be more difficult to prevent the heat from the sky around the sun from interfering with the determination. Again, with a lens there would be great facility in adjusting the amount of heat to be received by employing a set of diaphragms. There are thus considerable advantages in a lens, and there does not appear to be any objection to its use.

Third Report of the Committee, consisting of Profs. G. H. Darwin and J. C. Adams, for the Harmonic Analysis of Tidal Observations. Drawn up by Prof. G. H. Darwin.—"Record of Work during the past Year." The edition of the computation forms referred to in the second report is now completed, and copies are on sale with the Cambridge Scientific Instrument Company, St. Tibbs' Row, Cambridge, at the price of 2*s*. 6*d*. each. Some copies of the first report, in which the theory and use of these forms are explained, are also on sale at the same price. A few copies of the computation forms have been sent to the librarians of some of the principal scientific academies of Europe and America. In South Africa, Mr. Gill, at the Cape, and Mr. Neison, at Natal, are now engaged in reducing observations with forms supplied from this edition. A memorial has been addressed to the Government of the Dominion of Canada, urging the desirability of systematic tidal observation, and the publication of tide-tables for the Canadian coasts. There seems to be good hope that a number of tide-gauges will shortly be set up on the Atlantic and Pacific coasts, and in the Gulf of the St. Lawrence. The observations will probably be reduced according to the methods of the British Association, and the predictions made with the instrument of the Indian Government. Major Baird has completed the reduction of all the tidal results obtained at the Indian stations to the standard forms proposed in the Report of 1883, and Mr. Roberts has similarly reduced a few results read before the Association by Sir William Thomson and Capt. Evans in 1878. All these are now being published in the *Proceedings* of the Royal Society, in a paper by Major Baird and myself. A large number of tidal results have been obtained by the United States Coast Survey, and reduced under the superintendence of Prof. Ferrel. Although the method pursued by him has been slightly different from that of the British Association, it appears that the American results should be comparable with those at the Indian and European ports. Prof. Ferrel has given an assurance that this is the case; nevertheless, there appears to be strong internal evidence that, at some of the ports, some of the phases should be altered by 180°. The doubt thus raised will probably be removed, and the paper before the Royal Society will afford a table of reference for all —or nearly all—the results of the harmonic method up to the date of its publication. The manual of the tidal observation promised by Major Baird is now completed, and will be published shortly. This work will explain fully all the practical difficulties likely to be encountered in the choice of a station for a tide-gauge, and in the erection and working of the instrument. Major Baird's great experience in India, and the success with which the operations of which he has had charge have been carried out, render his advice of great value for the prosecution of tidal observation in other countries. The work also explains the method of measuring the tide diagrams, entering the figures in the computation forms, and the subsequent numerical operations.

Second Report of the Committee, consisting of Prof. Balfour Stewart (Secretary), Mr. J. Knox Laughton, Mr. G. J. Symons, Mr. R. H. Scott, and Mr. Johnstone Stoney, appointed for the purpose of cooperating with Mr. E. J. Lowe in his project of establishing a Meteorological Observatory near Chepstow on a permanent and scientific basis.—Since their re-appointment in 1885 this Committee have met twice, and have placed themselves in correspondence with Mr. Lowe, to whom the following letter was written by their Secretary: "The Committee request me to point out to you that the main feature of your proposal, which interests the British Association and the scientific public generally, is the prospect which it holds out of the establishment of a *permanent* institution, by means of which meteorological constants could be determined, and any secular change which may take place therein in the course of a long period of years be ascertained. It will be for you and the local authorities to decide what amount of work of *local interest* should be contemplated, and on this will the scale of the observatory mainly depend. The Committee are therefore unable to say what amount of capital would be required. They would point out four conditions which they hold to be indispensable:—(1) The area of ground appropriated should be sufficient to ensure freedom from the effects of subsequent building in the neighbourhood. (2) A sufficient endowment fund of at least 150*l*. annually should be created. (3) The control should be in the hands of a body which is in itself permanent as far as can be foreseen. (4) The land for the site shall be handed over absolutely to the above-mentioned governing body. Until the precise amount of the local meteorological requirements is ascertained and further progress is made in the scheme the Committee consider that they would not be justified in any more prominent action than that which they have already taken.

Report of the Committee, consisting of Profs. A. Johnson (Secretary), J. G. MacGregor, J. B. Cherriman, H. T. Bovey, and Mr. C. Carpmael, appointed for the purpose of promoting Tidal Observations in Canada.—The Committee, in order to strengthen their representation to the Canadian Government on the necessity of establishing stations for continuous tidal observations, deemed it well to get the opinions of Boards of Trade and ship-owners and ship-masters. On inquiry it appeared that the Montreal Board of Trade were at the very time considering the question, which had been brought independently before them. On learning the object of the Committee they gave it their most hearty support, and addressed a strong memorial on the subject to the Dominion Government. The Boards of Trade of the other chief ports of the Dominion also sent similar memorials. The ship-owners and masters of ships, to whom application was made, were practically unanimous in their testimony as to the pressing need for knowledge on the subject. The representations were made through the Minister of Marine, with whom an interview was obtained, at which a memorial was submitted. Copies of the answers of the ship-masters (a large number of which had been received) were submitted at the same time. The reply of the Minister of Marine stated that, owing to the large outlay on the Georgian Bay Survey and on the expedition to Hudson's Bay during the past summer (1885), the Government did not propose to take action in the matter of tidal observations at present. The Committee have reason to believe that if the financial prospects improve by next session of Parliament the Government will take the matter into earnest consideration; they therefore suggest that the Committee be reappointed.

Seventeenth Report of the Committee, consisting of Profs. Everett and Sir W. Thomson, Mr. G. J. Symons, Sir A. C. Ramsay, Dr. A. Geikie, Mr. J. Glaisher, Mr. Pengelly, Prof. Edward Hull, Prof. Prestwich, Dr. C. Le Neve Foster, Prof. A. S. Herschel, Prof. G. A. Lebour, Mr. Galloway, Mr. Joseph Dickinson, Mr. G. F. Deacon, Mr. E. Wethered, and Mr. A. Strahan, appointed for the purpose of investigating the Rate of Increase of Underground Temperature downwards in various Localities of Dry Land and under Water. Drawn up by Prof. Everett (Secretary).—The present Report is for the two years since the summer of 1883. Observations have been taken in a deep bore at Richmond, Surrey, by Mr. Collett Homersham, C.E., the engineer of the boring, on the premises of the Richmond Vestry Waterworks, on the right bank of the Thames, and about 33 yards from high-water mark. The surface is 17 feet above Ordnance datum. The upper part consists of a well 253 feet deep, with an internal diameter of 7 feet at top and 5 feet at bottom, which was sunk in 1876 for the purpose of supplying water to the town of Richmond, and carried down to the chalk. From the bottom of the well a 24-inch bore-hole was sunk to the total depth of 434 feet, thus penetrating 181 feet into the chalk. This portion of the work was completed in 1877. Above the chalk were tertiaries, consisting of 160 feet of London clay, 60 feet of the Woolwich and Reading beds, and some underlying sands. The water yielded at this stage was about 160 gallons a minute, and, when not depressed by pumping, was able to rise 4 or 5 feet above the surface. Its ordinary level, owing to pumping, was about 130 feet lower. In 1881 the Richmond Vestry determined to carry the bore-hole to a much greater depth, and the deepening has been executed under the direction of Mr. Homersham. The existing bore-hole was first enlarged and straightened, to enable a line of cast-iron pipes, with an internal diameter of 16¼ inches, having the lower end driven water-tight into the chalk at a depth of 438 feet, to be carried up to the surface. The total thickness of the chalk was 671 feet. Below this was the upper greensand, 16 feet thick; then the gault clay, 201½ feet thick; then 10 feet of a sandy rock, and a thin layer of phosphatic nodules. Down to this point the new boring had yielded no water. Then followed a bed 87½ feet thick, consisting mainly of hard oolitic limestone. Two small springs of water were met with in this bed at the depths of 1203 and 1210 feet, the yield at the surface being 1¼ gallons a minute, with power to rise in a tube and overflow 49 feet above the ground. A partial analysis of this limestone rock showed it to contain 2·4 per cent. of sulphide of iron in the form of pyrites. At the depth of 1239 feet this limestone rock ended, and hard red sandstone was found, alternating with beds of variegated sandy marl or clay. After the depth of 1253 feet had been attained, the yield of water steadily increased as the boring was deepened, the overflow at the surface being 2 gallons a minute at 1254 feet, 8 gallons at 1363 feet, and 11 gallons at 1387 feet. It rose to the top of a tube carried 49 feet above the surface, and overflowed; and a pressure-gauge showed that it had power to rise 126 feet above the surface. The diameter of the bore was 16¼ inches in the chalk, 13½ inches in the gault, 11¼ inches in the oolitic limestone, and at the depth of 1334 feet it was reduced to a little under 9 inches. At 1337 feet the method of boring was changed, and, instead of an annular arrangement of steel cutters, a rotary diamond rock-boring machine was employed. The bore-hole, with a diameter of 8½ inches, was thus carried down to 1367½ feet, at which depth, lining tubes having to be inserted, the diameter was reduced to 7¼ inches, and this size was continued to 1447 feet, at which depth the boring was stopped. The bore-hole was lined with strong iron tubes down to the depth of 1364 feet; and those portions of the tubes that are in proximity to the depths where water was struck were drilled with holes to admit the water into them. Three observations of temperature taken with an inverted Negretti maximum at the depth of 1337 feet, when the bore-hole was full of water, recorded 75½° F. In the first observation, March 25, 1884, the thermometer was left for an hour and a quarter at the bottom of the bore-hole, and three weeks had elapsed since the water was disturbed by boring. The second observation was taken on March 31, when the thermometer was 5½ hours at the bottom. In the third observation special precautions were taken to prevent convection. The thermometer was fixed inside a wrought-iron tube, 5 feet long, open at bottom. The thermometer was near the lower end of the tube, and was suspended from a water-tight wooden plug, tightly driven into the tube. There was a space of several inches between the plug and the thermometer, and this part of the tube was pierced with numerous holes to allow the escape of any cold water which might be carried down by the tube. The tube was one of a series of hollow boring-rods used in working the diamond drill-machine. By means of these it was lowered very slowly, to avoid disturbance of the water as much as possible; and the tube containing the thermometer was gradually worked through the sand at the bottom of the bore-hole. The lowering occupied five hours, and was completed at noon on Saturday, June 7. Cement, mixed with sugar, for the purpose of slow setting, was immediately lowered on to the surface of the sand, and above this a mixture of cement and sand, making a total thickness of 3 or 4 feet of cement plugging. The thermometer was left in its place for three full days, the operation of raising being commenced at noon of Tuesday, June 10, and completed at 5 p.m. The thermometer again registered 75½° F., exactly the same as in the two previous observations which were taken without plugging. It would therefore appear that the steady upflow of water in the lower part of the bore prevents any downward convection of colder water from above.

The boring has since been carried to the depth of 1447 feet, with a diameter reduced to 7¼ inches, and Mr. Homersham lowered the thermometer to the bottom without plugging. It remained down for six days (February 3 to 9, 1885), and gave a reading of 76¾° F. The water overflowing at the surface had a temperature of 59° F. To deduce the mean rate of increase downwards, we shall assume a surface temperature of 50°. This gives for the first 1337 feet an increase of 25½°, which is at the rate of 1° F. in 52·4 feet, and for the whole 1447 feet an increase of 26¾°, which is at the rate of 1° F. in 54·1 feet. These results agree well with the Kentish Town well, where Mr. Symons found in 1100 feet an average increase of 1° in 55 feet.

Mr. Galloway has furnished observations taken during the sinking of a shaft to the depth of 1272 feet in or near the Aberdare valley, Glamorganshire. The position of the shaft is on the slope on the east side of the valley, about midway between the bottom of the valley and the summit of the hill which separates it from the Merthyr valley. The mouth of the shaft is about 800 feet above sea-level. Observations were taken at four different depths—546 feet, 780 feet, 1020 feet, and 1272 feet—the thermometer being in each case inserted, and left for twenty-four hours, in a hole bored to the depth of 30 inches at a distance not exceeding 2½ yards from the bottom of the shaft for the time being. About eight hours elapsed between the completion of the hole and the insertion of the thermometer. The strata consist mainly of shales and sandstone, with a dip of 1 in 12, and the flow of water into the shaft was about 250 gallons per hour. The first of the four observations was taken in the fireclay under the Abergorkie vein; the second in strong "clift" (a local name for argillaceous shale) in disturbed ground; the third in bastard fireclay under a small rider of coal previously unknown; the fourth in "clift" ground two yards above the red ash vein, which overlies the 9-foot seam at a height of from 9 to 12 yards. The observations were as follow:—At 546 feet, 56° F.; 780 feet, 59½° F.; 1020 feet, 63° F.; 1272 feet, 66½° F. Comparing consecutive depths from 546 feet downwards, we have the following increments of temperature:—3½° in 234 feet, giving 1° for 67 feet; 3½° in 240 feet, giving 1° for 69 feet; 3½° in 252 feet, giving 1° for 72 feet; showing a remarkably regular rate of increase. A comparison of the first and fourth observations gives an increase of 10½° in 726 feet, which is at the rate of 1° F. in 69·1 feet. As a check upon this result we find that this rate of *decrease* reckoned *upwards* from the smallest depth (546 feet) would give a surface temperature of (56 − 7·9 =) 48°·1, which, as the elevation is 800 feet, is probably very near the truth.

Mr. Garside has sent an observation of temperature taken by himself in the roof of the Mersey tunnel in August, 1883. The temperature was 53°, the depth below Ordnance datum being 92 feet. A great quantity of water from the river was percolating through the sides of the tunnel. On August 13, 1854, he verified his previous observation in Denton Colliery (15th Report). The second observation was made at the same depth as the first (1317 feet), in the same pit and level, and under the same circumstances, except that the thermometer was allowed to remain fourteen days in the hole bored for it, instead of only six hours. The temperature observed was the same as before—namely 66°, Mr. Garside has also supplemented his previous contribution to our knowledge of the surface temperature of the ground in the East Manchester coal-field (16th Report) by two more years' results from the same observing stations. The difference between them agrees well with the generally accepted rate of 1° for 300 feet, and indicates about 48° as the surface temperature at small elevations, such as 30 feet. The pits in the East Manchester coal-field from which we have observations—namely, Astley Pit (Dukinfield), Ashton Moss, Bredbury, Denton, and Nook Pit, are all sunk in ground at elevations of between 300 and 350 feet. It would therefore appear that the assumption of a surface temperature of 49°, which we made in reducing these observations, is about 2° in excess of the truth. A very elaborate paper on "Underground Temperature" has recently been communicated to the Royal Society by Prof. Prestwich. He is disposed to adopt 1° F. in 45 feet as the most probable value of the normal gradient.

Report of the Committee, consisting of Mr. W. T. Blanford and Mr. J. S. Gardner (Secretary), on the Fossil Plants of the Tertiary and Secondary Beds of the United Kingdom. Drawn *up by Mr. J. S. Gardner, F.G.S., F.L.S.*—The report opens with a list of all the principal works on the British Tertiary flora down to the year 1885. The number of species that had been more or less described were :—From the Thanet beds, 3 ; from the Reading beds, 9 ; from Sheppey, 108 ; from Alum Bay, &c., 43 ; from Bournemouth (deducting those not peculiar), 11 ; Bovey Tracy, 50 ; Upper Eocenes, 13 ; Mull, 9 ; Antrim, about 16 ; making a grand total of 262 species, not a tenth part of which, Mr. Gardner anticipates, would survive a rigorous examination. The study of only one group of plants—the Gymnosperms—has been the serious business of the past three years ; for not only have I had to study, but in the majority of cases to find the specimens as well. I trust that the results attending the expenditure of the grant I have been favoured with may be considered satisfactory, and these I now proceed to detail.

Bracklesham Flora.—Two visits have been made to Selsey. The beds, it is well known, are marine, but a few terrestrial fruits are from time to time procured from them. I was able to make a large collection of fossil shells while looking for plants, which, being from the highest beds, are less known, and are interesting as illustrating the passage from the Bracklesham to the Barton fauna, which is more gradual, I think, than is supposed. The surface of one of these beds is dotted over with fossil *Posidonias*, a marine monocotyledonous plant identical with the species now inhabiting the Mediterranean. It had not been previously recorded as a British fossil, though another species is abundant in the contemporary beds of the *Calcaire grossier* of the Paris basin. In our species the rhizomes radiate from a centre, whilst in the French and other European fossil species they are long and branching. They are found among beautiful *Tellina* shells, preserving, to a large extent, their banded colours. The only other fossil plant to record here is a *Nipadites*, which, unlike those of the Bournemouth beds, is large, flattened, and oval.

Reading Beds.—A considerable portion of the grant has been expended in working these beds with, I am pleased to report, the happiest results. The flora is found in the Katesgrove pit, on the banks of the Kennet, immediately beneath the mottled clay. The matrix is a fine porcelainous fuller's earth interstratified with sand, and the beds seem very local. The limit of the pit being reached, it is not probable that any part of the beds will be exposed for long. I have illustrated a beautiful specimen—one of several—of *Anæmia subcretacea*, Sap., from these beds. This fern is highly characteristic of the lower Eocenes in France, but had only previously been found in the middle Bagshot beds of Bournemouth in this country. I have also illustrated another fern (?) from these beds, of which I have only as yet found a small fragment. The figures are therefore taken from specimens found many years ago by Prof. Prestwich. Other valuable additions to the Reading flora are some splendid specimens of a conifer, which I can see no ground for distinguishing from *Taxodium heterophyllum* of China. Another interesting specimen from Reading is a pine leaf of two needles, about the size and substance of those of *P. maritima*, the first pine foliage, I believe, ever found in the English Eocene. One leaf bed is almost wholly made up of leaves of *Plutonis*, and a bed above is fairly sprinkled with fruits of the same. Fruits are very abundant, and include four kinds of leguminous pods, and there are many flowers. As a result of this work the Reading flora no longer appears so completely distinct from that of Bournemouth.

Woolwich Beds.—I regard these as thoroughly distinct in age from those of Reading. I have not found, in the course of two visits paid for the purpose, any bed worth collecting from, though I think such must exist at Lewisham.

Studland Beds.—We were able to reach a leaf bed in the Lower Bagshot at Studland, and to obtain a great number of specimens, nearly all of whieh are quite new to me. They are mostly dycotyledonous leaves and fruits, which will require time to determine. There are no Coniferæ among them, and I am only able to add one fern—a *Lygodium*, very near to that of Bournemouth—to the *Chrysodium langæanum*, procured abundantly by me ten years ago in a different bed at the same locality.

Hordwell Beds.—I have to add *Salvinia* to the flora, not previously found fossil in England, and exclusively confined to the Miocene in Austria and Switzerland.

Barton Beds.—A new species of pine from Highcliff was discovered quite unlike those hitherto found at Bracklesham. The beds are rapidly assuming an angle of repose, and becoming deeply buried under *débris*, so that some of them are no longer visible except by making excavations. Though the Barton series is one of the most interesting of our Eocene formations, the detailed bedding has not been worked out like that of the Bracklesham series below and the Headon series above, and the greatest misconceptions seem to prevail as to the number of species of fossils that it contains.

Bournemouth Beds.—Five series of leaves were obtained this year by Mr. Keeping and myself, the most noteworthy of which are some specimens of *Godoya* which exceed any I had previously seen. I have illustrated a new and very distinct species of *Adiantum*, a fragment of what may be *Gymnogramma*, and a trifid group of *Polypodium* leaves, which seem to be different from either of the species previously recorded.

The London Clay.—Mr. Shrubsole has kindly sent me some of the best of the fruits that have been found. I have not made any complete studies of them yet, but they promise to afford results of the highest value. Among a few recognised is the very unmistakable seed of *Verschaffeltia*, a genus of palms from Seychelles quite new to fossil floras.

Gurnet Bay Beds.—I have been able to ascertain that another fern rivals *Anæmia subcretacea* in range, *Chrysodium langæanum*, which extends from the town of Bagshot upwards into the Bembridge beds. The plants are as a rule dreadfully macerated and chopped up. Among them are small fragments of a *Gleichenia*, which, though not very beautiful, is a very important fern, coming from the horizon. By far the most important discovery, however, is that of *Doliostrobus*, the first really extinct conifer that I have met with in British Eocenes. It belonged to the tribe of *Araucarieæ*, and its identification has been thoroughly confirmed by correspondence and the interchange of specimens with Dr. Marion, the well-known botanist of Marseilles. It is certain that during the Eocene period, as the temperature increased from the base upward to the Middle Bagshot, when the maximum of heat seems to have prevailed, there was a tendency for the plant world to move northward. It is equally certain that in the later half of the Eocene, as the temperature began to decrease, the movement was in the opposite direction, and we find in the European Miocenes of Switzerland and Italy a number of plants that at an earlier period were growing in the far north.

Report of the Committee, consisting of H. Bauerman, F. W. Rudler, and Dr. H. Johnston Lavis, for the Investigation of the Volcanic Phenomena of Vesuvius, by H. Johnston Lavis, M.D., F.G.S., Reporter.—The unfortunate outbreak of cholera in Naples and the stringent local quarantine measures prevented work on Vesuvius being carried out during the autumn of 1884. Nevertheless, daily observations were made of the variations in the activity of the volcano, of which a careful record has been kept. All important changes of the crater-plain, and in the cone of eruption, have been photographed. Descriptions of the small eruption of May 2 of 1883 have already been given in NATURE, and the results of a microscopical examination of the sides of the remarkable hollow dyke then formed will soon be published. The Naples section of the Italian Alpine Club have generously undertaken to publish a journal of Vesuvius, which will contain reproductions of the photographs exhibited. The third sheet of the geological map of Vesuvius and Monte Somnia (scale 1 : 10,000) has been completed by the reporter, and is exhibited at the meeting. The relationship of the varying activity of a volcano in a Strombolian state of activity to barometric pressure, the lunar tides, and rainfall, cannot but be regarded as important in solving some questions of vulcanology. Instrumental means of measuring such present so many practical difficulties that a scale of activity has been drawn up, which requires only a few minutes to learn, can be practised by any one with good eyesight and moderate intelligence who is within visual range of the volcano, and, above all, requires no further outlay than pen, ink, and paper. The objections will be mentioned after describing the process. 1st degree, a faint red glimmer above the main vent interrupted by complete darkness ; 2nd degree, the glimmer is continuous, but the ejection reaches hardly above the central crater rim at the most ; 3rd degree, glimmer continuous and well marked ; the ejections are distinctly discernible as they rise and then fall on the slopes of the cone of eruption and roll down its slopes ; 4th degree, the ejections reach a considerable height, are brilliant, and light up the top of the great cone ; 5th degree, verging on an actual paroxysmal eruption, the ejections are shot up very high, being only very slightly or not at all influenced in their course by a strong wind. Each explosion follows with much rapidity, and corresponds with the "boati" heard all around the west, south, and south-east slopes of the mountain. The objections to this method of registering the variations in the activity of a volcano are: (*a*) cloud-cap, which may for days cut off the view; (*b*) after a great eruption, resulting in a deep crater, the changes of activity would be invisible from the neighbourhood of the mountain; (*c*) it is only applicable after dark, so that usually only one observation a day can be made; (*d*) should lava be flowing from a lateral outlet, as is often the case, the level of the fluid in the chimney would vary as the outflow took place with greater or less rapidity, dependent on its blocking the passage more or less. The reporter thinks it desirable to introduce a description of this method into the report, so that it may be made use of in the case of other suitable volcanoes.

Report of the Committee, consisting of Prof. Ray Lankester, Mr. P. L. Sclater, Prof. M. Foster, Mr. A. Sedgwick, Prof. A. M. Marshall, Prof. A. C. Haddon, Prof. Moseley, and Mr. Percy Sladen (Secretary), appointed for the purpose of arranging for the occupation of a Table at the Zoological Station at Naples.—In the Report read last year at Montreal it was announced that a scheme was on foot for the building of a large physiological laboratory in connection with the Zoological Station at Naples, and for the purchase of a new sea-going steamer, to be equipped as a floating laboratory. Your Committee are now able to report that both these projects are steadily advancing towards attainment. For the physiological laboratory the Municipality of Naples has made a grant of 400 square metres of ground, and the Italian Parliament has voted the sum of 50,000 lire towards the cost of building. In addition to this assistance from the Italian Government, a union of the maritime provinces of South Italy is about to be formed for the purpose of contributing towards the cost of the new laboratory, and of maintaining two tables there for the use of natives of the provinces concerned. The new steamship, which it is hoped will shortly be in the possession of the station, will form a further addition to the capabilities of the establishment This undertaking is in the hands of an influential committee in Germany, organised for the purpose of collecting subscriptions, and by whom the vessel will be presented to the station. It is intended that the steamer should be of 300 to 400 tons burden, with engines of 150 to 200 horse-power, and be fitted up in all respects as a floating laboratory. With such a vessel it will be perfectly practicable to remain weeks or months in any desired locality, and distance from home will be no obstacle, as naturalists will live and work on board. Concurrent with these strides of the Zoological Station, improvements in the general management, in methods of work, and in instruments of research are constantly being made. The general efficiency of the establishment is so well known that it will suffice to say that the whole organisation of the station is in a state of active and prosperous vitality. The best evidence of this is furnished by the accompanying lists:—(1) of the naturalists who have occupied tables during the past year, and (2) of the publications resulting from work carried out at the station.

The General Collections.—Additions have been again received from Capt. Chierchia, who has, since the last Report, sent two collections of specimens from the Pacific and Indian Oceans. Other collections have been likewise received from Lieut. Cercone, Lieut. Orsini, and Lieut. Colombo, from the Atlantic, the Red Sea, and the Mediterranean respectively. Some of the material previously obtained by Capt. Chierchia has already been utilised by Count Béla Haller in a paper on the molluscan kidney, recently published; and the same author is at present preparing a monograph on the Patellæ. In like manner the Pteropoda have been investigated by Dr. Boas, of Copenhagen, whose monograph upon the subject is now in the press. Since the last Report the British Association table has been occupied by Mr. Wm. E. Hoyle, who, although limited in time, was enabled to prosecute researches on the embryology of the Cephalopoda, and to collect material from which important results may be expected. The report forwarded by Mr. Hoyle is appended:—

Report on the Occupation of the Table, by Mr. William E. Hoyle.—I reached Naples on April 6, 1885, and left on the 28th of the same month. In so short a time it was obviously impossible to make anything of the nature of a complete investigation in a subject of such magnitude and difficulty as the embryology of the Cephalopoda; it seemed, herefore, that the opportunities afforded me could best be utilised by collecting material for subsequent examination. Of this I had an abundant and immediate supply, thanks to the kindly forethought of your secretary, who had given notice to the authorities of the station of the nature of the work I had undertaken, so that they had a quantity of ova ready for my use. The greater part of my time was spent in extracting embryos from the egg and preserving them in various fluids, and a fairly complete series of developmental stages of *Loligo* and a good many embryos of *Sepia* were thus obtained. When the young Cephalopods have reached a stage at which the rudiments of the arms are clearly visible, it is moderately easy, after a little practice, to extricate them by making an incision into the egg-membrane with a fine scalpel; but previously to this period they so nearly occupy the whole interior of the egg that it is almost impossible to obtain them uninjured. A quantity of such eggs I preserved whole by a method suggested to me by Dr. Jatta, who is at work upon a monograph of the Cephalopoda of the Bay of Naples. The strings of eggs are placed whole in weak solution of chromic acid (about 0·25 per cent.) for a few hours, and then in distilled water for twenty-four hours, after which they are preserved in alcohol. The embryos can then be extracted much more readily than when fresh. Some time was devoted to examining and drawing the embryos in the fresh condition, and in watching the process of segmentation in *Loligo* and *Sepia*. I observed the presence of the "Richtungsbläschen" in the former, which, so far as I am aware, has only been noted in a Russian memoir on the development of *Sepiola* by Ussow. A number of blastoderms in process of segmentation were preserved according to a method proposed by Ussow, for the knowledge of which I am indebted to Dr. Edward Meyer, who kindly translated it for me from the original. The egg, without removal of the membranes, is placed in 2 per cent. solution of chromic acid for two minutes, and then in distilled water, to which a little acetic acid (one drop to a watchglassful) has been added, for two minutes longer. If an incision be now made into the egg-membrane the yolk flows away and the blastoderm remains; if any yolk still cling to it, it may be removed by pouring away the water and adding more. The blastoderms thus prepared show, when appropriately stained, fine karyokinetic figures, of which I hope shortly to publish an account. The reduction of the collected embryos to serial sections and their examination will of course occupy some time, but I hope in a few months to prepare some account of the results obtained from them.

Report of the Committee, consisting of Prof. Huxley, Mr. Sclater, Mr. Howard Saunders, Mr. Thiselton Dyer, and Prof. Moseley (Secretary), appointed for the purpose of promoting the Establishment of Marine Biological Stations on the Coast of the United Kingdom.—The Committee has received the sum granted (150*l.*) from the Treasurer of the Association, and has paid it to the funds of the Marine Biological Association of the United Kingdom, as the most direct means of promoting the speedy establishment of a marine laboratory in a most favourable situation on the British coast—namely, Plymouth. An excellent site for a laboratory has been granted to the Marine Biological Association by Government, at Plymouth. A sum of 8000*l.* has been raised by subscriptions and donations, the Government has promised to aid the working of the laboratory by an annual subsidy, and there is every prospect of success. It is probable that the building of the laboratory will commence in November.

Report of the Committee, consisting of the Rev. Canon Tristram, the Rev. F. Lawrence, and Mr. James Glaisher (Secretary), appointed for the purpose of promoting the Survey of Palestine.—The Survey of Eastern Palestine has been carried on during the last year privately by Herr G. Schumacher, C.E., assisted by Mr. Laurence Oliphant, who has also furnished the Committee with valuable notes of personal exploration in the district now called Junlau—the ancient Gaulanitis. The portion surveyed by Herr Schumacher consists of about 200 square miles, and covers an area previously quite unknown. The map, which is now in the hands of the Committee, is accompanied by voluminous memoirs and a great number of sketches, drawings, and plans of ruins figured for the first time, which it is proposed to publish, with the memoirs, in October. The map of the Wady Arabah has been laid down in the Society's sheets; the geological memoirs compiled by Prof. Hule after his expedition of 1883-84 are nearly ready, and will be issued before the end of the year; and the Society has been enabled to secure Mr. Chichester Hart's

Natural History memoir, made from new observations during the same journey. In addition the Committee have received from Mr. Guy Le Strange, and published, observations and notes made by him during a recent journey east of Jordan. The results of the survey, so far as it has been completed, will appear in a map reduced to a scale of about three miles to an inch, showing the country on both sides of the river Jordan, instead of on the western side only. This portion of the work is under the direction of Col. Sir Charles Wilson, K.C.M.G., F.R.S. The Society has also issued during the last year a popular account, by Prof. Hule, of his recent journey, called "Mount Seir," and reprints of Capt. Conder's popular books, "Tent Work in Palestine" and "Heth and Moab." Finally, the Committee have completed the issue of their great work, the "Survey of Western Palestine," with the last volumes of "Jerusalem," the "Flora and Fauna," and a portfolio of plates showing the excavations and their results.

SECTION H

ANTHROPOLOGY

OPENING ADDRESS BY FRANCIS GALTON, F.R.S., ETC., PRESIDENT OF THE ANTHROPOLOGICAL INSTITUTE, PRESIDENT OF THE SECTION

THE object of the Anthropologist is plain. He seeks to learn what mankind really are in body and mind, how they came to be what they are, and whither their races are tending; but the methods by which this definite inquiry has to be pursued are extremely diverse. Those of the geologist, the antiquarian, the jurist, the historian, the philologist, the traveller, the artist, and the statistician, are all employed, and the Science of Man progresses through the help of specialists. Under these circumstances, I think it best to follow an example occasionally set by presidents of sections, by giving a lecture rather than an address, selecting for my subject one that has long been my favourite pursuit, on which I have been working with fresh data during many recent months, and about which I have something new to say.

My data were the Family Records entrusted to me by persons living in all parts of the country, and I am now glad to think that the publication of some first-fruits of their analysis will show to many careful and intelligent correspondents that their painstaking has not been thrown away. I shall refer to only a part of the work already completed, which in due time will be published, and must be satisfied if, when I have finished this address, some few ideas that lie at the root of heredity shall have been clearly apprehended, and their wide bearings more or less distinctly perceived. I am the more desirous of speaking on heredity, because, judging from private conversations and inquiries that are often put to me, the popular views of what may be expected from inheritance seem neither clear nor just.

The subject of my remarks will be "Types and their Inheritance." I shall discuss the conditions of the stability and instability of types, and hope in doing so to place beyond doubt the existence of a simple and far-reaching law that governs hereditary transmission, and to which I once before ventured to draw attention, on far more slender evidence than I now possess.

It is some years since I made an extensive series of experiments on the produce of seeds of different size but of the same species. They yielded results that seemed very noteworthy, and I used them as the basis of a lecture before the Royal Institution on February 9, 1877. It appeared from these experiments that the offspring did *not* tend to resemble their parent seeds in size, but to be always more mediocre than they—to be smaller than the parents, if the parents were large; to be larger than the parents, if the parents were very small. The point of convergence was considerably below the average size of the seeds contained in the large bagful I bought at a nursery-garden, out of which I selected those that were sown.

The experiments showed further that the mean filial regression towards mediocrity was directly proportional to the parental deviation from it. This curious result was based on so many plantings, conducted for me by friends living in various parts of the country, from Nairn in the north to Cornwall in the south, during one, two, or even three generations of the plants, that I could entertain no doubt of the truth of my conclusions. The exact ratio of regression remained a little doubtful, owing to variable influences; therefore I did not attempt to define it. After the lecture had been published, it occurred to me that the grounds of my misgivings might be urged as objections to the general conclusions. I did not think them of moment, but as the inquiry had been surrounded with many small difficulties and matters of detail, it would be scarcely possible to give a brief and yet a full and adequate answer to such objections. Also, I was then blind to what I now perceive to be the simple explanation of the phenomenon, so I thought it better to say no more upon the subject until I should obtain independent evidence. It was anthropological evidence that I desired, caring only for the seeds as means of throwing light on heredity in man. I tried in vain for a long and weary time to obtain it in sufficient abundance, and my failure was a cogent motive, together with others, in inducing me to make an offer of prizes for family records, which was largely responded to, and furnished me last year with what I wanted. I especially guarded myself against making any allusion to this particular inquiry in my prospectus, lest a bias should be given to the returns. I now can securely contemplate the possibility of the records of height having been frequently drawn up in a careless fashion, because no amount of unbiassed inaccuracy can account for the results, contrasted in their values but concurrent in their significance, that are derived from comparisons between different groups of the returns.

An analysis of the records fully confirms and goes far beyond the conclusions I obtained from the seeds. It gives the numerical value of the regression towards mediocrity as from 1 to $\frac{2}{3}$ with unexpected coherence and precision, and it supplies me with the class of facts I wanted to investigate—the degrees of family likeness in different degrees of kinship, and the steps through which special family peculiarities become merged into the typical characteristics of the race at large.

The subject of the inquiry on which I am about to speak was Hereditary Stature. My data consisted of the heights of 930 adult children and of their respective parentages, 205 in number. In every case I transmuted the female statures to their corresponding male equivalents and used them in their transmuted form, so that no objection grounded on the sexual difference of stature need be raised when I speak of averages. The factor I used was 1·08, which is equivalent to adding a little less than one-twelfth to each female height. It differs a very little from the factors employed by other anthropologists, who, moreover, differ a trifle between themselves; anyhow it suits my data better than 1·07 or 1·09. The final result is not of a kind to be affected by these minute details, for it happened that, owing to a mistaken direction, the computer to whom I first entrusted the figures used a somewhat different factor, yet the result came out closely the same.

I shall explain with fulness why I chose stature for the subject of inquiry, because the peculiarities and points to be attended to in the investigation will manifest themselves best by doing so. Many of its advantages are obvious enough, such as the ease and frequency with which its measurement is made, its practical constancy during thirty-five years of middle life, its small dependence on differences of bringing up, and its inconsiderable influence on the rate of mortality. Other advantages which are not equally obvious are no less great. One of these lies in the fact that stature is not a simple element, but a sum of the accumulated lengths or thicknesses of more than a hundred bodily parts, each so distinct from the rest as to have earned a name by which it can be specified. The list of them includes about fifty separate bones, situated in the skull, the spine, the pelvis, the two legs, and the two ankles and feet. The bones in both the lower limbs are counted, because it is the average length of these two limbs that contributes to the general stature. The cartilages interposed between the bones, two at each joint, are rather more numerous than the bones themselves. The fleshy parts of the scalp of the head and of the soles of the feet conclude the list. Account should also be taken of the shape and set of many of the bones which conduce to a more or less arched instep, straight back, or high head. I noticed in the skeleton of O'Brien, the Irish giant, at the College of Surgeons, which is, I believe, the tallest skeleton in any museum, that his extraordinary stature of about 7 feet 7 inches would have been a trifle increased if the faces of his dorsal vertebræ had been more parallel and his back consequently straighter.

The beautiful regularity in the statures of a population, whenever they are statistically marshalled in the order of their heights, is due to the number of variable elements of which the stature is the sum. The best illustrations I have seen of this regularity were the curves of male and female statures that I obtained from the careful measurements made at my Anthropometric Laboratory in the International Health Exhibition last year. They were almost perfect.

The multiplicity of elements, some derived from one progenitor, some from another, must be the cause of a fact that has proved very convenient in the course of my inquiry. It is that the stature of the children depends closely on the average stature of the two parents, and may be considered in practice as having nothing to do with their individual heights. The fact was proved as follows:—After transmuting the female measurements in the way already explained, I sorted the children of parents who severally differed 1, 2, 3, 4, and 5, or more inches into separate groups. Each group was then divided into similar classes, showing the number of cases in which the children differed 1, 2, 3, &c., inches from the common average of the children in their respective families. I confined my inquiry to large families of six children and upwards, that the common average of each might be a trustworthy point of reference. The entries in each of the different groups were then seen to run in the same way, except that in the last of them the children showed a faint tendency to fall into two sets, one taking after the tall parent, the other after the short one. Therefore, when dealing with the transmission of stature from parents to children, the average height of the two parents, or, as I prefer to call it, the "mid-parental" height, is all we need care to know about them.

It must be noted that I use the word parent without specifying the sex. The methods of statistics permit us to employ this abstract term, because the cases of a tall father being married to a short mother are balanced by those of a short father being married to a tall mother. I use the word "parent" to save a complication due to a fact brought out by these inquiries, that the height of the children of both sexes, but especially that of the daughters, takes after the height of the father more than it does after that of the mother. My present data are insufficient to determine the ratio satisfactorily.

Another great merit of stature as a subject for inquiries into heredity is that marriage selection takes little or no account of shortness or tallness. There are undoubtedly sexual preferences for moderate contrast in height, but the marriage choice appears to be guided by so many and more important considerations that questions of stature exert no perceptible influence upon it. This is by no means my only inquiry into this subject, but, as regards the present data, my test lay in dividing the 205 male parents and the 205 female parents each into three groups—tall, medium, and short (medium being taken as 67 inches and upwards to 70 inches)—and in counting the number of marriages in each possible combination between them. The result was that men and women of contrasted heights, short and tall or tall and short, married just about as frequently as men and women of similar heights, both tall or both short; there were 32 cases of the one to 27 of the other. In applying the law of probabilities to investigations into heredity of stature, we may regard the married folk as couples picked out of the general population at haphazard.

The advantages of stature as a subject in which the simple laws of heredity may be studied will now be understood. It is a nearly constant value that is frequently measured and recorded, and its discussion is little entangled with considerations of nurture, of the survival of the fittest, or of marriage selection. We have only to consider the mid-parentage and not to trouble ourselves about the parents separately. The statistical variations of stature are extremely regular, so much so that their general conformity with the results of calculations based on the abstract law of frequency of error is an accepted fact by anthropologists. I have made much use of the properties of that law in cross-testing my various conclusions, and always with success.

The only drawback to the use of stature is its small variability. One-half of the population with whom I dealt varied less than 1·7 inch from the average of all of them, and one-half of the offspring of similar mid-parentages varied less than 1·5 inch from the average of their own heights. On the other hand, the precision of my data is so small, partly due to the uncertainty in many cases whether the height was measured with the shoes on or off, that I find by means of an independent inquiry that each observation, taking one with another, is liable to an error that as often as not exceeds $\frac{2}{3}$ of an inch.

It must be clearly understood that my inquiry is primarily into the inheritance of different degrees of tallness and shortness. That is to say, of measurements made from the crown of the head to the level of mediocrity, upwards or downwards as the case may be, and not from the crown of the head to the ground. In the population with which I deal, the level of mediocrity is $68\frac{1}{4}$ inches (without shoes). The same law, applying with sufficient closeness both to tallness and shortness, we may include both under the single head of deviations, and I shall call any particular deviation a "deviate." By the use of this word and that of "mid-parentage," we can define the law of regression very briefly. It is that the height-deviate of the offspring is, on the average, two-thirds of the height-deviate of its mid-parentage.

If this remarkable law had been based only on experiments on the diameters of the seeds, it might well be distrusted until confirmed by other inquiries. If it were corroborated merely by the observations on human stature, of which I am about to speak, some hesitation might be expected before its truth could be recognised in opposition to the current belief that the child tends to resemble its parents. But more can be urged than this. It is easily to be shown that we ought to expect filial regression, and that it should amount to some constant fractional part of the value of the mid-parental deviation. It is because this explanation confirms the previous observations made both on seeds and on men, that I feel justified on the present occasion in drawing attention to this elementary law.

The explanation of it is as follows. The child inherits partly from his parents, partly from his ancestry. Speaking generally, the further his genealogy goes back, the more numerous and varied will his ancestry become, until they cease to differ from any equally numerous sample taken at haphazard from the race at large. Their mean stature will then be the same as that of the race; in other words, it will be mediocre. Or, to put the same fact into another form, the most probable value of the mid-ancestral deviates in any remote generation is zero.

For the moment let us confine our attention to the remote ancestry and to the mid-parentages, and ignore the intermediate generations. The combination of the zero of the ancestry with the deviate of the mid-parentage, is that of nothing with something, and the result resembles that of pouring a uniform proportion of pure water into a vessel of wine. It dilutes the wine to a constant fraction of its original alcoholic strength, whatever that strength may have been.

The intermediate generations will each in their degree do the same. The mid-deviate of any one of them will have a value intermediate between that of the mid-parentage and the zero value of the ancestry. Its combination with the mid-parental deviate will be as if, not pure water, but a mixture of wine and water in some definite proportion had been poured into the wine. The process throughout is one of proportionate dilutions, and therefore the joint effect of all of them is to weaken the original wine in a constant ratio.

We have no word to express the form of that ideal and composite progenitor, whom the offspring of similar mid-parentages most nearly resemble, and from whose stature their own respective heights diverge evenly, above and below. He, she, or it, may be styled the "generant" of the group. I shall shortly explain what my notion of a generant is, but for the moment it is sufficient to show that the parents are not identical with the generant of their own offspring.

The average regression of the offspring to a constant fraction of their respective mid-parental deviations, which was first observed in the diameters of seeds, and then confirmed by observations on human stature, is now shown to be a perfectly reasonable law which might have been deductively foreseen. It is of so simple a character that I have made an arrangement with one movable pulley and two fixed ones by which the probable average height of the children of known parents can be mechanically reckoned. This law tells heavily against the full hereditary transmission of any rare and valuable gift, as only a few of many children would resemble their mid-parentage. The more exceptional the gift, the more exceptional will be the good fortune of a parent who has a son who equals, and still more if he has a son who overpasses him. The law is even-handed; it levies the same heavy succession-tax on the transmission of badness as well as of goodness. If it discourages the extravagant expectations of gifted parents that their children will inherit all their powers, it no less discountenances extravagant fears that they will inherit all their weaknesses and diseases.

The converse of this law is very far from being its numerical opposite. Because the most probable deviate of the son is only two-thirds that of his mid-parentage, it does not in the least follow that the most probable deviate of the mid-parentage is $\frac{3}{2}$, or $1\frac{1}{2}$ that of the son. The number of individuals in a population who differ little from mediocrity is so preponderant, that it is more frequently the case that an exceptional man is the somewhat exceptional son of rather mediocre parents, than the average son of very exceptional parents. It appears from the very same table of observations by which the value of the filial regression was determined, when it is read in a different way, namely, in vertical columns instead of in horizontal lines, that the most probable mid-parentage of a man is one that deviates only one-third as much as the man does. There is a great difference between this value of $\frac{1}{3}$ and the numerical converse mentioned above of $\frac{3}{2}$; it is four and a half times smaller, since $4\frac{1}{2}$, or $\frac{9}{2}$, being multiplied into $\frac{1}{3}$, is equal to $\frac{3}{2}$.

Let it not be supposed for a moment that these figures invalidate the general doctrine that the children of a gifted pair are much more likely to be gifted than the children of a mediocre pair. What it asserts is that the ablest child of one gifted pair is not likely to be as gifted as the ablest of all the children of very many mediocre pairs. However, as, notwithstanding this explanation, some suspicion may remain of a paradox lurking in these strongly contrasted results, I will explain the form in which the table of data was drawn up, and give an anecdote connected with it. Its outline was constructed by ruling a sheet into squares, and writing a series of heights in inches, such as 60 and under 61, 61 and under 62, &c., along its top, and another similar series down its side. The former referred to the height of offspring, the latter to that of mid-parentages. Each square in the table was formed by the intersection of a vertical column with a horizontal one, and in each square was inserted the number of children out of the 930 who were of the height indicated by the heading of the vertical column, and who at the same time were born of mid-parentages of the height indicated at the side of the horizontal column. I take an entry out of the table as an example. In the square where the vertical column headed[1] 69- is intersected by the horizontal column by whose side 67- is marked, the entry 38 is found; this means that out of the 930 children 38 were born of mid-parentages of 69 and under 70 inches, who also were 67 and under 68 inches in height. I found it hard at first to catch the full significance of the entries in the table, which had curious relations that were very interesting to investigate. Lines drawn through entries of the same value formed a series of concentric and similar ellipses. Their common centre lay at the intersection of the vertical and horizontal lines, that corresponded to $68\frac{1}{4}$ inches. Their axes were similarly inclined. The points where each ellipse in succession was touched by a horizontal tangent, lay in a straight line inclined to the vertical in the ratio of $\frac{2}{3}$; those where they were touched by a vertical tangent, lay in a straight line inclined to the horizontal in the ratio of $\frac{1}{3}$. These ratios confirm the values of average regression already obtained by a different method, of $\frac{2}{3}$ from mid-parent to offspring, and of $\frac{1}{3}$ from offspring to mid-parent. These and other relations were evidently a subject for mathematical analysis and verification. They were all clearly dependent on three elementary data, supposing the law of frequency of error to be applicable throughout; these data being (1) the measure of racial variability, (2) that of co-family variability (counting the offspring of like mid-parentages as members of the same co-family), and (3) the average ratio of regression. I noted these values, and phrased the problem in abstract terms such as a competent mathematician could deal with, disentangled from all reference to heredity, and in that shape submitted it to Mr. J. Hamilton Dickson, of St. Peter's College, Cambridge. I asked him kindly to investigate for me the surface of frequency of error that would result from these three data, and the various particulars of its sections, one of which would form the ellipses to which I have alluded.

I may be permitted to say that I never felt such a glow of loyalty and respect towards the sovereignty and magnificent sway of mathematical analysis as when his answer reached me, confirming, by purely mathematical reasoning, my various and laborious statistical conclusions with far more minuteness than I had dared to hope, for the original data ran somewhat roughly, and I had to smooth them with tender caution. His calculation corrected my observed value of mid-parental regression from $\frac{1}{3}$ to $\frac{6}{17\cdot 6}$, the relation between the major and minor axis of the ellipses was changed 3 per cent., their inclination was changed less than 2°. It is obvious, then, that the law of error holds throughout the investigation with sufficient precision to be of real service, and that the various results of my statistics are not casual determinations, but strictly interdependent.

In the lecture at the Royal Institution to which I have referred, I pointed out the remarkable way in which one generation was succeeded by another that proved to be its statistical counterpart. I there had to discuss the various agencies of the survival of the fittest, of relative fertility and so forth; but the selection of human stature as the subject of investigation now enables me to get rid of all these complications, and to discuss this very curious question under its simplest form. How is it, I ask, that in each successive generation there proves to be the same number of men per thousand who range between any limits of stature we please to specify, although the tall men are rarely descended from equally tall parents, or the short men from equally short? How is the balance from other sources so nicely made up? The answer is that the process comprises two opposite sets of actions, one concentrative and the other dispersive, and of such a character that they necessarily neutralise one another, and fall into a state of stable equilibrium. By the first set, a system of scattered elements is replaced by another system which is less scattered; by the second set, each of these new elements becomes a centre whence a third system of elements are dispersed. The details are as follows:—In the first of these two stages, the units of the population group themselves, as it were by chance, into married couples, whence the mid-parentages are derived, and then by a regression of the values of the mid-parentages the true generants are derived. In the second stage each generant is a centre whence the offspring diverge. The stability of the balance between the opposed tendencies is due to the regression being proportionate to the deviation; it acts like a spring against a weight.

A simple equation connects the three data of race variability, of the ratio of regression, and of co-family variability, whence, if any two are given, the third may be found. My observations give separate measures of all three, and their values fit well into the equation, which is of the simple form—

$$v^2\frac{p^2}{2} + f^2 = p^2,$$

where $v = \frac{2}{3}$, $p = 1\cdot 7$, $f = 1\cdot 5$.

It will therefore be understood that a complete table of mid-parental and filial heights may be calculated from two simple numbers.

It will be gathered from what has been said, that a mid-parental deviate of one unit implies a mid-grandparental deviate of $\frac{1}{3}$, a mid-ancestral unit in the next generation of $\frac{1}{9}$, and so on. I reckon from these and other data, by methods that I cannot stop to explain, that the heritage derived on an average from the mid-parental deviate, independently of what it may imply, or of what may be known concerning the previous ancestry, is only $\frac{1}{2}$. Consequently, that similarly derived from a single parent is only $\frac{1}{4}$, and that from a single grandparent is only $\frac{1}{16}$.

The most elementary data upon which a complete table of mid-parental and filial heights admits of being constructed are (1) the ratio between the mid-parental and the rest of the ancestral influences, and (2) the measure of the co-family variability.

I cannot now pursue the numerous branches that spring from the data I have given, as from a root. I will not speak of the continued domination of one type over others, nor of the persistency of unimportant characteristics, nor of the inheritance of disease, which is complicated in many cases by the requisite concurrence of two separate heritages, the one of a susceptible constitution, the other of the germs of the disease. Still less can I enter upon the subject of fraternal characteristics, which I have also worked out. It will suffice for the present to have shown some of the more important conditions associated with the idea of race, and how the vague word "type" may be defined by peculiarities in hereditary transmission, at all events when that word is applied to any single quality, such as stature. To include those numerous qualities that are not strictly measurable, we must omit reference to number and proportion, and frame the definition thus:—"The type is an ideal form towards which the children of those who deviate from it tend to regress."

The stability of a type would, I presume, be measured by the

[1] A matter of detail is here ignored which has nothing to do with the main principle, and would only serve to perplex if I described it.

strength of its tendency to regress; thus a mean regression from 1 in the mid-parents to $\frac{2}{3}$ in the offspring would indicate only half as much stability as if it had been to $\frac{1}{3}$.

The mean regression in stature of a population is easily ascertained, but I do not see much use in knowing it. It has already been stated that half the population vary less than 1·7 inch from mediocrity, this being what is technically known as the "probable" deviation. The mean deviation is, by a well-known theory, 1·18 times that of the probable deviation, therefore in this case it is 1·9 inch. The mean loss through regression is $\frac{1}{3}$ of that amount, or a little more than 0·6 inch. That is to say, taking one child with another, the mean amount by which they fall short of their mid-parental peculiarity of stature is rather more than six-tenths of an inch.

With respect to these and the other numerical estimates, I wish emphatically to say that I offer them only as being serviceably approximate, though they are mutually consistent, and with the desire that they may be reinvestigated by the help of more abundant and much more accurate measurements than those I have had at command. There are many simple and interesting relations to which I am still unable to assign numerical values for lack of adequate material, such as that to which I referred some time back of the superior influence of the father over the mother on the stature of their sons and daughters.

The limits of deviation beyond which there is no regression, but a new condition of equilibrium is entered into, and a new type comes into existence, have still to be explored. Let us consider how much we can infer from undisputed facts of heredity regarding the conditions amid which any form of stable equilibrium, such as is implied by the word "type," must be established, or might be disestablised and superseded by another. In doing so I will follow cautiously along the same path by which Darwin started to construct his provisional theory of pangenesis; but it is not in the least necessary to go so far as that theory, or to entangle ourselves in any questioned hypothesis.

There can be no doubt that heredity proceeds to a considerable extent, perhaps principally, in a piecemeal or piebald fashion, causing the person of the child to be to that extent a mosaic of independent ancestral heritages, one part coming with more or less variation from this progenitor and another from that. To express this aspect of inheritance, where particle proceeds from particle, we may conveniently describe it as "particulate."

So far as the transmission of any feature may be regarded as an example of particulate inheritance, so far (it seems little more than a truism to assert) the element from which that feature was developed must have been particulate also. Therefore, wherever a feature in a child was not personally possessed by either parent, but transmitted through one of them from a more distant progenitor, the element whence that feature was developed must have existed in a particulate, though impersonal and latent, form in the body of the parent. The total heritage of that parent will have included a greater variety of material than was utilised in the formation of his own personal structure. Only a portion of it became developed; the survival of at least a small part of the remainder is proved, and that of a larger part may be inferred by his transmitting it to the person of his child. Therefore the organised structure of each individual should be viewed as the fulfilment of only one out of an indefinite number of mutually exclusive possibilities. It is the development of a single sample drawn out of a group of elements. The conditions under which each element in the sample became selected are, of course, unknown, but it is reasonable to expect they would fall under one or other of the following agencies: first, self-selection, where each element selects its most suitable neighbour, as in the theory of pangenesis; secondly, general co-ordination, or the influence exerted on each element by many or all of the remaining ones, whether in its immediate neighbourhood or not; finally, a group of diverse agencies, alike only in the fact that they are not uniformly helpful or harmful, that they influence with no constant purpose—in philosophical language, that they are not teleological; in popular language, that they are accidents or chances. Their inclusion renders it impossible to predict the peculiarities of individual children, though it does not prevent the prediction of average results. We now see something of the general character of the conditions amid which the stable equilibrium that characterises each race must subsist.

Political analogies of stability and change of type abound, and are useful to fix the ideas, as I pointed out some years ago. Let us take that which is afforded by the government of a colony which has become independent. The individual colonists rank as particulate representatives of families or other groups in the parent country. The organised colonial government ranks as the personality of the colony, being its mouthpiece and executive. The government is evolved amid political strife, one element prevailing here and another there. The prominent victors band themselves into the nucleus of a party, additions to their number and revisions of it ensue, until a body of men are associated capable of conducting a completely organised administration. The kinship between the form of government of the colony and that of the parent state is far from direct, and resembles in a general way that which I conceive to subsist between the child and his mid-parentage. We should expect to find many points of resemblance between the two, and many instances of great dissimilarity, for our political analogy teaches us only too well on what slight accidents the character of the government may depend when parties are nearly balanced.

The appearance of a new and useful family peculiarity is a boon to breeders, who by selection in mating gradually reduce the preponderance of those ancestral elements that endanger reversion. The appearance of a new type is due to causes that lie beyond our reach, so we ought to welcome every useful one as a happy chance, and do our best to domicile and perpetuate it. When heredity shall have become much better and more generally understood than now, I can believe that we shall look upon a neglect to conserve any valuable form of family type as a wrongful waste of opportunity. The appearance of each new natural peculiarity is a faltering step in the upward journey of evolution, over which, in outward appearance, the whole living world is blindly blundering and stumbling, but whose general direction man has the intelligence dimly to discern, and whose progress he has power to facilitate.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

THE meeting of 1885 of the American Association for the Advancement of Science was held at the Ann Arbor University. The total attendance (according to *Science*) of members was not a large one, the number reaching only to 365; the number of papers was 176. Two changes in the organisation were made; by one, the section of histology and microscopy was abolished, as it has been urged for some time that a special science of microscopy does not exist, the microscope being rather a tool to be used by scientific men in various branches. The other change was in the name of the section of mechanics, the words "and engineering" being added to the title, that it may be more clearly understood by Americans that those interested in all branches of engineering are invited to take part in the proceedings. As this was the first meeting since the action of the Government in regard to the Coast Survey, the question was generally discussed. The matter was referred to a committee, which offered to a general session of the Association the following resolutions, which were unanimously accepted:—

WHEREAS, The attention of this Association has been called to articles in the public press, purporting to give—and presumably by authority—an official report of a Commission appointed by the Treasury department to investigate the condition of the U.S. Coast Survey Office, in which report the value of a certain scientific work is designated as "meagre."

AND WHEREAS, This Association desires to express a hope that the decision, as to the utility of such scientific work, may be referred to scientific men.

Resolved, That the American Association for the Advancement of Science is in earnest sympathy with the Government in its every intent to secure the greatest possible efficiency of the public service.

Resolved, That the value of the scientific work performed in the various departments of the Government can be best judged by scientific men.

Resolved, That this Association desires to express its earnest approval of the extent and high character of the work performed by the U.S. Coast Survey—especially as illustrated by the

[1] For early copies of the addresses and papers we are indebted to the editor of *Science*.

gravity determinations now in progress—and to express the hope that such valuable work may not be interrupted.

Resolved, That this Association expresses, also, the hope that the Government will not allow any technical rule to be established that shall necessarily confine its scientific work to its own *employés*.

Resolved, That in the opinion of the American Association for the Advancement of Science, the head of the Coast Survey should be appointed by the President, by and with the advice and consent of the Senate, should have the highest possible standing among scientific men, and should command their entire confidence.

Resolved, That copies of these resolutions shall be prepared by the general secretary, and certified by the President of the Association and by the permanent secretary, and shall be forwarded to the President of the United States, the Secretary of the Treasury, and given to the press.

Various improvements with the object of securing a more rapid despatch of business were either suggested or adopted; thus members are to be elected by a standing committee instead of in general session, and it is proposed to restrict general sessions of the Association to the beginning and close of the meeting, and to limit the public reading of committee reports in general session to such as seem to the standing committee specially desirable from their interest or importance. The next meeting will be held at Buffalo, beginning August 18, 1886, under the presidency of Prof. Edward S. Morse, of Salem.

We regret much that it is impossible for us to reproduce in full the President's address and the sectional reports; the obvious pressure on our space at the present time will only enable us to refer to a few salient topics. The President's address was delivered by Prof. J. P. Lesley, of Philadelphia. We find the following striking observations on the "dead-work" of science:—

There is a topic which I think should be frequently considered by all who engage in scientific pursuits, and by none so earnestly as by those who are ambitious to reach the higher points of view, from which to survey and describe those systematic combinations of phenomena which are more or less panoramic: I allude of course to generalisers or discoverers of natural laws, and the professional teachers of such laws: while those who deal in itemised science, the mere observers of isolated facts, discriminating specimens and naming genera and species in the animal, vegetable, or mineral worlds, and especially such as occupy themselves with geographical and geological studies in detail, stand in less need of having it pressed upon their attention, because in their case it insists upon its own necessity.

I allude to what is technically known among experts as "dead-work."

This topic has to be treated in the most prosaic style. To describe dead-work is to narrate all those portions of our work which consume the most time, give the most trouble, require the greatest patience and endurance, and seem to produce the most insignificant results. It comprises the collection, collation, comparison and adjustment, the elimination, correction, and re-selection, the calculation and representation—in a word, the entire first, second, and third handling of our data in any branch of human learning—wholly perfunctory, preparatory, and mechanical, wholly tentative, experimental, and defensive—without which it is dangerous to proceed a single stage into reasoning on the unknown, and futile to imagine that we can advance in science ourselves, or assist in its advancement in the world. It is that tedious, costly, and fatiguing process of laying a good foundation which no eye is ever to see, for a house to be built thereon for safety and enjoyment, for public uses or for monumental beauty. It is the labour of a week to be paid for on Saturday night. It is the slow recruiting, arming, drilling, victualling, and transporting of an entire army to secure victory in one short battle. It is the burden of dead weight which every great discoverer has had to carry for years and years, unknown to the world at large, before the world was electrified by his appearance as its genius. Let us examine it more closely: it will repay our scrutiny. Those of you who have been more or less successfully at work all your lives may get some satisfaction from the retrospect: and those who have commenced careers should hear what dead-work means, what its uses are, how indispensable it is, how honourable it is, and what stores of health and strength and happiness it reserves for them.

My propositions, then, are these:—(1) That, without a large amount of this dead-work, there can be no discovery of what is rightly called a scientific truth. (2) That, without a large amount of dead-work on the part of a teacher of science, he will fail in his efforts to impart true science to his scholars. (3) That, without a large amount of dead-work, no professional expert can properly serve, much less inform and command, his clients or employers. (4) That nothing but a habitual performance of dead work can keep the scientific judgment in a safe and sound condition to meet emergencies, or prevent it from falling more or less rapidly into decrepitude; and (5) That in the case of highly-organised thinkers, disposed or obliged to exercise habitually the creative powers of the imagination, or to exhaust the will-power in frequently-recurring decisions of difficult and doubtful questions, dead-work and plenty of it is their only salvation; nay, the most delicious and refreshing recreation; a panacea for disgust, discouragement, and care; an elixir vitæ; a fountain of perpetual youth. . . .

First, then, is it so that scientific truths cannot be discovered without a large amount of preliminary dead-work? Surely no one in this assembly doubts it who has established even one original theory for himself, or won for it the suffrages of judges capable of weighing evidence. Now the immense disproportion in numbers between theories broached and theories accepted is the best proof we could have, not only of the value and necessity of dead-work, but of the scarcity of those who depend upon it as a preparatory stage of theorising. And, moreover, not theories only, but simple statements of fact believed and disbelieved—that is, finally accepted or finally rejected—exhibit the like numerical disproportion, and betray a general carelessness or laziness of observers; at all events their manifest lack of appreciation of the value and necessity of the dead-work part of observation, which imperatively must precede any clear mental perception of the simplest phenomenon, before the attempt is made to establish its natural relationships, and present it for acceptance as a part of science.

No; dead work cannot be delegated. The man who cannot himself survey and map his field, measure and draw his sections properly, and perfectly represent with his own pencil the characteristic variations of its fossil forms, has no just right to call himself an expert geologist. These are the badges of initiation; and the only guarantees which one can offer to the world of science that one is a competent observer and a trustworthy generaliser. Nor has one become a true man of science until he has already done a vast amount of this dead work; nor does one continue in his prime, as a man of science, after he has ceased to bring to this test of his own ability to see, to judge, and to theorise, the working and thinking of other men. But enough of this.

My second proposition was that no teacher of science can be successful who does not himself encounter some of the dead work of the explorer and discoverer; who does not discipline his own faculties of perception, reflection, and generalisation, by field-work and office-work, independently of all text-book assistance; who does not himself make at least some of the diagrams, tables, and pictures for his class-room, in as original a spirit and with as much precision of detail as if none such had ever been made before, and these were to remain sole monuments of the genius of investigation. What the true teacher has to do first and foremost is to wake up in youthful minds this spirit of investigation *ab initio*. The crusade against scholastic cramming promises to be successful; but the crusade against pedagogic cramming has hardly yet been organised. How is the scholar to be made an artist if the teacher cannot draw? The instinct of imitation in man is irresistible. Slovenly drawing on the blackboard—sufficient evidence of the teacher's imperfect information and inaccurate conception of facts, the nature of which he only thinks he understands—can do little more than raise a cold fog of suspicion in the class-room, by which the tender sprouts of learning must be either dwarfed or killed. But even slovenly diagrams are preferable to purchased ones; for whatever diminishes the dead-work of a teacher enervates his investigating, and thereby his demonstrating, powers, and lowers him toward the level of his scholars.

Were I dictator I should drive all teachers of science out into the great field of dead-work; force them to go through all the gymnastics of original research and its description, and not permit them to return to their libraries until their notebooks were full of their own measurements and calculations, sketch-maps and farm-drawings, severely accurate and logically classified, to be then compared with those recorded in the books. What teachers fail to keep in mind is this: that learning is not knowledge; but as Lessing says: Learning is only our knowledge of the experience of others; knowledge is our own. No man really comprehends what he himself has not created. Therefore we know nothing of the universe until we take it to pieces for inspection, and rebuild it for our understanding. Nor can one man do this for another; each must do it for himself; and all that one can do to help another is to show him how he himself has morsellated and recomposed his small particular share of concrete nature, and inspire him with those vague but hopeful suggestions of ideas which we call learning, but which are not science.

My third proposition was that an expert in practical science can command the respect and confidence of his professional fellows, and through their free suffrages build up his own reputation in the learned and business worlds, only in exact proportion to the amount of good dead-work to which he voluntarily subjects himself. For, although the most of it is necessarily done in secrecy and silence, enough of it leaks out to testify to his honest and diligent self-cultivation; and enough of it must show in the shape of scientific wisdom to make self-evident the fact that he is neither a tyro nor a charlatan. More than once I have heard the merry jest of the Australasian judge quoted with sinister application to experts in science. When a young colleague, just arrived from England, asked him for advice, he answered: Pronounce your decisions, but beware of stating your reasons for them. Many an ephemeral reputation for science has been begot by this shrewd policy; but the best policy to wear well is honesty; and honesty in trade means selling what is genuine, well-made, and durable; and honesty in science means, first, facts well proved, and then conclusions slowly and painfully deduced from facts well proved, in sufficient number and order of arrangement to exhaust alike the subject and the observer. Reap your field so thoroughly that gleaners must despair. Fortify your position, that your most experienced rival can find no point of attack. Lay your plans with such a superfluity of patient carefulness that fate itself can invent no serious emergency. Demonstrate your theory so utterly and evidently that it shall require no defender but itself. Die for your work, that your work may live for ever. Forget yourself, and your work will make you famous. Enslave yourself to it, and it will plant your feet upon the necks of kings, and your mere Yes or No will become a law to multitudes. This is what the dead-work of science, when well done, does for the expert in science.

My fourth proposition—that only the habitual performance of dead-work can preserve the scientific intellect in pristine vigour, and prevent it from becoming stiffened with prejudices, inapt to receive fresh truth, and forgetful of knowledge already won—hardly needs discussion. Human muscles become atrophied by disuse. Men's fortunes shrink and evaporate by mere investment. I pray you to imagine what I wish to say, for it all amounts to this—that the grass will surely grow over a deserted footpath. Let me hurry to the close of this address, which I have found too serious a duty for my liking, and perhaps you also have found it too personal a preachment for yours. One more suggestion, then, and I have done.

My fifth proposition was that the wearied and exhausted intellect will wisely seek refreshment in dead-work.

The physiology of the brain is now sufficiently well understood to permit physicians to prescribe with some assurance for its many ills, and to regulate its restoration to a normal state of health. Its tissues reproduce themselves throughout life if no extraordinary over-balance of decay takes place, if there be no excessive and too long-continued waste. For the majority of mankind, nature provides for the adjustment between consumption and reproduction of brain matter, by the alternations of day and night, noise and silence, society and solitude; and also by the substitution of the play of fancy in dreams, for the work of the judgment and the will in waking hours. We follow the lead of nature when we seek amusement as a remedy for care. We bring into activity a rested portion of the brain, to permit the wearied parts of it to restore themselves unhindered.

In Section A Prof. Newton, of Yale, read a paper upon "The Effect of Small Bodies passing near a Planet upon the Planet's Velocity."

The former researches of Prof. Newton upon meteors are recognised among astronomers as our principal source of knowledge about the character, distribution, and motion of these minute bodies with which the solar system is filled, especially those which strike our atmosphere and are burned up as meteors. The possible effect of these upon the rotation of the earth, and the revolution of the earth and moon in their orbits, has been subjected to elaborate investigation at the hands of several mathematical astronomers. The recent publications of Mr. Denning, of Bristol, claiming the fixity of long-continuing radiant points of meteor streams, have raised the question of the existence of broad streams of meteoroids moving swiftly through stellar space outside of solar attraction; and any new investigation bearing upon any of these points is more than usually timely. In this paper Prof. Newton has discussed the effect upon the earth's motion of those bodies which do not pass near enough to the earth to be drawn into its atmosphere, but still near enough to be drawn out of their course, and swung for a time in hyperbolic orbits around it. He began by saying that the results of the investigation might perhaps be considered negative as far as measurable quantities in the solar system are concerned, but that they had a mathematical interest, and might possibly have a bearing upon somewhat similar questions in molecular physics, like the kinetic theory of gases. The mathematician and astronomer must be referred to the paper itself, and the results of popular interest may be briefly summarised as follows:—Considering, first, the case of a cylindrical stream of small bodies evenly distributed, and all moving in the same direction with a common velocity past the earth supposed to be in the axis of the cylinder, it is shown that they will communicate to the earth in each unit of time a velocity along the axis: (1) that is proportional to the density of the group; (2) that decreases as the velocity increases nearly inversely as the square of the velocity; (3) that increases as the logarithm of the radius of the cylinder, the radius being measured by a unit differing from the earth's radius by a small quantity, which is a function of the velocity. Second, in the case of a widely-extended group of small bodies evenly distributed in space, and having speeds all equal, but directed towards points evenly distributed over the celestial sphere with the earth moving in a right line through them, it is shown that, for those which do not strike the earth, but only affect it by their attraction, the effect will be an exceedingly minute acceleration of the earth's motion, if the latter *is less than that of the bodies*, even though the group is infinite in extent. If the earth's velocity *is greater than that of the bodies*, their total effect will consist of two parts: a very minute retardation of the earth's motion, depending in amount upon the absolute velocity of the bodies; and another retardation depending upon the assumed extent of the group. In conclusion, the effect of bodies *striking* the earth or moon is manifold greater than that of those only *passing near*; and since it has before been shown that any admissible magnitude of meteroids would make the effect upon the moon's mean motion of those which strike it only a minute fraction of the observed acceleration, still less can any action of those passing near the moon have any appreciable effect.

Papers were also read by Prof. Harkness on the flexure of transit instruments; by Prof. Hough, describing some improvements recently introduced in the printing chronograph, first designed and brought into use by himself at the Dudley Observatory in 1871, by Prof. Burkitt Webb, describing a method of using polar coordinates, by transferring the origin from the centre to the end of the unit radius, thus substituting $(r-1)$ for r, and then using the length of the arc and the distance out from its end upon the radius vector, as x and y are used in rectangular coordinates. He found this a very convenient transformation in the application of polar coordinates to the discussion of Amsler's planimeter; and, pointing out, that by substituting infinity for unit-radius in the equations thus transformed, they were reduced to those of rectangular coordinates, he thought this transformation of polar coordinates might be found generally useful.

In this section also Mr. Rockwell presented some results of his observations for time and latitude with the almucantar, an instrument devised by Mr. Chandler, of the Harvard College Observatory, a year or two ago, which promises at least to furnish an entirely new and radically different method of attacking the question of absolute positions of the stars, and very probably far to surpass all others in accuracy, on account of its freedom from systematic errors. The results thus far published by Mr. Chandler seem fully to confirm all that was expected of the instrument; and it is probably not too much to say, that it is the most important addition of the present century to the instruments and methods used in the determination of absolute star positions.

The sources of systematic error would seem to be almost wholly reduced to those of varying personal equation in the observation of transits at all speeds and at all inclinations and directions over horizontal wires, and to possible systematic difference in atmospheric refraction in different azimuths. Mr. Rockwell exhibited some results, simply copied from his observing-books, illustrating the methods of reduction for time and latitude observations, and showing the degree of accuracy that can be attained by the instrument in both these directions. They served to show that the instrument when duplicated will give equally good results with the one first constructed; and their consideration gave rise to a very interesting discussion, participated in by many members, as to the character of work the instrument might be expected to do, in the course of which Mr. Rockwell answered, in a very entertaining way, many questions, put by various members, as to the details of observing and reducing, which were not before clearly understood on account of the novelty of the work. One of the most important problems which the instrument is specially adapted to investigate, and one which we hope Mr. Chandler will soon find time to undertake, is the determination of the declination of fundamental stars south of the equator, tying them to northern stars at corresponding zenith-distances below the pole. This would seem to be by far the best, perhaps the only, method of connecting these together in a way that shall be free from systematic error.

In the Physical Section, the first paper read was by Prof. Langley, on the spectra of some sources of invisible radiations, and on the recognition of hitherto unmeasured wave-lengths. This was followed by one by Mr. Brashear on a practical method of working rock-salt surfaces for optical purposes.

Prof. H. S. Carhart presented a paper on surface transmission of electrical discharges, which was an ingenious revision of work by Prof. Henry. Prof. E. L. Nichols presented some further notes on the chemical behaviour of magnetic iron, a continuation of work described in a paper at the Philadelphia meeting. Major H. E. Alvord of Mountainville, New York, presented the results of telemetric observations at Houghton Farm. This is a method by which changes in temperature are transmitted and recorded electrically; and Major Alvord's results show that, with increasing experience, the records followed more and more satisfactorily the observations made on the mercurial thermometer.

Prof. T. C. Mendenhall called attention to the modifications and improvements already made or desired in electrometers, especially with reference to their use in observations on atmospheric electricity. Observations of this kind have been made regularly for the last year or two; but, as Prof. Mendenhall well said, the meaning of the variations recorded is still a mystery. Prof. A. E. Dolbear read three papers: in one he described a method of studying contact-theory of electricity by means of the telephone. He has found that a click is produced in the telephone every time the circuit is broken between two heterogeneous materials, as copper and zinc. In another paper he referred to his success in employing a Bernstein incandescent lamp for projection purposes; and in the third he described a new galvanic element of high electromotive force and great constancy, consisting of carbon in a saturated solution of bichromate of potash, and sulphuric acid and zinc in a saturated solution of ammonic chloride; nitric acid could be used in place of sulphuric. Mr. A. J. Rogers presented a paper on electrolysis of the salts of the alkaline earth.

Prof. E. D. Nicholls has, by means of a spectro-photometer, described at a previous meeting, compared the spectrum of the unclouded sky with that of the light reflected by magnesium carbonate, illuminated by direct sunlight.

Prof. Wead exhibited a combined spectro-photometer and ophthalmospectrcscope.

In the Chemical Section Prof. Nichols delivered an address on chemistry in the service of public health. Amongst the papers are:—Prof. Noyes, on para-nitrobenzoic sulphuride; Dr. Wiley, on a method of estimating lactic and acetic acid in sour milk or *koumiss;* Mr. Young, on the thermo-chemical reaction between potassic hydrade and common alum. A general discussion took place on the question of what is the best initiatory work for students entering upon laboratory practice, and also, To what extent is a knowledge of molecular physics necessary to one who would teach theoretical chemistry?

In the Section of Mechanical Science Prof. Webb delivered an address on the second law of thermo-dynamics. Mr. Wagner presented an elaborate paper on electric light tests, giving an account of his work in testing the efficiency of two electric-light plants. Prof. Cooley explained and illustrated a method of testing indicator-springs. Prof. Thurston's paper on cylinder condensation is described as being of great scientific and practical value.

In the Section of Geology and Geography the address was by Prof. Edward Orton, and the subject, Problems in the study of coal, with a sketch of recent progress in geology. There were, in all, twenty-seven papers in this Section, none being geographical. Stratigraphy received the lion's share of attention, the most important paper on this subject being one by Prof. Henry S. Williams.

The address to the Biological Section was by Dr. Wilder, on Educational Museums of Vertebrates.

The Section opened with two papers by Prof. L. E. Sturtevant as the result of observations and experiments at the New York agricultural experiment station. The first, on the hybridisation and cross-fertilisation of plants. In the second—"Germination Studies"—the author gives, as a result of many trials with commercial seeds of our common plants, that very extended series of trials must be made with each species in order to obtain the desired accuracy in results.

An interesting paper on the biological deductions from a comparative study of the influence of cocaine and atropine on the organs of circulation, by Dr. H. G. Beyer, U.S.N., was read before the Section.

"On the Brain and Auditory Organs of a Permian Theomorph Saurian" was the title of an interesting paper by Prof. E. D. Cope. The author called special attention to the morphology of the brain, the character of the cranial walls and the auditory apparatus.

The disputed question of the bisexuality of the pond-scums (Zygnemaceæ) was discussed by Prof. C. E. Bessey, of the University of Nebraska, who concluded that these organisms do not possess true bisexuality.

"On the Process of Cross-fertilisation in *Campanula americana*" was the title of a paper presented by C. R. Barnes.

A paper on aquatic respiration in soft-shelled turtles (Aspidonectes and Amyda) was presented by Profs. Simon H. and S. Phelps Gage as a contribution to the physiology of respiration in vertebrates.

Prof. C. E. Bessey read a paper on the inflorescence of *Cuscuta glomerata*.

Prof. Gage addressed the Section (G) on Microscopy and Histology on the limitations and value of histological investigation, and Mr. Dall discoursed to the Anthropological Section on the native tribes of Alaska. The papers in this section were very numerous, many of great interest, and all naturally devoted to anthropological questions connected with the North American continent.

NOTES

THE National Sanitary Congress commenced its autumn meeting at Leicester on Tuesday, when the president, Prof. De Chaumont, F.R.S., gave an address on the work of the Sanitary Institute.

THE portrait of the late George Bentham, subscribed for by several of his friends, has been presented to the Herbarium, Royal Gardens, Kew, on behalf of the subscribers, by Sir John Lubbock. The picture is a successful reproduction, by Miss Merrick, of the original in the possession of the Linnean Society.

WE regret to notice the death of M. Breton des Champs, one of the French Government engineers, a mathematician and scientific writer who played a prominent part in connection with the Newton forgeries. In combination with his friend Leverrier, M. Breton des Champs exploded these frauds, which were so disgraceful to the good name of the French Academy of Sciences. He discovered the books from which the so-called "forger with long ears" had copied the assumed letter sold to M. Chasles.

THE Essex Field Club will hold its sixth annual cryptogamic and botanic meeting in Epping Forest on Friday and Saturday, October 2 and 3. On the Saturday afternoon and evening there will be an exhibition of fungi and other plants, fresh and preserved, with micro-objects; and papers will be read by Dr. Wharton and Mr. Worthington Smith. The following botanists, among many others, are expected to be present, and will act as "referees" in various departments of plant-lore:—Prof. Boulger, Dr. Braithwaite, Dr. M. C. Cooke, Rev. J. M. Crombie, Rev. Canon Du-Port, Messrs. J. L. English, Henry Groves, F. J. Hanbury, E. M. Holmes, David Houston, A. Vaughan Jennings, Frederick Oxley, W. W. Reeves, Worthington G. Smith, C. A. Wright, Dr. Spurrell, Dr. H. T. Wharton, &c. Those wishing to attend should communicate with the hon. secretary, Mr. W. Cole, Buckhurst Hill, Essex, who will forward programmes giving full particulars.

THE Trustees of the Gilchrist Lectures Fund have arranged for courses of six lectures in each of five Lancashire towns—Blackburn, Lancaster, Chorley, Colne, and Padiham, and for similar courses in Greenock, Paisley, Stirling, Alloa, and Kilmarnock—all to be delivered during October and December. No lectures will be given during November in consequence of the General Election in that month. The lecturers entrusted with the work are: Prof. R. S. Ball, Rev. W. H. Dallinger, Prof. W. C. Williamson, Dr. Andrew Wilson, and Mr. W. Lant Carpenter. Each course includes three lectures on biological and three on physical subjects, oxyhydrogen lantern illustrations being freely used, and in some cases experiments also. As usual the charge for admission will be one penny, and the largest available rooms are secured for the lectures, special measures being taken to insure the attendance of working men. There will probably be similar courses in five Midland towns in the spring.

WE are informed that the vacant Chair of Physics and Engineering in University College, Bristol, has been filled by the appointment to the post of Prof. John Ryan, M.A., King's College, Cambridge, D.Sc. London, and Member of the Institute of Mechanical Engineers. Dr. Ryan, who is a practical engineer, has hitherto held the appointment of Professor of Mechanics and Engineering in University College, Nottingham. At Bristol he succeeds Prof. Thompson, now Principal of the Finsbury Technical College, and Prof. Hele Shaw, recently appointed to the Professorship of Engineering in University College, Liverpool.

MR. F. C. LEHMANN, a German botanist, who has travelled or over ten years in Central and South America for the purposes of scientific researches, has arrived safely at Panama, from Europe, which he lately visited in order to arrange with other scientific colleagues to assist him in the classification of his extensive collection of objects of natural history. Mr. Lehmann was about to proceed to the Cauca, where he intends to remain for several years, with his domicile in Popayan. He proposes the continuation of former labours and minute researches into the botanico-geographical conditions of the Flora of Tropical America.

THE exceedingly unusual character of the following announcement, coming from the United States, will attract attention. We take it from *Science*:—"On account of the lack of funds necessary to maintain its activity, the Astronomical Observatory of Beloit College, Wisconsin (Prof. J. Tatlock, jun., director), has been closed."

THE experiments for the electrical illumination of the Palais Royal are very successful. The number of incandescent lights used is 150. The Théâtre Français, Théâtre du Palais Royal, and Council of State have agreed to the deed of agreement signed by the shopkeepers, so that thousands of lamps will soon be in operation. But before taking a final decision, the subscribers are trying every description of incandescent lamp.

A SERIES of science lectures has commenced at the Royal Victoria Hall, Waterloo Bridge Road, and promises to be as successful as any previous one. On September 29, W. J. Harrison, F.G.S., will lecture on "Stone Tools and the Men who used them." On October 6, Mr. A. H. Fison will lecture on "Some Other Worlds." On October 13, Prof. H. G. Seeley, F.R.S., will lecture on "Coal."

WE learn from the *London and China Telegraph* that a work on which Dr. Dudgeon of Peking has been engaged for upwards of ten years, has just been issued in eighteen Chinese volumes. It comprises a translation of Gray's "Anatomy" and Holden's "Osteology." There are in addition two volumes of plates, comprising 600 cuts, which have occupied the time of two men for two years and a half. The whole of these cuts have been made at the expense of the Chinese Foreign Office, and the work has been published in a series issued by the Foreign Language College at Peking. It is proposed to establish in connection with this college a medical school and hospital to provide proper practitioners for the service of the army, navy, and palace.

A REPORT on carp-culture in China has been made by Dr. Macgowan to the Carp-Culture Association of the United States. Pisciculture, it appears, was cultivated at a very early period, being regarded as a branch of agriculture. The carp is, of all fish, the most frequently reared by artificial means in China, but nearly every species of *Cyprinidæ*, bream, tench, roach, gold-fish, &c., is so raised. A treatise on fish-rearing has been attributed to a Minister of the fifth century before our era, but it it appears to have been really written eight centuries later. The work says that of the five modes of rearing animals by far the most productive and valuable is fish-breeding. The pond used for this purpose (it goes on) should be an acre in extent (the depth is usually less than eight feet), and nine stone islets, each having eight inlets or bays, a yard below the surface of the water, should be constructed in it; then twenty gravid carp and four males, each three feet long, are to be deposited in it noiselessly in the month of March. Two months later a turtle should be placed in the pond, two months later a couple, and after a like period three more. By this time there will be 360 carp. The turtles are to prevent their being transformed into dragons and flying away. The object of the islets and bays is to afford greater space for the fish in their sinuous voyages, for the more a fish travels the fatter and bigger he becomes. The Chinese author then makes the following calculation: in the following year the pond will be found to contain 150,000 carp 1 foot in length, 450,000 3 feet, 10,000 2 feet. In the third year 100,000 1 foot, 50,000 2 feet, 50,000 3 feet, and 40,000 4 feet. A thousand of those that are 2 feet in length should be retained for replenishment, and all the rest be sent to market. In another year their number will exceed all calculation, and they require no feeding, hence the value of carp culture. All the varieties, we are told, come from the black species. Those destined to become white change to silver or yellow, while the others turn first red and then golden. Some of the white sort are so nearly transparent that their viscera are visible. Much of the art of rearing them consists in affording due amounts of shade and sunshine in the course of their growth, and in changing their water, not more than half of which is to be removed every fourth day. In the earliest times the practice, which continues to-day, was introduced of planting mulberries on the margins on which apiaries were placed, the droppings from which fed the fish, while the leaves of the trees first nourished silkworms and then goats. These droppings are said to impart a peculiar flavour to the fish.

A CONSIGNMENT of soles and brill has lately been despatched by the National Fish Culture Association to the American

Government as a slight recognition of the presentations of ova made by them to this country. There is a great dearth of flat fishes in the United States, and at the instigation of the Commissioners of Fish and Fisheries many attempts have been made to forward young specimens for propagation from England. Hitherto these efforts have not met with success, it being exceedingly difficult to transmit live soles, as they are less tenacious of life than their congeners. We hope that Prof. Baird, who has received notice of the despatch of this valuable gift, will not be again disappointed. The fish have been placed in charge of an experienced pisciculturist, who will accompany the s.s. *Republic*, by which vessel they have been sent, and who will bring back a number of American species with a view to acclimatising them in this country.

THE Royal Commissioners of the Colonial Exhibition, to be held next year at South Kensington, have issued circulars to the Governors of our Colonies requesting them to send the various species of fish indigenous to their respective countries for exhibition. Special preparations will be made at the close of October for receiving them. The arrangements will necessarily be of an elaborate nature, as the tanks will have to be constructed in such a manner as to provide for the exigencies of each species and the regulation of high and low temperatures according to the climatal necessities of the fish.

SPECIAL interest is just now centred at the Aquarium in the incubation of the ova of some of the dogfish which have recently spawned. The eggs, which resemble filbert nuts in shape, are to be seen in a special tank, which presents a sight of much edification. The formation of the fish inside the ova is plainly perceptible, every part of them being apparent. The fish in the Aquarium are now being fed at 6 o'clock, partly on a new dietary specially invented by Mr. W. Burgess, of Malvern Wells.

THE Marquis of Lorne has successfully planted some whitefish in a specially constructed lake on the Isle of Mull. The fish form part of those reared by the National Fish Culture Association this year. His Lordship reports that the fish are doing well.

AT a lecture delivered by Mr. W. Oldham Chambers, F.L.S., at the Hull Town Hall last week on fish culture, living specimens of the whitefish and other foreign species of fish were exhibited, and excited much interest amongst the audience.

A RECENT *Bulletin* of the United States Fish Commission contains the following interesting account of the destruction of young trout by mosquitoes: "In the middle or latter part of June, 1882, I was prospecting on the head-waters of the Tumichie Creek, in the Gunnison Valley, Colorado. About 9 o'clock in the morning I sat down in the shade of some willows that skirted a clear but shallow place in the creek. In a quiet part of the water where their movements were readily discernible, were some fresh-hatched brook or mountain trout, and circling about over the water was a small swarm of mosquitoes. The trout were very young, still having the pellucid sack puffing out from the region of the gills, with the rest of the body almost transparent when they would swim into a portion of the water that was lighted up by direct sunshine. Every few minutes these baby trout—for what purpose I do not know, unless to get the benefit of more air—would come to the surface of the water, so that the top of the head was level with the surface of the water. When this was the case a mosquito would light down and immediately transfix the trout by inserting its proboscis, or bill, into the brain of the fish, which seemed incapable of escaping. The mosquito would hold its victim steady until it had extracted all the life juices, and when this was accomplished, and it would fly away, the dead trout would turn over on its back and float down the stream. I was so interested in this before unheard-of destruction of fish that I watched the depredations of these mosquitoes for more than half an hour, and in that time over twenty trout were sucked dry and their lifeless bodies sent floating away with the current. It was the only occasion when I was ever witness to the fact, and I have been unable by inquiry to ascertain if others have observed a similar destruction of fish. I am sure the fish were trout, as the locality was quite near the snow line, and the water was very cold, and no other fish were in the stream at that altitude. From this observation I am satisfied that great numbers of trout, and perhaps infant fish of other varieties in clear waters, must come to their death in this way; and if the fact has not been heretofore recorded it is important to those interested in fish-culture."

A TELEGRAM from Rome, September 21, states that repeated shocks of earthquake have occurred in Benevento. The inhabitants are terror-stricken, and are encamped in the open country.

THE Russian *Official Messenger* states that the city of Namangan, in Ferghana, has been visited all through the summer by repeated shocks of earthquake, which have hitherto been of very rare occurrence there. The strongest shocks took place on April 17 and August 4, but no very serious consequences resulted.

ON September 12, at 9.30 p.m., a magnificent meteor passed over the city of Stockholm, going from south to north. Its light was very brilliant. On account of the limited area of observation it was impossible to tell whether it burst near the city or not.

DURING the month of August enormous swarms of ants passed over the town of Solothurn in Switzerland. They came from the Jura mountains, and formed a cloud, consisting of seventy-five perpendicular columns, in which the ants circled around in spiral form. The swarm lasted for twenty minutes, the height of the cloud being upwards of ninety feet. Millions of them fell to the ground, however, without making any visible change in the phenomenon.

ACCORDING to the *Bergen Adresseblad*, fishermen at the island of Mögster, on the coast of the province of Bergen, on the west coast of Norway, have lately seen large floating blocks of ice at sea, which are believed to be parts broken off from icebergs in the North Atlantic. Such a phenomenon has never before been observed in these parts.

THE Swedish journal *Norrbottens Kuriren* states that the water is falling rapidly in the Gulf of Bothnia, a phenomenon to which we have on several occasions referred. As a further proof of this the journal states that a stone in the archipelago by the coast which fifty years ago at lowest tide was barely visible above water is now at mean tide three feet above it.

WE have pleasure in noticing the issue of No. 43 of the first part and Nos. 29-31 of the second part of the well-known "Encyklopædie der Naturwissenschaften" from the house of Eduard Trewendt, Breslau. The former brings forward Dr. A. Reichenow's "Handwörterbuch der Zoologie, Anthropologie, und Ethnologie," from article "Heteronereis" to "Icteridæ." Among other articles embraced within this interval are valuable contributions on the development of the organs of hearing by Prof. Griesbach; on "Hypnotismus," by Prof. Gustav Jäger; on "Januten," "Japaner," "Javanen," by Dr. von Hellwald; on "Hissarlik," "Hohlefels," "Hohlkeit," by Prof. Mehlis. Nos. 29 and 31 of the second part, again, continue the "Handwörterbuch der Chemie," while the 30th number continues the "Handwörterbuch der Mineralogie

Geologie, und Paläontologie." The two chemical numbers treat with all the fullness and thoroughness characteristic of this estimable work "Dichte," "Didym," "Diffusion," "Dinte," "Diphenylverbindungen," "Dissociation," "Dünger," and "Eisen," and the accompanying woodcuts illustrating any difficult experiments in the text add materially to the practical value of the articles. The new number, finally, of the Mineralogical, Geological, and Palæontological Dictionary contains important contributions on "Reptilien" and "Rhizopoden," by Rolle; on "Salze," by Kenngott; on "Schichtenlehre" and "Schwankungen im Niveau vom Meer und Festlande," by von Lasaulx—articles distinguished not more by fullness and compactness of matter than by clearness of dan. ne

WITH unflagging vigour and learning the new Italian quarterly, *La Nuova Scienza*, prosecutes the mission it has undertaken of building up an exact philosophy on the foundation of the natural and historical sciences. In the last number for June, 1885, the articles of chief interest, all contributed by the indefatigable editor, Prof. Enrico Caporali, are: Modern Italian thought, German anticlerical evolution, and the Pithagoric formula in cosmical evolution. The last-mentioned paper deals with the evolution of gravitation, of heat, of electricity, chemical affinity, lower organic force, higher organic force, sentient force, social authority; fatalist and free evolution. It is held in general that all evolution is due more to internal energy than to outward conditions, in opposition to Herbert Spencer's theory of mechanical causes.

THE address of Mr. W. H. Dall, vice-president to the Anthropological Section of the American Association for the Advancement of Science at Ann Arbor, last month, has been printed as a separate pamphlet. The subject of the address was "The Native Tribes of Alaska."

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. A. Cornet; a Red Kangaroo (*Macropus rufus* ♀) from Australia, presented by Mr. G. Wylie; a Bonelli's Eagle (*Nisaetus fasciatus*) from North Africa, presented by Capt. W. R. Taylor, s.s. *Empusa*; two Tawny Owls (*Syrnium aluco*), European, presented by Mr. H. Lee; a Nightjar (*Caprimulgus europæus*), European, presented by Mr. Cuthbeth Johnson; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; seven Blue-bearded Jays (*Cyanocorax cyanopogon*) from Para, purchased; a Beisa Antelope (*Oryx beisa* ♀), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, SEPTEMBER 27 TO OCTOBER 3

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on Sept. 27

Sun rises, 5h. 56m.; souths, 11h. 50m. 51·3s.; sets, 17h. 46m.; decl. on meridian, 1° 48′ S.: Sidereal Time at Sunset, 18h. 13m.

Moon (three days after Full) rises, 19h. 0m.*; souths, 2h. 1m.; sets, 9h. 13m.; decl. on meridian, 10° 42′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 29	11 1	17 33	5 36 N.
Venus	9 34	14 12	18 50	16 17 S.
Mars	0 19	8 11	16 3	19 47 N.
Jupiter	4 33	11 1	17 29	4 46 N.
Saturn	22 1*	6 9	14 17	22 19 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Sept.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
28	48 Tauri	6	21 56	22 45	33 273
28	γ Tauri	4	23 46	0 43†	36 279
29	75 Tauri	6	4 41	5 41	149 268
29	θ¹ Tauri	4½	4 48	5 26	54 1
29	B.A.C. 1391	5	5 41	6 51	109 324
30	111 Tauri	5½	3 2	4 17	73 268
30	117 Tauri	6	5 15	6 5	53 341
Oct.					
2	λ Geminorum	3½	0 38	1 32	30 248

† Occurs on the following day.

The Occultations of Stars are such as are visible at Greenwich.

Sept.	h.	
27	9	Mercury in conjunction with and 0° 52 north of Jupiter.
Oct.		
1	11	Saturn in conjunction with and 4° 15′ north of the Moon.
3	19	Mars in conjunction with and 5° 4′ north of the Moon.

THE ASTRONOMICAL ASSOCIATION

THE Astronomical Association held their eleventh general meeting this year at Geneva from Aug. 19 to 22 inclusive, and the representatives of so many nations were present that the meeting fully bore out the character of an international one. Among the fifty members, or thereabouts, attending were: Struve, from Pulkowa; Newcomb, from Washington; Christie, from Greenwich; Dunér, from Lund; Pechule, from Copenhagen; Tietjen, from Berlin; Krüger, from Kiel; Schur, from Strassburg; Tisserand, from Paris; Spörer, from Potsdam. The office-bearers were: Auwers, from Berlin, President; Schönfeld, from Bonn, and Seeliger, from Munich, Secretaries; Bruns, from Leipzig, Treasurer: while Bakhuyzen, from Leiden, Gyldén, from Stockholm, and Weiss, from Vienna, were honorary members of the Committee. Prof. Oppolzer, who was also a member of the Committee, was unable to attend.

The first sitting was opened by President Auwers in the aula of the University at 10 in the forenoon of the 19th. Among the scientific reports of the Committee the full communications of Prof. Weiss on the present state of the computations of the orbits of the comets were of special interest. Of the 12 periodical comets returned at different times to their perihelion, 8 had again been regularly determined by the same calculators. Of the remaining four three were removed from our present care: Biela's, which, as was known, had been lost to observation, and the comets of Halley and Pons-Brooks, whose next perihelion lay too remote in the future. There was, consequently, but one periodical comet—Brorsen's—to be taken account of. As to the remaining non-returning comets, of the 168 which had appeared in this century 41 were to be regarded as settled, 23 had their orbits pretty well determined; in the case of 58 comets a new calculation of the orbit was desirable for various reasons, and in all 46 had yet to be calculated definitely. There was, therefore, a wide field of labour open. Prof. Weiss accordingly sought to commend to the Society the establishment of a common calculation bureau for the settlement of the questions at issue, while the exact detailed treatment of a particular comet should in future, as hitherto, be left to the initiative of a single calculator. In the discussion following this address, Staatsrath Struve argued against the founding of such a bureau on the ground that the comets were of too peculiar a nature to accommodate themselves to the methodic treatment of a calculation bureau. No resolution was taken on the question.

This report was followed by communications of a business character on the great zone undertaking of the Society. These communications were of no great extent, the undertaking being already in near prospect of completion. The photometric survey of the heavens by Prof. Pickering, of Harvard College, read by Prof. Auwers, was heard with special interest.

Next followed the scientific addresses. Dr. Schram, Observer in the Austrian Triangulation, communicated a table calculated by him, which would shortly be published, a table which materially lightened the approximate calculation of an eclipse for a particular spot on the surface, according to Oppolzer's elements.

Prof. Weiss then communicated the publication of the second volume of the *Annals* of the Vienna Observatory, and followed this up with the remark that the meridian circle, which was sixty years old, was now very much in need of repair; but, unfortunately, there was no money at disposal for this purpose.

After the President had opened the second sitting at ten o'clock on August 20, he communicated a report on the photographic mapping of all the stars of the "Bonner-Durchmusterung" which Gill (of the Cape Observatory) had begun, and of which about 100 plates were already to hand. The time taken for the exposure of each plate amounted on an average to one hour.

After various deliberations of a more private character the discussion turned on Resolution VI. of the Meridian Conference of Washington. The President declared emphatically that the question could be considered in this assembly only from an astronomical standpoint. The question was simply whether it were desirable for the astronomer to transfer the beginning of the day to midnight, and to this question the discussion should be restricted. At the outset the President announced that the Committee of the Society, with the exception of one member not present (Oppolzer)—that is, in the proportion of seven to one—had voted against the adoption of the proposal.

Staatsrath Struve (from Pulkowa) at once opposed the restriction advanced by the President, which, he thought, involved a one-sided treatment of the matter. It was to their advantage, he asserted, not to seclude themselves from the rest of the world. Magnetic and meteorological observers, he said, counted their day from midnight. Many astronomers, moreover, he continued, worked by day, and most observations were made between six and twelve in the evening. The change was defended by men eminent in science. The reform assuredly met a deeply-felt want. The question was "Should they make this sacrifice or not?"

Prof. Spörer, of Potsdam, mentioned that he always counted his observations from midnight.

Prof. Newcomb, of Washington, spoke at considerable length on the question, and rather against than in favour of the adoption of the proposal of universal time.

Prof. Weiss, of Vienna, was of opinion that the sacrifices demanded of astronomers by this reform were too great, and that the advantages were more than counterbalanced by the disadvantages. He laid stress on the fact that astronomers were wont to make their calculation of time from the moment when the time-determining object—the spring point—the mean sun—passed the meridian. That was also the true point of commencement. The observations which were of interest to the public at large, might be given in universal time, whereas with their more esoteric observations they might adhere to the old reckoning. The astronomer should keep by himself, and pay no attention to claims of intercourse.

Prof. Safárik, of Prague, said, "Why should we make a sacrifice on behalf of the public that feels no concern with our labours?"

Prof. Krüger, of Kiel, thought that altogether there were but few necessary points of relation between the astronomer and the public—points, however, which could be readily taken account of if the public desired it.

Dr. Dunér, from Lund, argued that by a change of date it would be impossible not to make a sudden break in astronomical labours that had hitherto been carried on uninterruptedly, to whatever time of day or night the commencement of the day was transferred. He concluded by expressing his opinion that the sacrifices demanded were too great.

Geheimrath Auwers expressed himself as personally opposed to the change, principally in order to avoid a discontinuity in the calculation of time which might, later on especially, lead to sensible errors.

Prof. Bakhuyzen, of Leiden, was refused a hearing, because he wanted to speak of seamen, who have the reform specially at heart.

Staatsrath Struve remonstrated against this proceeding, and argued that the question ought not to be treated onesidedly. At the Washington Conference seamen had the majority of representation, and opinion had there been almost unanimously expressed in favour of the reform. He was swayed by the desire of rendering astronomy useful to the rest of the world.

Prof. Gyldén, of Stockholm, argued that the change must give rise to vexatious errors unless it were universally carried out on one line. As the realisation of this idea was, however, more than could be looked for at present, he would now have to vote against the universal time. He believed, nevertheless, that in twenty or thirty years hence the majority of astronomers would be in favour of the universal time.

Prof. Tietjen, of Berlin, thought that in the Berlin Year-Book at all events, no such change would find place before 1900.

Staatsrath Struve maintained that in the Royal Astronomical Society the majority were in favour of the universal time.

Dr. Pechule, of Copenhagen, was also of opinion that it would be well for astronomy to accommodate itself to the rest of the world; but only when all were of one mind should the innovation be simultaneously and universally introduced.

Prof. Folie, of Brussels, thought that in all reforms there were some stragglers, and in his opinion it was the duty of astronomers energetically to take the initiative in the good cause.

After some recapitulatory observations of the President the discussion closed. No resolution whatever was passed on the subject.

It may be worth while mentioning here in respect of this subject that in the reading of the protocol it was affirmed that all the members of the Committee who were present were opposed to the adoption of the universal time. Objecting to this declaration, Dr. Pechule stated that Prof. Gyldén had only voted against the *immediate* adoption, while he entirely approved the *principle* of the proposed reform. The protocol had accordingly to be altered so as to give effect to this statement.

The series of scientific addresses was resumed by Dr. Mittag-Leffler, from Stockholm, who communicated the mathematical prize exercises which, under the auspices of King Oscar II., had been instituted by a special Commission.

Staatsrath Struve handed, for circulation, photographs of the great refractor of 30 inches aperture, which a short time ago had been mounted in Pulkowa, and expressed his complete satisfaction with the result.

Prof. Newcomb had thoroughly studied the instrument for seven days continuously, and corroborated Staatsrath Struve's views regarding the value of the instrument, entering into various details on the matter.

Prof. Tisserand, of Paris, spoke of a purely theoretical examination of the rotation of the earth.

Dr. Steinheil spoke on the calculations of Galileo's telescopes of new construction.

Prof. Spörer, of Potsdam, gave a somewhat long address on the new views regarding the physics of the sun.

The following day was devoted to a common trip around the Lake of Geneva, Col. Emile Gautier, at present Director of the Geneva Observatory, engaging at his own cost the saloon steamship *Winkelried* for this purpose. The dinner, which was served on board ship, gave opportunity for expressing the warmly-felt thanks of so many guests to their generous host for the entertainment he had provided them during the continuance of the Congress.

On the last day of the meeting, Saturday, August 22, the proceedings of a business character were brought to a close. The statutory order respecting the raising of the fee for life-membership to 185 marks was adopted. As the place of meeting for 1887, Kiel was fixed on. The new election of a committee made no change in its former composition.

The scientific addresses were opened by Prof. Gyldén, who spoke of a graphic representation of planetary orbits.

Prof. Newcomb followed with an address on perturbations and their numerical calculation.

Prof. Bakhuyzen made communications respecting his treatment of Schröter's observations of Mars. He came to the conclusion that since Schröter's time "Huggin's Inlet" had probably changed considerably, whereby the hypothesis that Mars is in large part covered with fluid received material support.

Dr. Müller, of Potsdam, spoke on modern photometric apparatuses, and examined in particular those of Zöllner, Pickering, and Pritchard, entering into a searching criticism of them. The sources of error of the most considerable systematic deviations in the results obtained with these instruments were not yet sufficiently known, and it would therefore be well to mark out a number of stars of which thorough observations should be taken by the different observers with the use of all the three instruments.

Prof. Seeliger, of Munich, spoke of theoretical, and in part also practical, investigations he had commenced, which for the present had shown that the Lambert law respecting the reflective power of illumined surfaces, the basis hitherto of all photometric experiments, was entirely false. He reserved his more complete exposition of the matter till the close of his labours in this direction.

Prof. Safârik observed that some astronomers to whom he had communicated his "fluorescence plates," whose intermediate junction of eye-piece annulled the secondary spectrum, had given him a favourable report regarding their use. He was always ready, he said, to place other plates at the disposal of any who desired them.

Prof. Weiss announced that he was engaged in the preparation of a catalogue of 4500 stars which had formerly been observed at Geneva, a catalogue which was now approaching its completion.

President Auwers once more expressed thanks for the friendly reception the Association had met with at Geneva and proposed to the meeting that they should rise from their seats in honour of Col. Gautier. The proceedings were then declared to be concluded.

EDUCATION IN THE UNITED STATES

THE pride taken in popular education in the United States makes any digest of their experience valuable; and education, as carried on in their cities, the subject of a recent Circular of Information from the Bureau of Education, is necessarily the branch of it most interesting in our crowded island. Dr. Philbrick, the writer of it, has been, in Boston, a most successful school superintendent, an officer who undertakes the active duties of both School Board and Government Inspector, and one without whose services cities are here said to be behind the times. The uncertainty of a good choice of members for a School Board by popular election in the United States makes this office the more important; women having, as a rule, declined to counteract corrupt votes by their own. Every branch of education is treated upon here. Technical instruction, both as provided in Paris and in the United States, is largely and systematically considered; from the shape it takes in the school, where it simply replaces the gymnasium to boys over thirteen years of age, to the apprentice school which really attempts to supersede the worn-out system from which it gets its name by a more scientific and intelligent teaching of a few trades, among which building in its various branches, necessarily so important in a new country, is always one chosen. School museums are recommended, both of natural history and of technology; the decoration also of schoolrooms with statuary, &c., now provided for the purpose at low prices, a list of which is appended. The rules to be observed in building are a digest of both European and American experience, valuable to every one concerned with the architecture of schools of any class; and we may just note Dr. Philbrick's conclusions—that increased centralisation and permanency are found desirable; that *speaking* French or German is unnecessary to 90 per cent. of secondary scholars; and that high school education is bad for girls. "Free and uniform" is Dr. Philbrick's ideal. He believes that the work of elementary schools can be so revised that the higher subjects will be a simple continuation of the lower; so that a complete elementary course shall be just the same as the first few years of a university education. Higher stages are never to be commenced till after the age of fourteen. Free high schools, "the most truly democratic of all our institutions," are being used by youths who go back to farm work, contending that in no way does a classical education unfit a man for manual labour and attending meetings of "old boys" whose common interest in the school helps to obliterate social distinctions. Such schools are to be provided for the mechanic to carry on his studies therein in the evening; while for higher students manual labour, especially the use of carpenters' tools, is to replace the gymnasium, and be pursued afterwards in evening technical schools; and thus study and labour will complement each other, and the daily toil of the poor man is raised to the level of the rich man's recreation. Military and fire drill are to be taught, and replace out-door games. We fear that an elementary course complete in itself and different from university rudiments, although perpetuating class distinctions, will probably be a necessary evil for some time yet, and also that paralysis for lack of competition must be incurred where pupils are required to attend the school in their own district of their own city—this necessitating uniformity of books for the sake of families removing.

A PREHISTORIC CEMETERY

A DUNFERMLINE correspondent writes that another cemetery of prehistoric times has been discovered on the estate of Pitreavie. About two and a half miles to the north-east of the former discovery a number of workmen were, some days ago, engaged in collecting rough stones to form an embankment. Ere the work had proceeded far it was noticed that the stones, which lay on a moor, formed a circle, partly covering a mound 200 feet in diameter. In the centre of the mound, and about 36 inches below the surface, a cyst measuring 46 inches in length and 24 inches in width was found. The cyst was three-parts filled with a dark mould, and in it was discovered a beautifully-formed urn which stands 5 inches in height and measures 6 inches across the mouth. There was nothing in the urn but soil, but in the cyst some large calcined bones were found. Explorations were continued in the vicinity of the cyst and within the stone circle, with the result that no fewer than eleven other urns were found. All these urns contained calcined human bones and much vegetable charcoal, both in dust and in pieces, and numerous pieces of burnt bones were also found in the mound—a circumstance which indicates that a good many interments had taken place without urns. The urns measured from 5 to 12 inches in height, are hand-made, and of the type usually known as "food-vessels." They have everted rims, and are ornamented with varied designs, formed by oblique lines and dots on the upper part, and encircling projecting rings at the bulged part. The urns are of a reddish colour, but the pottery section shows a black interior with a mixture of coarse sand. There are several interesting features attached to the discoveries. In the first cemetery a row of cysts with an urn in each were discovered—circumstances which unmistakably indicate the predominance of inhumation over that of cremation. No bones were found in the urns. In the second discovery only one cyst was found, and eleven of the urns were simply buried in the mounds, and all contained burnt bones—facts suggestive of cremation. The second discovery corresponds more than the first with most of the prehistoric local cemeteries which have been laid bare in the county of Fife. The chronological relationship between the two kinds of interment—inhumation and cremation—as presented to us in the two Pitreavie cemeteries, opens up a most interesting field of inquiry to the enthusiastic archæologist. Dr. Worsaae, the late distinguished archæologist, says cremation was the outcome of higher and more advanced religious principles than characterised the people of the Stone Age, who were in the habit of burying their dead in dolmens and other megalithic tombs, with food-vessels, weapons, ornaments, and such articles as were supposed to be serviceable beyond the grave. Founding upon Dr. Worsaae's idea, it is not unreasonable to assume that the two discoveries under notice belong to the Stone and Bronze ages. The urns are all in the hands of the proprietor of the estate, Mr. Beveridge, and are likely to be handed over to the National Society of Antiquaries.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 8, July 15.—This contains the following:—On the time-relations of the formation of the electric residuum in paraffin, by C. Dieterici.—On the quantity of electrical elementary particles, by E. Budde.—On the theory of thermo-electric forces, by the same.—On a deduction from the laws of electro-dynamic points, suggested by Gauss, by the same.—On some applications of theory of change of form in a body when it is magnetically or dielectrically polarised, by G. Kirchhoff.—Determination of some coefficients of friction and experiments on the influence of magnetisation and electrification on the friction of liquids. The values obtained from swinging disks were always greater than from an outflow-apparatus. Experiments in which sulphate of manganese solution was let flow from a capillary tube placed between magnetic poles, and others in which the capillary tube, of flint glass coated with shellac, was brought into the field of a condenser (the liquid being sulphide of carbon), showed no alteration of the coefficient of friction.—On the solubility of salt mixtures, by F. Rüdorff. Of the pairs of salts examined, some were found to be forced from their common solutions when an excess of one or the other salt acted on these, but in other cases only those pairs of salts were forced out which separate from the common solution either in double salts or in mixed crystals.—On the theory of fluorescence, by E. Lommel. He answers some objections of Herr Wüllner to his theory.—Spectral photometric researches on some photographic sensitisers. He finds the sensitising colouring-matters divisible into: (1) those which gradually absorb the spectrum from the violet onwards, and are like the ordinary photographic; (2) those which have a regular absorptive action over great parts of the spectrum from the violet, but photographically show a maximum of sensitisation in the yellow; and (3) those which show an absorption band in the spectrum and a local increase of sensibility to light thereabouts (coincidence not exact).—Correction of new formulæ, by W. Wernicke.—Remarks on Herr Melde's acoustic experimental researches, by A. Else.—Alteration of the influence machine, by E. Lommel. He gets a spark of 12 cm.—On an inaccuracy of the theory of the gold-leaf electroscope, by T. Häbler.

Proceedings of the Boston Society of Natural History, vol. xxiii., part 1.—Mr. Bouvé contributes notes on gems, especially the garnet, hiddenite (an unnamed gem of a light yellow colour, a representative of the mineral spodumene, of which hiddenite is a green variety), and others.—Dr. S. Kneeland read a paper, illustrated by the stereopticon, on the subsidence theory of earthquakes as evidenced by the Ischian catastrophes of 1881 and 1883.—Prof Crosby has a long paper on the relations of the conglomerate and slate in the Boston Basin; Mr. Bouvé on the genesis of the Boston Basin and its rock formations; Messrs. Dickerman and Wadsworth on an olivine-bearing diabase from St. George, Maine; Prof. Shaler on the origin of kames, a kind of gravel deposit, also known as Eskers, and often called in America, Indian ridges. He supposes that at the close of the glacial period the re-elevation of the land must have been accomplished with very great suddenness.—Finally, Prof. Hyatt contributes a lengthy paper on the larval theory of the origin of cellular tissues.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 7.—M. Bouley, President, in the chair.—Researches on isomerism in the aromatic series: Action of the alkalis on the phenols of mixed function, by M. Berthelot.—Studies on the mode of action of the subnitrate of bismuth in the staunching of sores, by MM. Gosselin and Hérat.—Note on the fluorescence of some rare earths, by M. Lecoq de Boisbaudran. The author arrives at conclusions differing in several respects from those of Mr. Crookes, but reserves for the present an exposition of the grounds which induce him to infer that yttria is not the efficient cause of the fluorescence —On apparent anæsthesis and retarded sensations in hysterical, epileptic, and other nervous subjects, by M. V. Revillont.—Letter announcing the discovery of a new star in the nebula of Andromeda, by M. Lajoie.—Note on the changes recently observed in the nebula of Andromeda, by M. G. Bigourdan.—Observations of Brooks's new comet and of the new planet, 250, made at the Paris Observatory (equatorial of the west tower), by M. G. Bigourdan —Table of the chief elements of the ten regular polyhedric figures, one illustration, by M. Em. Barbier. — A new map of the solar spectrum, by M. L. Thollion. This work, which has occupied four years of incessant labour at the Observatory of Nice, comprises the whole of the solar spectrum between A and *b*—that is, about one-third of the prismatic spectrum. It is over ten metres long and includes 3200 lines, or double the number contained in Angström's Atlas. In the preparation of this plan the author's aim has chiefly been to determine as far as possible the present state of the solar spectrum, to serve as a starting-point for future observation. The physicist will by its means be able to record subsequent changes in the spectrum with the same certainty that the astronomer determines the changes taking place in stellar regions.—Account of the "Anemogene," an apparatus invented for generating aërial currents analogous to those of the terrestrial atmosphere, by Mgr. Rougerie, Bishop of Pamier. This instrument takes the form of a miniature globe, which, by rotating around its axis in the air, is made to produce by its mechanical action currents resembling those observed on the greater part of the oceanic basins. The currents are indicated by vanes placed at intervals of 5°, like the compass-cards of the thirty-two winds prepared for the French navy by M. Brault. A list is given of all the trade winds, ascending and descending currents, and other normal atmospheric phenomena reproduced with more or less accuracy by this apparatus.—On the period of latent excitation of some smooth muscles in the invertebrates, by M. Henry de Varigny. —On the so-called "vidian" nerves in birds, by M. F. Rochas. —On the anatomy and vital functions of *Truncatella truncatula*, by M. A. Vayssière.—On the marine annelids of the Bay of Algiers, by M. C. Viguier.—On the anatomical structure of the Ascidians (genera Saracenia, Darlingtomia, and Nepenthes), by MM. Edouard Heckel and Jules Chareyre.—Note on the black rot recently introduced from the United States into the vineyards of Hérault, by MM. P. Viala and L. Ravaz.—On the earthquake-shock felt at Orleans on August 16, by M. E. Renou. —M. H. Gadeau de Kervill announced that he had obtained a hybrid from a tame pigeon and a ring-dove, presenting in a modified form nearly all the special features of both parental types.

September 14.—M. Bouley, President, in the chair.—Discourses pronounced at the obsequies of the late M. Bouquet on September 11, by MM. J. Bertrand and Hermite.—On the fluorescence of some rare earths, continued, by M. Lecoq de Boisbaudran.—Description of the model of a new integraph serving to trace an integral curve ($y = \int f(x)\,dx + C$), any curve ($y = f(x)$) being given, one illustration, by MM. D. Napoli and Abdank-Abakanowicz. This integraph is capable of numerous applications, and may render great services to the engineer's art. It traces mechanically and with great precision the funicular curves or polygons which play so large a part in the problems of statics. Such problems as the centre of gravity, momenta of inertia, elastic curves and the like, are solved with great rapidity and accuracy.—On submarine countermines, by M. A. Trève.—On the new star in the nebula of Andromeda. Observations of Brooks' comet made at the Observatory of Paris (equatorial of the West Tower), by M. G. Bigourdan.—Numerical tables intended to facilitate the calculation of the ephemerides of the minor planets, by MM. O. Callandreau and L. Fabry.—On the mixed haloid and other derivatives of methylene, by M. Louis Henry.—On the fermentation of bread-stuffs, by M. Aimé Girard. From numerous researches instituted to determine the true character of the phenomenon by which the dough is changed into bread, the author concludes that the transformation is the result of alcoholic fermentation.—Researches on the morphology and anatomy of ferns, by M. P. Lachmann.—Disposition of the artesian waters in the Wed Rir' and throughout the Lower Sahara in general, by M. G. Rolland. In this paper the author sums up the results of observations continued for a period of six years on the underground supplies in the vast depression of the Shott Melrir in Algeria and Tunis.—Application of the laws of thermo-chemistry to geological phenomena: ores of manganese, by M. Dieulafait.—Note on a therapeutic operation, to which the name of "dielectrolysis" has been given, by M. A. Broudel.—Trigonometric study of a pyramid whose base is the triangle of Pythagoras, by M. G. Petrowitsch. The sides of the base being respectively related as the number 3, 4, 5, the faces of the pyramid satisfy the relation $3^3 + 4^3 + 5^3 = 6^3$, the number 6 being the measure of the right-angled triangle of the base.

Berlin

Physiological Society, July 17.—In consequence of a doubt expressed on a former occasion in the Society, Dr. H. Virchow had examined more minutely the eye of the frog, and had come to the conviction that it possessed a beautiful ciliary muscle with long fibres, which, as in the case of all other animals, composed the posterior and outer part of the ciliary body. The ciliary body, as was known, filled out the corner arising from the choroid, which closely adjoined the sclerotic, curving itself round to the iris at the point where the sclerotic passed into the cornea, and, besides the muscle, consisted of the pigmentary fold and a network of fibres, the ligamentum pectinatum iridis, which Dr. Virchow had searchingly investigated in a large number of animals. This network of fibres was so little developed in man as hardly to merit any consideration there. In other classes of animals, however, it attained a very remarkable development. The speaker gave a more detailed description of the course of the fibrous lines of the network, which presented a great multiplicity in the different animals. The fibres separated by larger interstices now pursued a principally posterior direction, now spread radiating from their place of origin at the union of the sclerotic and cornea, now they were developed more anteriorly, reaching far into the iris. By means of numerous diagrams and several preparations these anatomical relations were illustrated in greater detail. In regard to the physiological significance of this network of fibres the speaker was of opinion that they performed a mechanical function, but he dissented from the assumption put forth by some authors that the ligamentum pectinatum was the tendon of the ciliary muscle. Such an assumption was at variance with the fact that in the case of man, whose eye possessed powerful ciliary muscles, the ligamentum pectinatum was but weakly developed, whereas in other animals with a very weak ciliary muscle it was strongly developed. The fibres of the ligamentum pectinatum might operate as antagonists to the ciliary muscles in those cases in which they were especially directed posteriorly. In such cases, on the other hand, in which the fibres were developed more to the anterior side and passed into the iris, they would probably serve as antagonists to the musculus sphincter pupillæ. It was still more probable that by their radiation towards the membrana limitans they afforded support and hold to the fibres of the ligamentum suspensorium of the lens, establishing themselves at the other side of this membrane. This relation was brought very close by the course of the fibres, particularly in the case of the anthropoids.—Herr Aronsohn made some additions to his former communications on the physiology of the sense of smell. The most minimal quantities of clove oil and bromine, which dissolved in 0·6 per cent. of common salt solutions, he was yet able to smell distinctly, tallied very well with the most minute quantities which Valentin had found perceptible by the sense of smell in the air. By electrical stimulation of the olfactory nerve he had also been able to call forth distinct sensations of smell in some other trustworthy persons. The physiological common salt solution of the temperature of 40° C. he had previously found to be entirely indifferent to the olfactory nerves. Were a part of the common salt replaced by other salts, then, according to the nature of the salt, different, mostly somewhat large, quantities of the salt (osmodic equivalents) had to be taken in order to form an indifferent solution. These osmodic equivalents Herr Aronsohn had now exactly determined for a series of salts. Finally, in order to demonstrate that there were special fibres in the olfactories for special smells, he had hebetated his own sense of smell for a certain quality of smells, that, namely, of sulphuret of ammonium, and had convinced himself that, though, indeed, no longer able to perceive this smell, he was yet very well able to smell ethereal oils.—Dr. Benda spoke of a series of preparations of sensory and motory nerve-endings which he had exhibited in the Demonstrating Hall. They were prepared according to a new process recommended by Dr. Meys. The process consisted in adding arsenic acid to a chloride of gold and potassium. By means of this reagent the nerve-endings were made very beautifully visible, but in this way the epithelia were destroyed, and in order to preserve these likewise, Dr. Benda had further added to the fluid either chromic acid or alcohol. The exhibited preparations showed very clearly that the medullary motory nerves ended in Kühne's terminal plates, besides which in one case a marrowless, and certainly sensory, nerve-fibre, ending in a bifurcated ramification, could be distinctly traced. Marrowless fibres ended in an umbellate form, each single fibre on the muscle passing into a button-like swelling. These fibres, Dr. Benda held to be motory. There were further shown the nerve-endings in the papillæ of the tongue, in the Paccinian corpuscles, in the cornea, and in the skin of the neck.—Dr. Kossel spoke of some important chemical relations of the cell nucleus, of that constituent of it, namely, which morphologists denoted as chromatine, and chemists as nucleine. As products of decomposition of the nucleine he had formerly obtained three nitrogenous bases: xanthine, hypoxanthine, and guanine. Quite recently he had obtained, though, to be sure, only in very small quantities, from the nucleine, a fourth base, namely, adenine, discovered by him some time ago in the glands of the abdomen. After he had prepared 3 g. of this substance, he treated it with nitrous acid, and received as a product of the decomposition of adenine, hypoxanthine. When he treated guanine in the same manner he received xanthine. It was therefore probable that the first products of decomposition of the nucleine were adenine and guanine, and that from these, first hypoxanthine and then xanthine were formed. The chemical relations of these four bases were best rendered evident by their chemical formulæ:—

Adenine ...	$= C_5H_5N_5$	Guanine ...	$= C_5H_5N_5O$
Hypoxanthine	$= C_5H_4N_4O$	Xanthine ...	$= C_5H_4N_4O_2$

All the four bases stood in intimate relation to prussic acid, CHN, which by the action of caustic alkali was obtained from them in very large quantities, while other albuminous bodies under similar treatment yielded very little prussic acid, or none at all. It was doubtless of great importance that nuclei ne stood in such intimate relation to cyanogen. What part, however, the cyanogen bodies played in the cell nucleus was as yet unknown.

VIENNA

Imperial Academy of Sciences, June 5.—On the determination of the halogens of organic bodies, by K. Zulkowsky.—On the products of reduction of the nitro-azo-compounds and on azo-nitrolic acids, by T. V. Janovsky.—On the action of rock-crystal in the magnetic field, by T. Tumlirz.—On the distribution of heat on the earth's surface, by R. Spitaler.—Mycological researches, by H. Zukal.—Ideas on the prophylaxis and therapeutics of cholera, by L. Kastner.—On the fossil chalk-elements of the Alcyonidæ and Holothuridæ and other recent forms, by Ph. Pocta.—On the temperature of the Austrian alpine regions, by T. Hann.—Determination of the trajectory of the Comet VIII. 1884, by S. Oppenheim.

June 11.—On the behaviour of liquid and gaseous bodies under the greatest variations of atmospheric pressure, by C. Puschl.—On the electrical resistance of copper at the lowest temperature, by S. Wroblewski.—On the formation and dissolution of white blood-corpuscles (a contribution to the theory of leukœmia), by M. Loewit.—On the basalt of Kollnitz (in the Lavant valley, Carinthia), and on its vitreous cordierite-enclosures, by K. Prohaska.—Report on the experiments on the use of boiling oxygen, nitrogen, carbon oxide, and atmospheric air as refrigeratives, by K. Olscewski.—On the destruction of tartaric acid at higher temperatures under the presence of glycerine, by K. Tavanovitsch.

June 18.—Experiments on the chemical action of light, by T. M. Eder.—On the volumetric determination of phenol by bromine, by K. Weinreb and C. Bondi.—On the anatomy of Tyroglyphidæ, by A. Nalepa.—On the decomposition of didymium into its elements, by C. Auer von Welsbach.

CONTENTS

THURSDAY, OCTOBER 1, 1885

NORTH AMERICAN WATER-BIRDS

The Water-Birds of North America. By S. F. Baird, T. M. Brewer, and R. Ridgway. Two Vols., 4to. (Boston: Little, Brown, and Co., 1884.)

EXPECTATION was roused some years since when tidings came that the "North American Birds" of Prof. Baird, Dr. Brewer, and Mr. Ridgway, of which three volumes had been brought out in 1874, was in process of completion, and at last there appeared two quartos of goodly size under the title of "The Water-Birds of North America," which are not only the sequel to the work just named, but are also issued in continuation of the publications of the Geological Survey of California, of which a single volume on the land-birds of that State, edited by Prof. Baird from the notes of Dr. J. G. Cooper, saw the light in 1870. But, to complicate the matter further, the two quartos now before us form vols. xii. and xiii. of the "Memoirs of the Museum of Comparative Zoology" at Harvard. How all this came about is explained in the introduction by Prof. Whitney, the Californian State Geologist; but the only part that need concern us is the not surprising but still much-to-be-regretted fact that the cost of bringing out the volumes treating of the land-birds of North America was so great as to deter the publishers from continuing the work at their own risk. Most fortunately, then, the combination just mentioned was effected with the result we now see; but it still remains a reproach and humiliation to those interested in birds—not only in North America alone but all the world over—that so excellent a performance was not more encouraged by them. The obstinacy of the public in preferring a bad book to a good one is perhaps observable in almost every science, but that this obstinacy is nowhere more marked than in the case of natural history, and of ornithology in particular may be because it is one of the most popular branches of science, and because nine-tenths of those who pursue it hardly realise the fact that it is capable of serious study. Howbeit we may be sure that the old adage, "*Populus vult decipi*," was not first uttered by a man without worldly knowledge, and to this day experience tells us that it is as true as ever. It will take a long time yet to persuade people that they had better be well informed by an author who writes a book because he knows his subject, than by a badly-informed one who gets up his subject in order to write a book about it—though even this is perhaps saying too much, for many an author, on ornithology at least, has never taken the trouble to learn the rudiments of what he pretends to teach, and if he have but enough self-assurance he will get his claim to instruct allowed by those who are more ignorant than he is.

To all who have been concerned in the production of the text of the two volumes before us we must offer our hearty congratulations, as it is impossible for us to apportion to each anything like his proper share of merit. Besides the naturalists already named, Prof. Whitney states, in his introduction, that in revising the not wholly completed manuscript he has had the assistance of Mr. Allen, so long known as head of the ornithological department of the Harvard Museum, and that gentleman is therefore entitled to our thanks as much as any one of the others; but moreover it is also advisable to look back to the original preface of Prof. Baird, in which he states that "the most productive source" of the new information published in this work "has been the great amount of manuscript contained in the archives of the Smithsonian Institution in the form of correspondence, elaborate reports and the field-notes of collectors and travellers." The most important of these, he goes on to say, are those by the late Mr. Kennicott, and several residents in the then Hudson's Bay Company's Territory—Messrs. MacFarlane, Ross, Lawrence Clark, Strachan Jones, and others—besides Messrs. Dale, Bannister, and Henry Elliott in regard to Alaska and its islands. Now this being the case with respect to the former volume, which treated of the land-birds only, the importance of the labours of these gentlemen ought to be far more manifest in the present volumes, which deal with the water-birds, since an overwhelming majority of them have their home in the vast northern regions of the continent, and are only winter-visitants to most of the States and Territories of the Union. A good deal to our disappointment we find it otherwise. It may be that the late Dr. Brewer, who is believed to have been responsible for the "biographical" portion of these as of the former volumes, had not at his death completed the examination of the unpublished materials at his disposal; but certainly there is not so much information from American sources as we had hoped or even expected. On the other hand, European authors are freely, not to say redundantly, laid under contribution for such species as are common to the two continents, which it is needless to say are many. Of this we do not complain, though we confess we should rather have learned how these species behave themselves on the other side of the Atlantic; but there is a want of discrimination as to the opportunities possessed by the different observers quoted, and a lack of proportion as to the value of their observations. We do not say that this is not pardonable, perhaps it was unavoidable; but it is unfortunately no less a drawback; and, to make it worse, several instances might be cited in which absolutely contradictory assertions are reprinted without any attempt to indicate which is thought to be the more worthy of belief; while a good many of the statements to which this objection does not apply are but vain repetitions.

Passing to the descriptive part of the work, we do not hesitate to declare that, so far as we have been able to test it, it is excellent. The "specific characters" given seem really to deserve their name, since they indicate the species, and are not, as has lately become so common, drawn from an individual example. Moreover, they are sufficiently brief to be useful, for we have unfortunately entered upon days when specimens are described at a length that absolutely precludes the practical application of the description. Nothing marks more distinctly the difference between a naturalist and a book-maker than the being able to perceive and to tersely express the characters that are essential to the differentiation of a species. Among ornithologists, merely to cite the example of one who is gone, it seems to have been this faculty that gave the late Mr. Gould such a wonderful pre-eminence among his contemporaries. Others unquestionably far surpassed him as scientific ornithologists, indeed the scientific value of his works is very slight; but hardly any one had such an eye for a species, or could in a dozen words or so point out how it could be recognised. It is no doubt in consequence of this that so few of the species described by him have failed to be considered good by his successors.

The ornithologists of the New World are in one respect very fortunate. They are not encumbered by the enormous dead weight of synonomy that is so burdensome to their brethren of effete Europe; and, thanks to the steadfastness with which the North Americans follow the use of a nomenclature fixed by authority, they will probably be for ever exempt from much of the evil which afflicts the more independent writers of the Old World, almost each of whom likes to be a law unto himself. Whether the nomenclature now accepted in the United States and in Canada be founded on the best principle is a matter that need not be here discussed. It has been reduced to a practice the real advantage of which none can doubt. But that this state of things is possible arises in great measure from the fact that in one sense a very small number of North American birds have an ancient history such as is possessed by nearly all the European species, though of this ancient history the compilers of synonymy in general give but a feeble notion. Few things are more misleading than a long list of synonyms, such as is too often regarded as a test of an author's industry and knowledge. It almost always happens that in a list of this kind bad accounts and good are made to appear as though they stood, as it were, on an equal footing, and it not unfrequently occurs that a reference to the best account of a species may be wholly omitted, while a fantastic name introduced by some compiler or catalogue-maker, who perhaps never examined or even set eyes on a specimen, receives notice as if it were an important contribution to the history of the creature. If Americans suffered from this grievance to the same extent as Europeans do, we suspect that the ingenuity of the former would lead them to find some remedy for it, but they may bless their stars that they are comparatively free from it.

Every well-informed ornithologist knows that the systematic arrangement of birds presents a series of puzzles which as yet defy solution. Still, some steps towards the clearing away of the old trammels have been taken by various persons, and a few positions that may be looked upon as established have been gained. We are sorry to find so little in these volumes suggestive of further advance. The writers seem to be still enchained in the toils which the artificial system of Sundevall drew around the subject, and in the very brief space—barely two pages—thereto devoted, we have "altricial" and "præcocial," "gymnopædic," and "dasypædic" groups spoken of as if they were to be believed in. It is true that the arrangement adopted is said to be "not strictly natural;" but in the same paragraph are some other statements as to affinities or the reverse that we hope the author may live to repent. However we freely admit that the main object of these volumes is not to teach systematic ornithology, and therefore perhaps the less said on that contentious subject the better. They will, there can be no doubt, admirably fulfill the chief purpose for which they are intended, and enormously further the study of birds in English-speaking America. It would be out of place here to enter upon any minute criticism of their contents, and, while indicating in a general way, as we have attempted to do and as we conceive we are in duty bound, some of their shortcomings, we can strongly recommend them as on the whole justifying the high degree of expectation that had prevailed concerning them prior to their publication. Assuredly we shall have to wait long before another so comprehensive and, taking it all in all, so excellent an account of "The Water Birds of North America" is likely to make its appearance, and once more we tender our thanks to each and every one of those who have been concerned in the work, though we may perhaps make a reservation in regard to the wood-engraver.

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. No notice is taken of anonymous communications.*

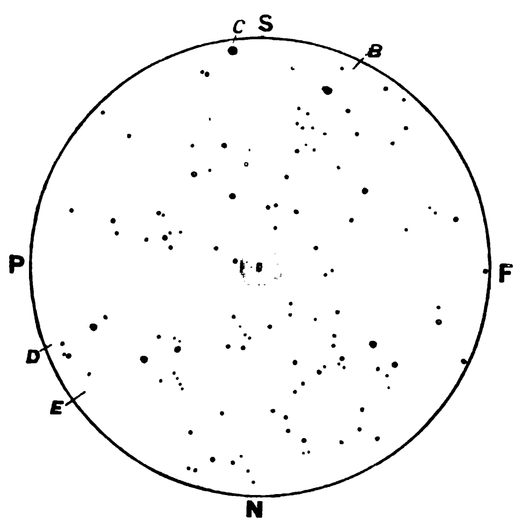
[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The New Star in Andromeda

THE information furnished by a photograph of the Great Nebula in Andromeda taken last year may be of value, particularly in relation to the presumed variability of the new star. An examination shows that no star brighter than about the 15th magnitude was then in the position now occupied by the new star.

This photograph was a trial plate taken on August 16 between 10h. and 11h., with an exposure of 30 minutes of the 3-foot reflector. With this exposure the impression of the nebula is very

FIG. 1.



Scale 0·1 inch = 100″.

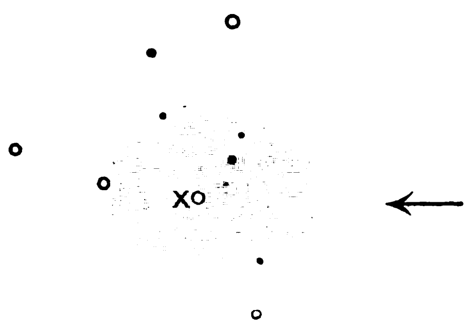
small for such a bright object as it appears in the telescope, being limited to about 2 minutes of arc around the nucleus (which was bright and round), not much more than is shown on a photograph of the Crab nebula with the same exposure, and not nearly so much as, though a little brighter than, a photograph of the Dumb-bell nebula taken a few days after. A great number of stars are to be seen. A defect in the apparatus then being used for the first time has caused a tilt of the plate and a consequent want of sharpness on one side, but the definition in the centre of the field is not injured.

To give some idea of the stars that can be seen and the value that may be given to photographic evidence of the existence or non-existence of faint stars, I give some particulars of this photograph. Without a magnifier 124 stars are to be seen within a radius of twenty minutes of arc from the nucleus.

I have traced these (see Fig. 1) so that they can be identified in the telescope; some of them may not be less than 13th magnitude, possibly fainter; the bright stars marked B, C, D, and E being shown in Argelander's maps of the Northern Heavens. B and C are at the present time about the same brightness as the new star, and can be well used to watch any variation in its light (when first seen by me on September 3 the new star was very much brighter than B or C, almost as bright as a star I have called A in my note-book that is just beyond the smaller nebula).

Using a magnifier to detect any fainter stars I find six near the nucleus: these I have shown as black dots on Fig. 2, using a

FIG. 2.



Scale 0·4 inch = 100″.

circle to show the stars near the nucleus that appear on Fig. 1, and a cross (×) to indicate the place of the new star. At this particular place there is not the slightest indication of any difference in the regular shading of the deposited silver from the denser part of the nucleus to the faint edge. The six stars indicated are extremely faint in the photograph and difficult to see, but I have no doubt of their real existence; from a comparison with other photographs I estimate them of about 15th magnitude, perhaps fainter. It may be that some of these may be identified at Birr Castle. From the absence of scale and orientation of the sketch given by Lord Rosse on p. 465 comparisons cannot be made, but a reference to the note-books would enable this to be done. A. A. COMMON

DURING last week I examined on three evenings the spectrum of this star apparently in the nebula. It appears to be continuous, extending from about D, as far as, or perhaps a little past F. Both Mr. Percy Smith and I are able to confirm Lord Rosse's conviction of the existence of a bright line or band. We compared its position with spark spectra, and feel satisfied that its position is not far from the bright line of the spark in air near to, and on the more refrangible side of D. The slit was of course necessarily wide, and the spectrum faint, so that this must only be considered as approximate.

GEO. M. SEABROKE

Temple Observatory, Rugby, September 29

IN the first evenings of September I observed the new nucleus of the nebula in Andromeda: I find it of the 8th magnitude. With a little Maclean's star spectroscope applied to the 10-inch refractor the spectrum of the nucleus is continuous, with suspected brighter bands. On the nights of Sept. 14 to 16, with 340 and 470 enlargements, I found to the east of the nucleus, and 15″ to 18″ distant from it, a faint object, probably a second nucleus, of 12th to 13th magnitudes. A. RICCO

Palermo Observatory

The Proposed Change in the Astronomical Day

IN your account of the proceedings at the recent meeting of the Astronomische Gesellschaft at Geneva (NATURE, vol. xxxii. p. 517) Dr. Struve is reported to have stated "that in the Royal Astronomical Society the majority were in favour of th universal day." There appears to be some mistake here: the Royal Astronomical Society as a body has not expressed any opinion on the subject. And, judging from the individual expressions of opinion which have been published, I should imagine that here, as at Geneva, the majority of real workers in our science (with the probable exception of those engaged on solar work) would be opposed to the proposed change. But how the majority of the Fellows of the Royal Astronomical Society could vote on the question it is impossible to say. My desire that a wrong impression on this subject, arising from a statement reported to have been made by such a high authority as Dr. Struve, should not be spread abroad, must be my excuse for trespassing thus far on your space.

A. M. D. DOWNING

Royal Observatory, Greenwich, S.E., September 26

A Tertiary Rainbow

PROF. TAIT remarks, in his recently-published work on "Light," that rainbows due to three or more internal reflections "are too feeble to be observed." It may therefore be worth recording that a tertiary bow was clearly visible from Thandiani Hill, Punjab, one evening last week (August 17). The bow extended over an arc greater than a semicircle, but was broken in two places. The colours were as distinct as in many an ordinary bow.

The condition of the sky was specially favourable for seeing a tertiary bow. The sun was low, and on nearly the same level with it there were several horizontal layers of cloud of considerable extent, whose nearer, unilluminated sides were therefore dark enough to serve as a good background for the bow. There was also a cloud in front of the sun itself, partially reducing its brightness. T. C. LEWIS

August 25

A White Swallow

ON August 3 I saw a white swallow flying among its fellows over a mill-pond at Garioch's Ford, Auchterless, Aberdeenshire. When I repassed on the following day it was still there, and it appeared to my brother and to me to be *entirely* white: otherwise I should suggest that the one seen in Westmoreland on September 4 (NATURE, No. 830, p. 500) might be the same bird on its southward pilgrimage. If it is true that the albino bird is never courted or paired ("Descent of Man," chap. xiv.) we are not likely ever to see many white swallows.

Mirfield, Yorks, September 28 ALEX. ANDERSON

THE enclosed paragraph from Yarmouth, in the *Norfolk News* of this day, will have interest for your correspondent at Milnethorpe. HUBERT AIRY

Stoke House, Woodbridge, September 26

Rara Avis.—A cream-coloured specimen of the swallow (*Hirundo urbica*) was shot on Caister Road, on Monday morning last, by Mr. A. Patterson. It is now in the hands of Mr. B. Dye of Row 60 for preservation.

DURING the summer of 1883 Mr. Cooper, of Bromwich, observed a white swallow throughout the season at a place within the city on the banks of the Severn. J. LL. BOZWARD

Worcester, September 28

THE ANNUAL CONGRESS OF THE SANITARY INSTITUTE OF GREAT BRITAIN

THE subjects dealt with by the Sanitary Institute of Great Britain at its annual meetings cover a wide field, and the Leicester gathering of this year, under the presidency of Prof. de Chaumont, F.R.S., forms no exception to the rule. The first aim of the Institute is, through its various agencies, to assist and indeed to lead in the improvement of public health, and the President did well to prove, by mortality statistics, how great a saving of life can be effected by the adoption of efficient sanitary measures, and how remunerative expenditure in this direction proves itself to be. The result of the sanitation carried out in the Army, and which is so much due to the labours of the late Dr. Parkes and to those of his successor, Dr. de Chaumont, is that, comparing the results of thirty years ago with those which now obtain, there is a saving in the home Army of two battalions per annum. Some substantial progress is also being made in the same direction as regards the general public, and when it is more fully understood that preventible diseases as a rule destroy those members of the population who are most remunerative in so far as the State is concerned, and that, speaking generally, each such premature death means a loss of at least 100*l*., even parsimonious members of sanitary authorities will not mind expending a little more of the public money in so good a cause.

Leicester was well chosen for this year's gathering, for in many respects the town has acquired some reputation in health matters. It may be regarded as the head-quarters of the anti-vaccination party; it prides itself, not without cause, on the efforts it has made to control the spread of infectious diseases; and it takes precedence amongst those English towns in which autumnal diarrhœa is so fatal to the infantile population. As regards the question of vaccination it would be premature to draw any general inferences from the Leicester results, for although during recent years only a comparatively small portion of the infantile population have been vaccinated, yet a vast majority of the inhabitants are fairly well protected against small-pox, and it is by no means so very strange that a disease which usually recurs in an epidemic form only after a lapse of years, should for a time remain absent from Leicester. Still, we frankly admit that the day of reckoning has been somewhat long in coming; but there are exceptional reasons for this. And in the first place we would note that Leicester is not so free from small-pox as is generally imagined. The Registrar-General's returns have, it is true, long shown an almost absolute blank as regards small-pox mortality there, but it must be remembered that the Leicester Small-pox Hospital, where the deaths from this disease take place, is not in the borough, and hence that the mortality occasioned is registered in altogether another district. Then again, the sanitary authority of Leicester, by the aid of a system of compulsory notification of infectious diseases, acquire the earliest knowledge as to the existence of cases of small-pox, and having provided themselves with an isolation hospital, the patients are at once removed, and their houses and clothing are efficiently disinfected. It may be said that any other town could do the same, and so vaccination would become unnecessary. But this is not so. Removal to hospital is only compulsory under conditions which, were objection raised to it by the people, would make this early isolation impracticable, and all populations are not so proud of their defiance of one of the laws of the country as to submit without resistance to the steps which are held necessary in order to prove that this law is a superfluous one. But Leicester goes much further than this. The authorities not only remove the sick, but they remove the healthy members of the sick person's family, and hold them in a species of quarantine until they know that they have escaped infection. Such a step may be very desirable from a health point of view, but it is altogether illegal, and it is quite certain that if any attempt were made to enforce such a system in other parts of the kingdom it would be resisted. The majority of the nation would also hold it to be unnecessary; and the recent publication by the German Government of the Report of a Commission showing that since re-vaccination was made compulsory in 1874 not a single death from small-pox has occurred in their Army, affords ample evidence that the simple operation of vaccination can fully meet all the difficulty.

But little further light was thrown, at the meeting, upon that obscure zymotic diarrhœa which annually causes so large a mortality in Leicester. But Dr. E. W. Buck, who has made the subject a special study, probably pointed out the essential cause of this fatality by showing how a large portion of the population of Leicester was exposed to the influence of a water-logged soil charged with decomposing organic matter. Temperature so largely influences this mortality that it was at one time regarded as its sole cause; but it is certain that a high temperature alone is powerless to produce it, whereas the effect of temperature on such conditions as obtain in Leicester must be very potent in favouring the development of organic germs, such as are now supposed to lie at the root of the evil. Extensive inquiry is needed as to this subject, and we hope that the results of the investigation which have been conducted for some years past by the Medical Department of the Local Government Board will soon be made public.

Amongst the many other matters of interest which were dealt with at the Congress is that of the provision of dwelling-accommodation for the working classes, and in view of the steadily extending practice of massing together vast numbers of human beings in great buildings where storey is piled upon storey, the warning uttered by Mr. Gordon Smith, President of the Engineering and Architectural Section, and the occupant of an important official appointment which adds weight to his opinion, should receive careful consideration. He asserts that in this class of buildings there has been an excessive infantile death-rate, and it is certain that the provision of ample open space about dwellings, which is, as regards ordinary dwellings, being more insisted on than ever, is especially necessary in the interests of child-life, which is so extremely sensitive to such insanitary surroundings as influence the quality of the air breathed.

The question of a rational system of burial was discussed at the last meeting of the Congress in connection with a paper by the Rev. F. Lawrence, who quoted the authority of the burial service of the Church of England as suggesting a system which would allow of the rapid action of the soil upon the dead, and who advocated burial at a depth of three or four feet only in coffins designed to ensure speedy perishability, and laid singly at a depth of three or four feet only from the surface. The advocates of cremation were naturally represented, but the progress of this method for the disposal of the dead is hindered by considerations which it is not easy to overcome. Foremost amongst these stands the difficulty of tracing cases of poisoning, and, even if the public were ready to assent generally to post-mortem examinations before the cremation was carried into effect, no such examination as is usually carried out could be trusted to decide whether this species of crime was the cause of death or not. Indeeed, in many cases of poisoning the most skilled pathological and chemical knowledge is required in order to avoid error. On the whole, such discussions as have taken place at Leicester tend to improvement in matters where change is desirable in the interests of public health, and the Institute may be congratulated on the results of their recent meeting.

INSECT RAVAGES

THE preservation of our garden and field crops from the attacks of injurious and destructive insects is a study which Miss E. A. Ormerod has made specially her own and which she has carried out with such signal success. Miss Ormerod's labours in popularising the subject so as to bring it within the knowledge of all classes in any way connected with agricultural and gardening pursuits are too well known to need even a reference, so thoroughly has she at heart the welfare of our food crops and field produce that she has taken other steps, besides the dissemination of her well known books, to bring the importance of the subject before those who are not likely to be reached by the works in question. We refer to the prize offered by her at an agricultural show held at Frome last year, the result of which was satisfactory in drawing a considerable amount of attention to the subject, and one of the outcomes of which has been the preparation of a series of object lessons, so to speak, which have been elaborated from the plan of Mr. W. H. Haley, who took the prize at Frome last year. The plan ot these lessons is as follows:—One insect is taken as an example and the life-history of this particular insect is illustrated by showing the creature in all its stages of development where practicable, or by neat and accurate-coloured drawings of pupa, larva. and perfect insect, each stage of which is carefully labelled, then a spray or twig of the plant attacked, or a model showing the insect's ravages is given, and in many cases also the parasites which attack the insect itself. Beneath this is carefully printed the life-history of the particular insect, and an enumeration of the plants upon which it feeds; and, finally, under the head of "Prevention and Remedies," some brief but concise instructions how to proceed to rid one's crops of the pest. All this is arranged on a cardboard mount 12 inches long by 8 inches wide, and placed in a box with a glass cover, so that one insect only is treated of in one case, thus making the information imparted very clear, and preventing all confusion. Of the insects treated in this way are the turnip and cabbage gall weevil, turnip moth, turnip fly, cabbage aphis, large white cabbage butterfly, cabbage moth, vine beetle, bean beetle, pea and bean weevil, winter moth, American blight on apple, magpie moth on gooseberry, celery-leaf miner, silver moth, beet or mangold fly, click beetle and wireworms, goat moth, lacky moth, daddy-long-legs, and onion fly.

Twenty of these cases have recently been prepared by Mr. Mosley, of Huddersfield, under the superintendence of Miss Ormerod, and are now in the museum at Kew, and a set of ten of a similar character are to be placed in the Aldersey School of the Haberdashers' Company at Bunbury, Cheshire, where plain teaching on such subjects is being satisfactorily carried on. J. R. J.

AMERICAN AGRICULTURAL GRASSES[1]

HOWEVER complicated the systematic synonymy of the Gramineæ may be, the popular nomenclature of the grasses is probably in an even more unsatisfactory state. In the former case the name of the author appended to the scientific name of the plant is usually sufficient to dispel any ambiguity as to what particular plant is meant, even though that plant may have received half a dozen systematic names from as many different botanists. In the case of the trivial name, however, even this means of identification is lacking, and it is no uncommon circumstance to find the same name applied to several different grasses, each one of which may, moreover, have one or two additional names. To those who are studying the grasses in their agricultural aspect this confusion is very perplexing, particularly as both the English and the American agricultural journals usually refer to a grass by its trivial name. The difficulties which surround this subject are well exemplified in the volume before us. For example, in American agricultural publications the term "salt-grass" is frequently met with, and we searched this volume in the hope of finding out the species so denominated. But instead of one we find no less than four distinct species, in as many genera, called "salt-grass," namely, *Vilfa depauperata*, *Sporobolus airoides*, *Brizopyrum spicatum* (*Distichlis maritima*), and *Spartina juncea*. To an English agriculturist foxtail means *Alopecurus pratensis* only, whereas in America the name is also given to *A. geniculatus*, *Hordeum murinum*, *H. jubatum*, and *Setaria setosa*. Rye-grass in England is *Lolium perenne*; in America the term is applied in addition to four species of Elymus. Blue grass is the name given to four distinct species of Poa, varying considerably in their agricultural value, and one of these, *P. pratensis*, often spoken of as Kentucky blue-grass, is also called "June grass," "spear grass," and "red top," the last name being equally applied to *Agrostis vulgaris*. Bunch grass is more vague in its application, for it embraces at least six species in five genera, while in Canada the same name is given to two other grasses, *Elymus condensatus* and *Kœleria cristata*, the former of which is known in the United States as "giant rye grass." The term "goose grass," which in England is restricted to the rubiaceous hedgerow weed *Galium Aparine*, is, in America, applied to *Poa annua*, which is also called annual spear grass, and to *Panicum Texanum*, further known as Texas millet. The grass *Holcus lanatus*, which to all English farmers is known as Yorkshire fog, is variously termed velvet grass, velvet mesquite, satin grass, and meadow soft grass, this last term being also current in England.

There are about 600 species of grasses in the United States, a few only of these having been introduced. The work under notice embraces descriptions of 120 species, each accompanied by a plate. Of these, about forty, included under twenty-six genera, are identical with British species. Five additional British genera are represented, but not by British species; these are Elymus, Melica, Spartina, Stipa, Triodia. About a dozen British genera do not appear, the most noteworthy among these being, perhaps, Brachypodium, Briza, and Cynosurus. Two dozen of the genera enumerated are extra-British; the chief ones are Andropogon, Aristida, Bouteloua, Buchloë, Danthonia, Muhlenbergia, Paspalum, Sorghum, Sporobolus, and Zizania. The so-called buffalo grasses are *Bouteloua oligostachya*, *Stipa spartea*, and *Buchloë dactyloides*; the first two may be gathered in quantity by any one who travels across the Canadian prairies, but the last-named, which is regarded as the true buffalo grass, does not extend into Canada.

In upwards of 100 pages of text we find collected much information both of botanical and of agricultural interest. The structural and economic characters of each grass figured are detailed at some length, but Dr. Vasey has, perhaps wisely in a work of this kind, made no attempt at classification. Though systematic synonyms are seldom given, there is a lavish display of trivial ones, for which the agricultural reader, at all events, will be grateful. Orthographic blunders are rather numerous, and the index might be more complete. The term *chartaceous* ("the texture resembling paper or parchment in thickness") is, we believe, not current on this side of the Atlantic; let us hope we may do without it.

The chemical analyses are of much agricultural interest, and readers should compare the results here given with those obtained by Wolff in his analyses of German grasses. The figures before us serve to show how considerably the same gramineous species may vary in composition according to the soil and climate in which it is grown, this point being specially illustrated by analyses of *Phleum pratense* and *Dactylis glomerata*, each from half a dozen different localities. How variable is the composition of gramineous herbage generally is well shown in the following table, in which are given the highest and lowest percentages of the constituents named, obtained in 136 analyses of different species of grasses:—

Dry substance	Highest	Lowest
Ash	19·24 ...	3·57
Fat	5·77 ...	1·48
Nitrogen free extract	66·01 ...	34·01
Crude fibre...	37·72 ...	17·68
Albuminoids	23·13 ...	2·80

[1] "The Agricultural Grasses of the United States." By Dr. George Vasey, Botanist of the Department of Agriculture; also, "The Chemical Composition of American Grasses," by Clifford Richardson, Assistant Chemist. (Washington: Department of Agriculture, 1884.)

A process which has been the means of throwing much light on problems in vegetable physiology and agricultural chemistry, namely, a comparison of the analyses of a plant and of its separate members in different stages of growth, has been applied to fifteen familiar species of grasses, and the results are tabulated and briefly discussed.

Many useful suggestions, some of them of the highest practical importance, are to be met with in these pages. Here is one by Prof. Asa Gray which refers to the Teosinte, or Guatemala grass, *Euchlæna luxurians*, a native of Mexico and Central America, and has the true ring of progress about it:—

"To make the *Teosinte* a most useful plant in Texas and along our whole south-western border the one thing needful is to develop early-flowering varieties, so as to get seed before frost. And this could be done without doubt if some one in Texas or Florida would set about it. What it has taken ages to do in the case of Indian corn, in an unconscious way, might be mainly done in a human lifetime by rightly directed care and vigorous selection."

This volume is highly creditable to its authors, and it adds one more to the many useful publications which have emanated from the United States Department of Agriculture. W. FREAM

THE DEVELOPMENT OF THE CÆCILIANS

IN a letter recently published in the *Arbeiten aus dem zoologisch-zootomischen Institut in Würzburg*, Messrs. P. B. and C. F. Sarasin give a preliminary account of the development of *Epicrium glutinosum* as observed at Peraderinia in Ceylon, where these naturalists have taken up their quarters near the celebrated Botanical Gardens. Since the original discovery by Johannes Müller of the larval form of the Cæcilians, almost the only information obtained on this important subject is a short account of the gilled larvæ of *Cæcilia compressicauda* by Peters, founded on specimens procured by Jelski in Cayenne.

The brothers Sarasin show that *Epicrium* is not viviparous, as is *Cæcilia*, but oviparous. In the most advanced stage before hatching the embryo is provided with very long blood-red external gill-filaments, and has also a distinct tail with a strong fin. The gill-filaments are shed previous to the hatching, after which the young Cæcilians make their way to the neighbouring stream, and live in the water, breathing by means of gill-slits. After they leave the water their gill-slits close up, and they breathe by lungs. The brothers Sarasin compare these Cæcilians to Urodeles, in that they pass through the perennibranchiate stage in the egg. As larvæ they are derotrematous, and in the adult stage become true land-animals like Salamanders. Our authors also show that the spermatozoon has a spiral filament, and that there is a fourth gill-arch, from which the pulmonary artery is given off. Both these facts tend to show that the Cæcilians are more nearly allied to the Urodeles than to the Anurous Amphibians.

THE BRITISH ASSOCIATION

REPORTS

Fifth Report of the Committee, consisting of Mr. R Etheridge, Mr. Thomas Gray, and Prof. John Milne (Secretary), appointed for the purpose of investigating the Earthquake Phenomena of Japan. (Drawn up by the Secretary).—On account of an excursion which I have the intention of making during the coming summer to Australia and New Zealand, I am compelled to draw up this report a month earlier than usual. As the only time when the work of attending to observations and experiments repays itself is during the winter months, I may safely say that my intention of shortening the time usually devoted to earthquake observations is not likely to involve any serious loss. The number of earthquakes felt during corresponding periods in two previous years and this last year were respectively twenty-six, thirty-nine, and eighty, and not only have the earthquakes been numerous, but some of them have been pretty stiff, as is testified by the fact that on several occasions chimneys fell and walls were cracked. The work done during the last year is briefly as follows:—

Seismic Experiments.—Seismic experiments were commenced in conjunction with Mr. T. Gray in 1880. The movements then recorded were produced by allowing a heavy ball, 1710 lbs. in weight, to fall from various heights up to thirty-five feet. Subsequently many experiments were made by exploding charges of dynamite and gunpowder placed in bore-holes. During the last year, whilst working up the long series of records which accumulated, several laboratory experiments were made to investigate the methods to be employed when analysing the diagrams of earth motion. The first of these experiments consisted in projecting a small ball from the top of a tall flat vertically-placed spring, and at the same time causing the spring to draw a diagram of its motion. From the distance the ball was thrown its initial velocity could be calculated. From the diagram, either by calculation on the assumption of simple harmonic motion or by direct measurement, the maximum velocity of movement could be obtained. These three quantities practically agreed. The most important result obtained by these experiments was that they indicated an important element to be calculated in earthquake or dynamite diagrams, and, further, that in these diagrams the first sudden movement, which invariably has the appearance of a quarter-oscillation, ought apparently to be considered as a semi-oscillation. The second set of experiments consisted in determining the quantity to be calculated from an earthquake diagram which would give a measure of the overturning or shattering power of a disturbance. For this purpose a light strip of wood was caused by means of a strong spiral spring and a heavy weight to move horizontally back and forth with the period of the spring. On this strip small columns of wood were stood on end, and it was determined how far the spring had to be deflected and then suddenly released to cause overturning. The more important results of all these experiments are:—

I. *Effect of Ground on Vibration.*—(1) Hills have but little effect in stopping vibrations. (2) Excavations exert considerable influence in stopping vibrations. (3) In soft damp ground it is easy to produce vibrations of large amplitude and considerable duration. (4) In loose dry ground an explosion of dynamite yields a disturbance of large amplitude but of short duration. (5) In soft rock it is difficult to produce a disturbance the amplitude of which is sufficiently great to be recorded on an ordinary seismograph.

II. *General Character of Motion.*—(1) The pointer of a seismograph with a single index first moves in a normal direction, after which it is suddenly deflected, and the resulting diagram yields a figure partially dependent on the relative phases of the normal and transverse motion. These phases are in turn dependent upon the distance of the seismograph from the origin. (2) A bracket seismograph indicating normal motion at a given station commences its indications before a similar seismograph arranged to write transverse motion. (3) If the diagrams yielded by two such seismographs be compounded, they yield figures containing loops and other irregularities not unlike the figures yielded by the seismograph with the single index. (4) Near to an origin, the first movement will be in a straight line outwards from the origin; subsequently the motion may be elliptical, like a figure 8, and irregular. The general direction of motion, is, however, normal. (5) Two points of ground only a few feet apart may not synchronise in their motions. (6) Earthquake motion is probably not a simple harmonic motion.

III. *Normal Motion.*—(1) Near to an origin the first motion is outwards. At a distance from an origin the first motion may be inwards. (2) At stations near the origin the motion inwards is greater than the motion outwards. At a distance the inwards and outwards motion are practically equal. (3) At a station near the origin, the second or third wave is usually the largest, after which the motion dies down very rapidly in its amplitude, the motion inwards decreasing more rapidly than the motion outwards. (4) Roughly speaking the amplitude of normal motion is inversely as the distance from the origin. (5) At a station near an origin the period of the waves is at first short. It becomes longer as the disturbance dies out. (6) The semi-oscillations inwards are described more rapidly than those outwards. (7) As a disturbance radiates the period increases. Finally it becomes equal to the period of the transverse motion. From this it may be inferred that the greater the initial disturbance the greater the frequency of waves. (8) Certain of the inward motions of "shock" have the appearance of having been described in less than no time. (9) The first outwards motion, which on diagrams has the appearance of a quarter-wave, must be regarded as a semi-oscillation. (10) The waves on the diagrams taken at different stations do not correspond. (11) At a station near the origin, a notch in the crest of a wave of shock gradually increases as the disturbance spreads, so that at a second station the wave with a notch has split up into two waves. (12) Near the origin the normal motion has a definite commencement. At a distance the motion commences irregularly, the maximum motion being reached gradually.

IV. *Transverse Motion.*—(1) Near to an origin the transverse motion commences definitely but irregularly. (2) Like the normal motion, the first two or three movements are decided, and their amplitude slightly exceeds that of those which follow. (3) The amplitude of transverse motion as the disturbance radiates decreases at a slower rate than that of the normal motion. (4) As a disturbance dies out at any particular station the period decreases. (5) As a disturbances radiates the period increases. This is equivalent to an increase in period as the intensity of the initial disturbance increases. (6) As we recede from an origin the commencement of the transverse motion becomes more indefinite.

V. *Relation of Normal to Transverse Motion.*—(1) Near to an origin the amplitude of normal motion is much greater than that of the transverse motion. (2) As the disturbance radiates, the amplitude of the transverse motion decreases at a slower rate than that of the normal motion, so that at a certain distance they may be equal to each other. (3) Near to an origin the period of the transverse motion may be double that of the normal motion; but as the disturbance dies out at any given station, or as it radiates, the periods of these two sets of vibrations approach each other.

VI. *Maximum Velocity and Intensity of Movement.*—(1) An earth particle usually reaches its maximum velocity during the first inward movement. A high velocity is, however, sometimes attained in the first outward semi-oscillation. (2) The intensity of an earthquake is best measured by its destructive power in overturning, shattering, or projecting various bodies. (3) The value

$$v^2 = \frac{4}{3} g \sqrt{a^2 + b^2} \times \left(\frac{1 - \cos\theta}{\cos^2\theta}\right)$$

used by Mallet and other seismologists to express the velocity of shock as determined from the dimensions of a body which has been overturned, is a quantity not obtainable from an earthquake diagram. It represents the effect of a sudden impulse. (4) In an earthquake a body is overturned or shattered by an acceleration, f, which quantity is calculable for a body of definite dimensions. The quantity f as obtained from an earthquake diagram lies between $\frac{v}{t}$ and $\frac{v^2}{a}$, where v is the maximum velocity, t is the quarter-period, and a is the amplitude. (5) The initial velocity given in the formula $v^2 = \frac{2a^2}{b}$ (for horizontal projection) used by Mallet as identical with v^2 in 3, are not identical quantities. (6) In discussing the intensity of movement I have used the values $\frac{v^2}{a}$. (7) The intensity of an earthquake at first decreases rapidly as the disturbance radiates; subsequently it decreases more slowly. (8) A curve of intensities deduced from observations at a sufficient number of stations would furnish the means of approximately calculating an absolute value for the intensity of an earthquake.

VII. *Vertical Motion.*—(1) In soft ground vertical motion appears to be a free surface-wave which outraces the horizontal component of motion. (2) Vertical motion commences with small rapid vibrations, and ends with vibrations which are long and slow. (3) High velocities of transit may be obtained by the observation of this component of motion. It is possibly an explanation of the preliminary tremors of an earthquake and the sound phenomenon (4) The amplitude and period of vertical waves as observed at the same or different stations have been measured.

VIII. *Velocity.*—(1) The velocity of transit decreases as a disturbance radiates. (2) Near to an origin the velocity of transit varies with the intensity of the initial disturbance. (3) The rate at which the normal motion outraces the transverse motion is not constant. (4) As the amplitude and period of the normal motion approach in value to those of the transverse motion, so do the velocities of transit of these motions approach each other. (5) That the ratio of the speed of normal and transverse motions is not constant is shown from a table of these velocities calculated for different rocks from their moduli of elasticity.

IX. *Miscellaneous.*—(1) At the time of an earth-disturbance, currents are produced in telegraph lines. (2) The exceedingly rapid decrease in the intensity of a disturbance in the immediate neighbourhood of the epicentrum has been illustrated by a diagram. (3) For the duration of a disturbance due to a given impulse in different kinds of ground, reference must be made to the detailed descriptions of the first four sets of experiments.

Experiments on a Building to resist Earthquake Motion.—In the Report of last year I described a house which rested at its foundations upon cast-iron balls. These balls were 10-inch shell. The records obtained from an instrument placed inside this house showed that, although it was subjected to considerable movement at the time of an earthquake, all *sudden* motion had been destroyed. Although the balls did very much to mitigate earthquake motion, wind and other causes produced movements of a far more serious nature than the earthquake. To give greater steadiness to the house, 8-inch balls were tried, and then 1-inch balls. Finally the house was rested at each of its piers upon a handful of cast-iron shot, each ¼-inch in diameter. By this means the building has been rendered astatic, and, in consequence of the great increase in rolling friction, sufficiently stable to resist all effects like those of wind. The shot rest between flat iron plates. That the house had peculiar foundations would not be noticed unless specially pointed out. From these experiments it seems evident that it is possible to build light one-storied structures of wood or iron in which, relatively to other houses, but little movement will be felt.

Observations in a Pit 10 *feet deep.*—The instrument placed in this pit is similar to all the other instruments, and is installed in a similar position. Comparing the maximum amplitudes, maximum velocities, and maximum accelerations obtained in the pit with those obtained at about thirty feet distance, they are for one particular earthquake respectively in the ratios of 1 : 43, 1 : 52, and 1 : 82. In most earthquakes the extent of motion has been too small to admit of measurement, and that there had been any movement could only be detected by holding the plate on which the record was written up to the light and glancing along it lengthways. This investigation tends to confirm the view which I have previously put forward, that an earthquake at a short distance from its epicentrum is practically a surface disturbance, principally consisting of horizontal movements. The vertical motion is small, and is best seen in the preliminary tremors either of an actual earthquake or of a dynamite explosion. From a practical point of view these results must be of the greatest importance to those who have to erect heavy structures in earthquake districts.

Buildings in Earthquake Countries.—As during the last few years so much destruction both to life and property has taken place in various parts of Europe, it seems that an epitome of the results of observations and experiments carried on in Japan relative to construction in seismic districts might not only be interesting, but possibly it might also be of practical value. When erecting a building it appears that we ought first to reduce as far as possible the quantity of motion which ordinary buildings receive; and, second, to construct a building so that it will resist that portion of the momentum which we are unable to keep out. To reduce the momentum which usually reaches a building the following may be done:—

(1) Institute a seismic survey of the district or area in which it is intended to build, and select a site where experiment shows that the motion is relatively small. (2) For heavy buildings adopt deep foundations (perhaps with lateral freedom), or at least let the building be founded on the hardest and most solid ground. It is perhaps because the tops of the hills in Tokio are harder than the plains that they have relatively the least motion. A building only *partially* isolated may be exceedingly dangerous from the fact that motion entering in the unprotected side will make the excavations (cuttings, valleys, &c.) upon the opposite side into free surfaces which will swing forward through a range greater than they would have swung had the excavations

not existed. (3) For light buildings, especially if erected on soft ground, where the range of motion is always great, if the structure rests on layers of fine cast-iron shot, it cannot possibly receive the same momentum as a building attached to the moving ground. To resist the effects of momentum which cannot be cut off a building: (1) Bear in mind the fact that it is chiefly stresses and strains which are applied horizontally to a building which have to be encountered. A vertical line of openings like doors or windows in a building constitute a vertical line of weakness to horizontally-applied forces. (2) Avoid coupling together two portions of a building which have different vibrational periods, or which from their position are not likely to synchronise in their motion. If such parts of a building must of necessity be joined, let them be so joined that the connecting link will force them to vibrate as a whole, and yet resist fracture. Brick chimneys in contact with the framing of a wooden roof are apt to be shorn off at the point where they pass through the roof. Light archways connecting heavy piers will be cracked at the crown. To obviate destruction due to these causes a system of construction similar to that to be seen in several of the buildings of San Francisco, Tokio, and Yokohama may be adopted. This essentially consists of tieing the building together at each floor with iron and steel tie-rods crossing each other from back to front and from side to side. (3) Keep the centre of inertia of a building or its parts as low as possible. Heavy tops to chimneys, heavy copings, and balustrades on walls and towers, heavy roofs and the like are all of serious danger to the portion of the structure by which they are supported. When the lower part of a building is moved, the upper part by its inertia tending to remain behind often results in serious fractures. All the chimneys in Tokio and Yokohama which have fallen in consequence of their ornamental heads have been replaced by shorter and thicker chimneys without the usual coping. The roof of a portion of the Engineering College rests loosely on its walls, and has therefore a certain freedom. In Manila many heavy roofs have been replaced by roofs of sheet iron. Walls may be lightened in their upper parts by the use of hollow bricks. Such vertical motion as may exist is also partly obviated by light superstructures. Vertically-placed iron tie-rods give additional security. If these and other rules which are the result of experiment and observation could be adopted in earthquake countries, it is certain that the loss of life and property might be greatly diminished.

Earth Tremors and Earth Pulsations.—Notwithstanding the untrustworthiness of level observations, they nevertheless have given results of interest. (1) The bubbles from time to time move back and forth without apparent reason. Considerable changes have sometimes been observed before an earthquake (2) The greatest movement of the bubble of a level takes place during the colder part of the year, which is the season of earthquakes, and also the season when the barometric gradient between Siberia and the Pacific is the steepest. (3) The bubble of a level continues to move long after the sensible motion of an earthquake has ceased, enabling us to study the slow movements which bring an earthquake to a close. (4) When the barometer is very low, as, for instance, during a typhoon, the bubble of a level may be distinctly seen to pulsate back and forth through a range of about ·5 mm. In September of last year, in conjunction with Mr. W. Wilson, C.E., and Mr. Mano, of the Imperial College of Engineering, I carried an instrument to the summit of Fujiyama, which is about 12,365 feet in height, where I succeeded after many failures in recording automatically earth tremors and earth pulsations. But we were unable to remain for more than five days.

The results of interest connected with these observations are:—(1) That the movements on the top of the mountain were much greater than those which I usually observe in Tokio. (2) The tremors, or slight swing-like movements of the instrument, did not necessarily accompany the wind. (3) That during the heavy south and south-east gales the direction of displacement of the pointer was towards the south-east, which is the same result as would be obtained if the bed-plate of the instrument were raised on the south-east side, or if the mountain had tipped over to the north-west. My colleague, Mr. T. Alexander, treating Fuji as a conical solid made of brick, with a wind-load of 50 lbs. on the square foot, found the slope and deflection of a point 100 feet below the apex of the cone. This calculated slope was two or three times greater than the greatest deflection which I measured. As it is difficult to imagine that a mountain could suffer deflection by a wind pressure, I will not insist upon the fact that deflection actually occurred. It is certainly curious that the results of calculation and observation should point in the same direction.

Report of the Committee on Electrical Standards, consisting of Prof. G. C. Foster, Sir W. Thomson, Prof. Ayrton, Prof. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Prof. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead, Mr. Preece, Mr. H. Taylor, Prof. Everett, Prof. Schuster, Dr. J. A. Fleming, Prof. G. F. Fitzgerald, Mr. R. T. Glazebrook, Prof. Chrystal, Mr. H. Tomlinson, and Prof. Barnett, with Mr. Glazebrook as Secretary.—The Committee reported that the Secretary has had constructed a series of coils to serve as standards in terms of the legal ohm. These standards, in accordance with the resolution of the Committee, were constructed on the supposition that the value of the legal ohm is 1·0112 B.A. units. The comparisons were made by the methods given in the reports for 1885 and 1884, and the values found were—

No.	Resistance	Temperature
100	·999515	14·1
101	·998845	14·1
102	10·00415	16·7
103	10·00352	16·75
104	100·0304	16·05
105	100·0436	16·05
106	1000·694	17·4
107	1000·677	17·45
108	10006·8	17·35
109	10006·8	17·35

These standards have also been compared with mercury-tube resistances constructed by Mr. Benoit, of Paris, and a difference of ·00049 legal ohm was found. The legal ohm standards, as constructed by the Committee, exceed by this amount those constructed in Paris. Six coils have been compared with the standards during the year, and the values are given. The Committee hope that arrangements may be made for issuing standards of electromotive force, and for constructing and issuing standards of capacity. In conclusion, they ask to be reappointed, with the addition of the names of Prof. J. J. Thomson and Mr. W. N. Straw, with a renewal of the unexpended grant of 50*l*.

Report on Electrical Theories, by Prof. J. J. Thomson.—This report deals exclusively with those theories which only profess to give mathematical expressions for the forces due to a distribution of currents. Those theories which profess to give mechanical explanation of these forces are not considered. There was not sufficient time to consider both classes of theories, and it is evident that the mathematical theory must be settled before we can get a satisfactory mechanical one. As to the general result of the inquiry, we may say that all that has been proved is that it is absolutely necessary to take into account the currents in the dielectric; and that the action of these, as well as other currents, must be given by some form of the potential theory—that is, the theory propounded by F. E. Neumann and generalised by Von Helmholtz. But nothing definite is known as to what we should take as the measure of these electric currents, and which of the many forms of the potential theory is the right one. We hardly require experimental proof that alteration in the polarisation of the dielectric, at any rate if the dielectric be other than the ether, produce effects analogous to those produced by an ordinary current flowing through a conductor. For the polarisation of a dielectric by an electromotive force produces a change in the structure of the dielectric. This is shown by the alteration in volume experienced by glass and other bodies when placed in the electric field, and also by the breaking down of the dielectric when the strength of the field is great enough. Now, if we move a magnet we shall, since we produce an electromotive force in its neighbourhood, produce a change in the structure of the dielectric around it because we alter its state of polarisation. It follows, then, from the principle of action and reaction, that if we alter the state of polarisation of the dielectric we shall alter the state of motion of the magnet. So that an alteration in the polarisation of the dielectric produces a magnetic force. We can show in a similar way that an alteration in the polarisation must produce all the effects produced by an ordinary conduction current. We know nothing, however, about the magnitude of the current which is equivalent to a change in the state of polarisation. It seems natural to suppose that the intensity of the current is proportional to the rate of change of the electromotive force. Let us suppose that it equals η (rate of change of the electromotive force). The quantity η has never been experimentally determined, but two hypotheses have been made as to its value by Maxwell and Helmholtz. According to Maxwell $\eta = \kappa/4\pi$, where κ is the specific inductive capacity, and, according to Helmholtz, η is also a function of κ. There is very little experimental evidence for either of these theories. For Maxwell's theory, perhaps the best evidence is that, if we assume the electro-magnetic theory of light, the refractive index should, if $\eta = \kappa/4\pi$, equal the square root of a specific inductive capacity, which is very approximately the case for a good many substances. Maxwell's assumption has the great advantage of getting rid of all discontinuity in the currents; and, when this is the case, all forms of the potential theory lead to the same result. So that, if we could prove Maxwell's theory experimentally, it would be a complete theory of electro-dynamic action. If it should turn out, however, that Maxwell's theory is not true, then we should have to go on further and determine which of the several forms of the potential theory is the true one; as, if the currents are not closed, the different forms of the theory lead to different results. It would seem that the most important thing to be done in electro-dynamic theory is to determine whether $\eta = \kappa/4\pi$ or not, and the author has described two ways in which this may be done. If Maxwell's theory should prove not to be true, we must go on to determine the value of η for all dielectrics, and which of the forms of the potential theory is the true one.

Report on Standards of White Light.—Various experiments have been made by the Committee. The members have come to the conclusion that the standard candle as defined by Acts of Parliament is not in any sense a standard. The spermaceti used is not a definite chemical substance, and is mixed with other substances. Also the constitution of the wick is not properly defined. The Committee have considered the relative merits of different proposed standards, and have come to the conclusion that for *commercial* purposes the pentane standard of Mr. Vernon Harcourt is the best. Although the Committee wish their opinion on this point to be known to the Board of Trade and the public, they do not recommend the adoption of any particular standard until further experiments on radiation have been made. Several experiments are enumerated which they propose to make. They ask reappointment, with a grant of 50*l.* towards the proposed researches.

Report of the Committee on Meteoric Dust.—Experiments have been made at the Scottish Marine Station by means of an apparatus in which the wind blows through gratings of fine platinum wire. The moisture deposited is collected and examined for suspended particles. Funnels have also been placed at different localities for catching rain. The presence of carbonaceous matter is most marked. In smaller quantities occur quartz, felspar, mica, tourmaline, garnet, glassy particles resembling Krakatoa dust or pumice, and small round magnetic particles about 1-500th of an inch in diameter. They resemble similar larger particles got from deep-sea deposits at the greatest distance from continental land. None are of cosmic origin. Usually they have a small nucleus in the interior, but are frequently hollow. Further observations are to be made at various stations all over the world.

Report of the Committee on Meteorological Observations on Ben Nevis.—The chief additional observations made during the year were with regard to rainfall and wind. The amount of water substance deposited, in whatever form, has been collected by specially-designed gauges and measured every hour since June 24, 1884. In the end of October the anemometers designed by Praf. Chrystal were added to the instruments. But during seven months—November, 1884, to May, 1885—no anemometer could indicate results, with the exception of thirty days. This is owing to the deposition of ice-crystals. The greatest speed indicated during three days was on the night of April 24. The mean speed for 12 hours was 74 miles per hour, the speed for one particular hour being 81 miles per hour. The highest temperature reached, 60°·1 F., occurred at 2 p.m., August 9; and the lowest, 11°·1 F., at midnight, February 16. The coldest week—average temperature, 16°·2 F.—was the one ending on February 21. The changes of temperature, particularly in winter, were caused, not by direct solar influence, but by the passage of cyclones or anticyclones over the observatory. Indeed in the stormy months of winter this may be taken to be accurately the case. In summer the afternoon minimum of atmospheric pressure was 0·007 inches above the mean for the whole day, but in winter it was below the mean. During twelve months there were 464 hours of sunshine, being about 11 per cent. of the total possible amount. Heavy rainfalls frequently occur. The longest for one hour was on December 10, 1884. The largest daily fall occurred then also, being 4·264 inches. On an average, a fall of at least one inch occurred one day in seven.

Report of the Committee on Solution, Secretary Dr. W. W. J. Nicol.—The subjects discussed in this Report are:—(1) Molecular volumes, (2) saturation, (3) supersaturation, (4) vapour pressures, and (5) expansion of salt solutions. (1) The results of a series of experiments show the molecular volume of a salt in dilute solution to be a quantity composed of two constants: one for the metal and the other for the salt radical; hence the same volume change is produced by replacement of one metal or salt radical by another metal or salt radical. *Water of crystallisation* is not to be distinguished from the solvent water, but the *water of constitution* possesses a volume different from that of the rest of the water—results showing the existence in solution of the anhydrous salt in contradistinction to the view that a hydrate, definite or indefinite, is formed in solution. (2) Saturation is reached when the further addition of salt would produce diminution of the mean molecular volume of the molecules already present. (3) The so-called supersaturated solutions are simply saturated or non-saturated solutions of the anhydrous salts, the only truly supersaturated solutions being those which result from the fact that, when a hot solution is cooled, a finite time is required for the excess of salt to crystallise out.

The Report of the Committee appointed to investigate by means of Photography the Ultra-violet Spark Spectra emitted by Metallic Elements and their Combinations under Varying Conditions, drawn up by Prof. Hartley, F.R.S., was presented by him to the Section; in it an account is given of the results of the investigation of the changes in the character of the spectra of the metals produced by variation in the strengths of the solutions of their salts—*e.g.* chlorides, nitrates, or sulphates. The study of a very considerable number of the photographs of such spectra shows the strength of the solution to have a marked effect on their character, the more dilute the solution the smaller the number of lines; further, that under the same spark conditions, similar solutions of the same strength emit the same spectrum. Solutions containing 1 per cent., 1-10th, 1-100th, and 1-1000th of the metal were used; solutions of the latter strength seldom gave a spectrum of more than three or four lines, and with solutions containing less than 1-10th per cent. the diminution in the number of lines is usually very marked. The spectrum reaction may be utilised for the quantitative analysis of minerals, and yields results more reliable than those obtained by ordinary methods. The reaction is extremely delicate, and in the case of magnesium one part of the metal in 10,000 millions of solution can be detected by the appearance of two characteristic lines.

Third Report of the Committee, consisting of Profs. Williamson, Dewar, Frankland, Crum Brown, Odling, and Armstrong, Drs. Hugo Müller, F. R. Japp, and H. Forster Morley, and Messrs. A. G. Vernon Harcourt, C. E. Groves, J. Millar Thomson, H. B. Dixon (Secretary) and V. H. Veley, reappointed for the purpose of drawing up a Statement of the Varieties of Chemical Names which have come into use, for Indicating the Causes which have led to their Adoption, and for Considering what can be done to bring about some Convergence of the Views on Chemical Nomenclature obtaining among English and Foreign Chemists.—An account of the authorship of some of the various systems of nomenclature which have been devised for the purpose of distinguishing between compounds formed by the union of the same elements in different proportions has been given in the "Historical Notes" prefixed to the Second Report of this Committee. Among these systems the use of the termination *ous* and *ic*, to denote respectively lower or higher degrees of saturation of one element or group with another element or group, is perhaps that which has met with the widest acceptance. This system further directs that when electro-negative groups, the names of which end in *ous* and *ic*, unite with electro-positive groups to form salts, these terminations are to be changed into *ite* and *ate* respectively. It would be ill-advised to attempt on etymological grounds to change a system so firmly established as that involved in the present use of the prefixes *hypo* and *hyper*. No ambiguity can arise from the use of terms about the meaning of which every one is agreed, and their mere etymological accuracy is, in view of this all-important consideration, of secondary importance. As a metal rarely—if ever—forms more than two salifiable oxides, the *ous* and *ic* terminations generally suffice for purposes of distinction so far as the salts of metals are concerned. The practice of further employing these terminations in the case of acid-forming oxides does not lead to confusion, since these oxides are distinguished by the name *anhydride* (or *acid*). Thus we have

CrO	Cr_2O_3	CrO_3
Chromous oxide.	Chromic oxide.	Chromic anhydride. (Chromic acid.)

Indifferent oxides have frequently been classified and named by regarding them as compounds of salifiable, with acid-forming oxides, Cr_2O_4 being termed *chromic chromate.* For stages lower than *ous*, the prefixes *hypo* and *sub* are employed. Custom appears to have restricted *hypo* chiefly to acids and to acid-forming oxides, *sub* to salifiable and to indifferent oxides. With regard to the termination *ous*, the minor question arises, how far this termination ought to be written in the forms *ious* and *eous.* The answer is: as seldom as possible. "Cupreous" has generally given way to "cuprous"; no one writes "chromious" (although the name of the metal is "chromium"); and there is no reason why such names as "ruthenious" and "iridious" should not equally be shorn of their superfluous penultimate syllable. A further question, concerning which considerable difference of opinion has prevailed, is whether any *ous* or *ic* terminations ought to be employed in the names of salts of which only one class is known—thus *magnesic sulphate* instead of *magnesium sulphate.* There is something to be said here for both systems; and, as the diversity of practice does not lead to confusion, and consequently does but little harm (beyond in each case offending the ears of those accustomed to the opposite system), the question need not be regarded as a vital one. In the case of carbon compounds, however, there is a distinct advantage in affixing *ic* to the names of the positive radicals in ethereal salts. A neglect of this precaution leads to ambiguity—at all events in the *spoken* name. Thus, though there is no ambiguity in the name *ethyl phenylacetate* when written, yet the ear cannot distinguish between it and *ethylphenyl acetate.* This ambiguity is obviated by the use of the termination *ic*—thus, *ethylic phenylacetate* and *ethylphenylic acetate.* In the use of the terminations *ous* and *ic* to distinguish different series of *acids and acid-forming oxides*, with the exception of one or two isolated eases, almost perfect unanimity has prevailed. To sum up, the *ous* and *ic* terminations when employed for purposes of distinction in cases where two series of oxides, acids, salts, &c., are known, have been almost free from ambiguity, and for this reason deserve to be retained. On the other hand, in cases where only one series is known, those chemists who have employed one or other of these terminations have occasionally differed as to which ought to be used: the difficulty may be solved, as it has been done by some chemists, by avoiding the use of any termination in such cases. In complex cases where the above modes of naming prove inadequate, recourse may be had to numeral designations. These appear especially admissible in cases where an oxide occurs which is intermediate between the *ous* and the *ic* stage, and at the same time cannot be classed as a compound of oxides already classified and named. In applying numeral designations it is most important to select only such as are free from hypothesis and which afford correct information. In this respect chemists appear not to have been sufficiently careful of late years. As an example, *arsenious oxide* may be quoted; this compound is frequently termed "arsenic trioxide," the formula being written As_2O_3, and it is tacitly assumed that the molecule contains three oxygen atoms. There are three objections to this name:—(1) That, assuming the formula on which it is based to be correct, it affords no information as to the number of *arsenic* atoms associated with the *three* oxygen atoms; (2) that it involves the assumption that arsenious oxide does not vary in molecular weight, whatever its physical state; and (3) that the formula of *gaseous* arsenious oxide is As_4O_6. In employing numeral designations to indicate molecular composition in cases where this is established, it is therefore important to express the number of atoms of each constituent element, as *dicarbon hexachloride*, C_2Cl_6. But in the case of solid and liquid bodies of whichthe molecular weight is unknown, or which may vary with temperature, the name should merely indicate the relative proportions in which the constituents are associated; or, more explicitly, the name should indicate the proportion of the radical associated with what may be termed the characteristic element of the compound. No difficulty occurs in the case of the chloride, or analogous compound, of the monad elements generally, these being termed mono-, di-, tri-, tetra-, penta-, or hexa-chloride, &c., according as combination is in the proportion of 1, 2, 3, 4, 5, or 6 atoms of chlorine to 1 atom of the characteristic element. The application of this system would involve the use of the names tin dichloride and iron trichloride (not sesqui-chloride) for stannous and ferric chlorides respectively, names which accurately express the relative proportions of metal and of chlorine in these compounds without any hypothesis as to their molecular composition, which in the case of the former compound, at all events, certainly depends on temperature. It will, however, involve a slight departure from the existing practice when applied to oxides, sulphides, and other compounds of polyad elements; thus oxides of the type $(R_2)''O$ would be termed *hemi*-oxides, since they consist of the characteristic element and oxygen in the proportion of *one* atom of the former to *half* an atom of the latter. Oxides of the type $(R_2)^{vi}O_3$ would be termed *sesqui*-oxides, since the characteristic element and oxygen are present in the proportion of *one* of the former to *one and a half* of the latter. Oxides of the type R_2O_5 would be termed *sesterti*-oxides, as they contain oxygen and the characteristic element in the proportion of *two and a half* atoms of the former to *one* of the latter. Oxides of the types RO, RO_2, RO_3, and RO_4, would be termed respectively *mono-*, *di-*, *tri-*, and *tetr*-troxides.

The remainder of the report treats of the various systems which have been proposed for the naming of acid, basic, and double salts.

Report of the Committee appointed for the purpose of inquiring in to the Rate of Erosion of the Sea-Coasts of England and Wales, and the Influence of the Artificial Abstraction of Shingle or Material in that Action (*C. E. De Rance and W. Topley, Secretaries*).—The Committee has, during the past year, received several Returns relating to the south and east coasts of England. Most of those relating to the coast south of the Thames are printed. The thanks of the Committee are especially due to Major-Gen. Sir A. Clarke, who has instructed the officers of the Royal Engineers stationed around the coast to supply the Committee with such information as they may possess or be able to obtain. Further returns are expected from the same department and from other official sources; the Committee therefore think it best to defer any general Report until more complete information is obtained. The Memorandum drawn up by Mr. J. B. Redman so fully sets forth the work of the Committee, and the importance of the inquiry referred to it, that this is now printed. The Memorandum by Mr. G. Dowker, on East Kent, gives a sufficiently complete account of the changes of the coast in this district; changes which are of especial historical importance and interest. Mr. Whitaker has drawn up a list of works relating to the coast-changes of England and Wales, which will be of great service to the Committee and to those who may assist in the work. The Committee would again ask for the assistance of any who, by long residence or other means, have special knowledge of changes on any part of the English and Welsh coast. Printed forms of questions can be obtained from the secretaries or from any member of the Committee.

Third Report of the Committee, consisting of Sir J. Hooker, Dr. Günther, Mr. Howard Saunders, and Mr. Sclater (*Secretary*), *appointed for the purpose of exploring Kilima-njaro and the adjoining mountains of Equatorial Africa.*—In their last report, presented at Montreal, the Committee stated the arrangements that they had made with Mr. H. H. Johnston for undertaking an expedition to Kilima-njaro, and gave extracts from Mr. Johnston's letters showing the progress of his expedition up to May, 1884. Mr. Johnston gave an account of his expedition to the Royal Geographical Society at their meeting on January 26, 1885, in which he states that in consequence of the desertion of two natives whom he had taken out with him from Zanzibar as collectors, the collections were not so large as the Committee could have wished. Capt. Shelley prepared a report on the birds collected by Mr. Johnston, and Mr. F. D. Godman on the butterflies of his collection, after which the first sets in both these collections were handed over to the British Museum, as were also all the other zoological collections, with a request to the director that reports might be prepared for publication on such portions of them as seemed to be of sufficient interest. Reports on the zoological collections made by Mr. H. H.

Johnston have already been published in the *Proceedings* of the Zoological Society for this year. The botanical collections were handed over to the Royal Herbarium at Kew, where they were arranged, named, and a set sent to the British Museum. The report upon them is ready, and will be presented to the Linnean Society for publication. Prof. Bonney has kindly undertaken to report on the rock and mineral specimens collected by Mr. Johnston, and his report is presented herewith, and will be read in the Geological Section. Mr. H. H. Johnston has in preparation a volume containing a narrative of his expedition and a summary of the results arrived at, which will shortly be ready for issue. The sum of 25*l.* granted to the Committee at the Montreal meeting has been returned to the treasurer.

Report of the Committee, consisting of Dr. E. B. Tylor, Dr. G. M. Dawson, Gen. Sir J. H. Lefroy, Dr. Daniel Wilson, Mr. Horatio Hale, Mr. R. G. Haliburton, and Mr. George W. Bloxam (Secretary), appointed for the purpose of investigating and publishing Reports on the Physical Characters, Languages, Industrial and Social Condition of the North-Western Tribes of the Dominion of Canada.—The Committee have been in active correspondence with missionaries and others stationed among the Indians, but the unsettled state of the country during the past year has made it impossible to do more than collect materials for a preliminary report; the Committee, therefore, ask that they may be reappointed with a continuance of the grant.

Report on the Blackfoot Tribes. Drawn up by Mr. Horatio Hale.—The tribes composing the Blackfoot Confederacy, as it is commonly styled, have been until recently less known than any others. A correspondence was opened with two able and zealous missionaries residing among these Indians. The Rev. Albert Lacombe, widely and favourably known as Father Lacombe, Roman Catholic Missionary among the Siksika, or proper Blackfeet Indians, and the Rev. John McLean, Missionary of the Canadian Methodist Church to the Blood and Piegan (or Kena and Piekanè) tribes. Father Lacombe has been many years a missionary in the Canadian North-West, and has a very extensive knowledge of the tribes of that region. His elaborate work, the "Grammar and Dictionary of the Cree Language" ranks among the best contributions to American philology. Mr. McLean has been engaged in his missionary duties for five years, has prepared a grammar of the Blackfoot language, and is at present occupied in translating the Scriptures into that tongue. The unfortunate troubles of the past season have for a time interrupted the correspondence, and the principal portion of the report on these Indians will therefore have to be deferred for another year. Some other sources of information, however, have been examined, particularly the valuable official reports and maps of the Canadian and United States Indian Departments.

Fifty years ago the Blackfoot Confederacy held among the western tribes much the same position of superiority which was held two centuries ago by the Iroquois Confederacy among the Indians east of the Mississippi. The nucleus, or main body is still composed of three tribes, speaking the proper Blackfoot language: the Siksika, or Blackfeet proper; the Kena, or Blood Indians; and the Piekanè, or Piegans (pronounced Peegans), a name sometimes corrupted to "Pagan" Indians. To these are to be added the Sarcees from the north, and the Atsinas from the south. The Sarcees are an offshoot of the great Athabascan stock, which is spread over the north of British America, through Oregon and California into Northern Mexico. The Atsinas, who have been variously known as Fall Indians, Rapid Indians, and Gros Ventres, speak a dialect similar to that of the Arapohoes, who now reside in the "Indian Territory" of the United States. It is a peculiarly harsh and difficult language, and is said to be spoken only by those two tribes. None of the Atsinas are now found on Canadian territory, and no recent information has been obtained concerning them, except from the map which accompanies the United States Indian Report for 1884, and on which their name appears on the American Blackfoot Reservation. The five tribes were reckoned, fifty years ago, to comprise not less than 30,000 souls, the terror of all the western Indians on both sides of the Rocky Mountains. It was not uncommon for thirty or forty war parties to be out at once against the Salish (or Flatheads) of Oregon, the Upsarokas (or Crows) of the Missouri Plains, the Shoshonees of the far south, and the Crees of the north and east. The country which the Blackfoot tribes claimed properly as their own comprised the valleys and plains along the eastern slope of the Rocky Mountains, between the Missouri and the Saskatchewan, the favourite resort of the buffalo, whose vast herds afforded the Indians their principal means of subsistence. In the year 1836 a terrible visitation of the small-pox swept off two-thirds of the people, and five years later they were supposed to count not more than 1,500 tents, or about 10,000 souls. Their enemies were then recovering their spirits, and retaliating upon the weakened tribes the ravages which they had formerly committed.

In 1855 the United States Government humanely interfered to bring about a complete cessation of hostilities between the Blackfoot tribes and the other Indians, and framed a treaty for them, accompanying the act by a large distribution of presents. Dr. F. V. Hayden, in his account of the Indian Tribes of the Missouri Valley, states: "From my own experience among them, and from information derived from intelligent men who have spent the greater portion of their lives with them, I am convinced that they are among the most peaceable and honourable Indians in the West; and in an intellectual and moral point of view they take the highest rank among the wild tribes of the plains." This favourable opinion of Dr. Hayden is entirely in accordance with the testimony of the Indian agents and other officials of the Canadian North-West. At the present time, while constantly harassed on their reserves by the incursions of thievish Crees and other Indians, they forbear to retaliate, and honourably abide by the terms of their treaty, which binds them to leave the redress of such grievances to the Dominion authorities. Since the general peace the numbers of the Blackfeet have apparently qeen on the increase. Dr. Hayden reports the three proper Blackfeet tribes as numbering in 1855 about 7000 souls. The present population of the three Canadian Reserves is computed at about 6000, divided as follows: Blackfeet proper, 2400; Bloods, 2800; Piegans, 800. On the American Reservation there are stated to be about 2300, mostly Piegans. This would make the total population of the three tribes exceed 8000 souls. The adopted tribe, the Sarcees, have greatly diminished in numbers through the ravages of the small-pox. This tribe, now numbering less than 500 souls, have their Reserve near Calgary. They are reputed to be less cleanly and moral than the proper Blackfeet tribes. In this respect their habits and character correspond with those of other Athabascan tribes. During the past five years, as is well known, a great change has taken place in the condition of the north-western tribes through the extermination of the buffalo. The Blackfeet have been the greatest sufferers from this cause. The buffalo were their main dependence. Suddenly, almost without warning, they found themselves stripped of nearly every necessary of life. The change was one of the greatest that could well befall a community. The Governments both of the United States and of Canada came to the rescue; but in the former country the urgency of the case was not at first fully understood, and much suffering ensued. The agent on the Blackfoot Reservation in Montana (Major Allen) states in his official report that when he entered upon his duties in April 1884 he found the Indians in a deplorable condition. The supplies of food which had been sent for them had proved insufficient, and before these could be renewed many died from actual starvation. Some stripped the bark from the saplings which grew along their creeks, and ate the inner portion to stifle their sense of hunger. On the Canadian side, fortunately, the emergency was better understood. Col. McLeod, an able and vigilant officer, was in charge of the Mounted Police at that time, and through his forethought the necessary preparations were made. In 1879 and 1880 the buffalo disappeared from that region. Arrangements were at once made for settling the Indians on Reserves, and for supplying them with food and clothing, and teaching them to erect wooden houses and cultivate their lands. Daily rations of meat and flour were served out to them. Ploughs, cattle, and horses were furnished to them. Farm instructors were placed among them. The Indians displayed a remarkable readiness to adapt themselves to the new conditions. According to the reports of all the agents, they have evinced a quickness to learn and a persevering industry which place them decidedly in advance of the other Indian tribes of that region. In 1882 more than 500,000 lbs. of potatoes were raised by the three Blackfoot tribes, besides considerable quantities of oats, barley, and turnips. The Piegans had sold 1000 dollars' worth of potatoes, and had a large supply on hand. "The manner in which the Indians have worked," writes the agent, "is really astonishing, as is the interest they have taken, and are taking, in farming." Axes and other tools were distributed among them, and were put to good use. In November, 1882, log-houses had "gone up thick and fast on the Reserves, and were most creditable to the builders." In many cases the logs were hewn, and in nearly all the houses fireplaces were built. In the same year another official found comfortable dwellings, well-cultivated gardens, and good supplies of potatoes in root-houses. Most of the families had cooking stoves, for which they had sometimes paid as much as 50 dollars. He "saw many signs of civilisation, such as cups and saucers, knives and forks, coal-oil lamps, and tables; and several of the women were baking excellent bread and performing other cooking operations." Three years before these Indians were wild nomads, who lived in skin tents, hunted the buffalo, and had probably never seen a plough or an axe.

The Blackfeet have been known to the whites for about a century, and during that period have dwelt in or near their present abode. There is evidence, however, that they once lived further east than at present. The explorer Mackenzie, in 1789, found them holding the south branch of the Saskatchewan, from its source to its junction with the north branch. He speaks of four tribes—the Picaneaux, Blood, and Blackfeet. and the Fall Indians (Atsinas), which latter tribe then numbered about 700 warriors. Of the three former tribes he says: "They are a distinct people, speak a language of their own, and, I have reason to think, are travelling north-west, as well as the others just mentioned (the Atsinas); nor have I heard of any Indians with whose language that which they speak has any affinity. Mr. McLean's inquiries confirm this opinion of the westward movement of these Indians in comparatively recent times. "The former home of these people," he writes, "was in the Red River country, where, from the nature of the soil which blackened their mocassins, they were called Blackfeet." This, it should be stated, is the exact meaning of *Siksika*, from *siksinam*, black, and *ka*, the root of *oqkatsh*, foot. The meaning of the other tribal names, *Kena* and Piekanè, is unknown. This westward movement has probably been due to the pressure of the Crees, who, according to their own tradition, originally dwelt far east of the Red River, in Labrador and about Hudson's Bay. They have gradually advanced westward, pushing the prior occupants before them by the sheer force of numbers. This will explain the deadly hostility which has always existed between the Crees and the Blackfeet. M. Lacombe, however, expresses a doubt as to their former sojourn in the Red River region: "They affirm, on the contrary, that they came from the south-west, across the mountains—that is from the direction of Oregon and Washington Territory. There were" (he adds) "bloody contests between the Blackfeet and the Nez-percés, as Bancroft relates, for the right of hunting on the eastern slope of the Rocky Mountains." Mr. McLean, who mentions the former residence of the Blackfeet in the Red River country as an undoubted fact, also says: "It is supposed that the great ancestor of the Blackfeet came across the mountains." Here are two distinct and apparently conflicting traditions, each having good authority and evidence in its favour. One of the best tests of the truth of tradition is to be found in language. Mackenzie, well acquainted with the Crees and Ojibways, who speak dialects of the great Algonkin stock, recognised no connection between their speech and that of the Blackfeet. Another traveller (Umfreville), whose book was published in 1791, gave a list of forty-four words of the Blackfoot language. Albert Gallatin, whose "Synopsis of the Indian Tribes" appeared in 1836, examined this list of Umfreville, and pronounced it sufficient to show that the language of the Blackfeet was "different from any other known to us." A few years later, having received from an Indian trader a more extended vocabulary, he corrected his former statement, and showed that there was a clear affinity between the Blackfoot speech and the language of the Algonkin family. More recently the French missionaries made the same discovery. M. Lacombe writes to me: "The Blackfoot language, although far from, belongs to the same family as, the Algic, Ojibway, Santeux, Maskegon, and Cree. We discovered this analogy by studying the grammatical rules of these languages." Thus some of the ablest and most experienced of North American linguists have at first supposed the Blackfoot language to be distinct from all others, and have only discovered its connection with the Algonkin family by careful study. M. Lacombe has been good enough to send me a pretty extensive vocabulary of Blackfoot words, compared with the corresponding words in the Cree and Ojibway languages. He has added many paradigms of grammatical forms in the Blackfoot, compared with similar forms in the Cree and Ojibway tongues. The Blackfoot language is thus shown to be, in its grammar, purely Algonkin. The resemblance is complete in the minutest forms. But when we turn to the vocabulary, by which the first judgment of a language is necessarily formed, the origin of the early error becomes apparent. Many of the most common words are totally different from the corresponding words in the Algonkin languages. Others, found on careful examination radically the same as the corresponding Algonkin terms, are yet so changed and distorted that the resemblance is not at first apparent. Of this variation and distortion the numerals afford a good example. Other words in ordinary use show the total unlikeness in some cases and the distorted resemblance in others. The possessive pronoun "my" is expressed by the same prefix *ni* (or *n'*) in all three languages. Pursuing this trace we compare the personal pronouns, and find a close resemblance, the difference being mainly in the terminations. In the possessive prefixes the resemblance is still more notable. Thus in the Blackfoot language *n'otas* means "my horse, or dog" (the same word, oddly enough, applying in this form to both animals); and in Cree *n't'em* has the same meaning. These words are thus varied with the possessive pronouns and in the two numbers:—

	Blackfoot	Cree
My horse (or dog)	n'otas	n't'em
thy ,, ,,	k'otas	kit'em
his ,, ,,	otas	otema
our ,, ,,	n'otasinan	n't'eminan
your ,, ,,	k'otasinan	kitemiwaw
their ,, ,,	otasiwaw	otemiwawa
my horses (or dogs)	n'otasiks	n't'emak
thy ,, ,,	k'otasiks	kit'emak
his ,, ,,	otasiks	otema
our ,, ,,	notasinaniks	n't'eminanak
your ,, ,,	kotasiwaweks	kitemiwawok
their ,, ,,	otasiwaweks	otemiwawa

It will be seen that the close resemblance in grammar is as striking as the wide difference in the vocabulary. These facts admit of but one explanation. They are the precise phenomena to which we are accustomed in the case of mixed languages. In such languages—our English speech is a notable example—we expect the grammar to be derived entirely from one source, while the words will be drawn from two or more. Furthermore, wherever we find a mixed language we infer a conquest of one people by another. In the present instance we may well suppose that when the Blackfoot tribes were forced westward from the Red River country to the foot of the Rocky Mountains they did not find their new abode uninhabited. It is probable enough that the people whom they found in possession had come through the passes from the country west of those mountains. If these people were overcome by the Blackfeet, and their women taken as wives by the conquerors, two results would be likely to follow. In the first place, the language would become a mixed speech, in grammar purely Algonkin, but in the vocabulary largely recruited from the speech of the conquered tribe. A change in the character of the amalgamated people would also take place. The result of this change might be better inferred if we knew the characteristics of both the constituent races. But it may be said that a frequent, if not a general, result of such a mixture of races is the production of a people of superior intelligence and force of character. The circumstances thus suggested may account, not only for the peculiarities of the language and character of the Blackfeet tribes, but also for the different traditions which are found among them in regard to their origin and former abode. It would be very desirable to trace that portion of the Blackfoot vocabulary which is not of Algonkin origin to its source in the language of some other linguistic stock. The religion of these tribes (applying this term to their combined mythology and worship) resembles their language. It is in the main Algonkin, but includes some beliefs and ceremonies derived from some other source. "The primitive creation," writes M. Lacombe, "is attributed to a superior divinity, whom they call the Creator (*Apistotokin*). This divinity, however, is in some manner identified with the sun (*Natō*). The earth itself is believed to be a divinity of some kind, for, in their invocations, if they call the sun 'our father' (*Kinnon*), they call the earth 'our mother' (*Kikristonnon*). It seems also that the moon is considered to be one and the same divinity with the sun. At any rate, in the invocations it is designated by the same name, *Natōs*. Yet it is often said to be the 'old woman,' the consort of the sun. The whole of this is confused enough in the minds of the Indians to render them unable to give, when questioned, exact explanations. As to the secondary creation, the Indian account runs: At a certain time all the earth was covered with water. The 'Old Man' (*Napiw*) was in a canoe, and he thought of causing the earth to come up from the abyss. He used the aid of four animals. The musk-rat dived, and remained so long under water that when he came to the surface he was fainting, but brought a little particle of earth between the toes of his paw. This particle the 'Old Man' blew into the size of the whole earth. It took him four days to complete his work. The 'Old Man' worked two days more to make the first woman, for after the first day's work he had not succeeded in making anything graceful." This Napiw, or "Old Man," adds Father Lacombe, "appears again in many other traditions and legendary accounts, in which he is associated with the various kinds of animals, speaking to them, making use of them, and especially cheating them, and playing every kind of trick. According to the account of the Indians, the "Old Man" came from the south-west, across the mountains; and after a prolonged sojourn in these countries he went toward the north-east, where he disappeared, and nobody has heard of him since. Those who have read Schoolcraft's "Algic Researches," Mr. Leland's "Algonquin Legends," and, above all, Dr. Brinton's "Myths of the New World," will recognise in Napiw the most genuine and characteristic of all the Algonkin divinities. In every tribe of this widespread family, from Nova Scotia to Virginia, and from the Delaware to the Rocky Mountains, he reappears under various names—Manabosho, Michabo, Wetuks, Glooskap, Wisaketjack, Napiw—but everywhere with the same traits and the same history. While these beliefs are all purely Algonkin, the chief religious ceremony of the Blackfoot tribes is certainly of foreign origin. This is the famous "sun-dance." That this ceremony is not properly Algonkin is clearly shown by the fact that among the tribes of that stock, with the sole exception of the Blackfoot and a few of the western Crees, it is unknown. Neither the Ojibways of the lakes nor any of the numerous tribes east of the Mississippi had in their worship a trace of this extraordinary rite. The form of government among the Blackfeet, as among the Algonkin tribes generally, is exceedingly simple, offering a striking contrast to the elaborately complicated systems common among the nations of the Iroquois stock. Each tribe has a head-chief, and each band of which the tribe is composed has its subordinate chief; but the authority of these chiefs is little more than nominal. The office is not hereditary, the bravest or richest are commonly chosen; but in what manner the election is made is not stated. The term "confederacy" commonly applied to the union of the Blackfoot tribes is somewhat misleading. There is no regular league or constitution binding them together. "The tribes are separate," writes Mr. McLean, "and the bonds of union are the unity of religious belief, social customs, and language. They united against a common enemy, but I have never heard of their fighting against each other." Father Lacombe's account is similar. "The Blackfeet," he writes, "have no league or confederation, properly so-called, with councils and periodical reunions. They consider themselves as forming one family, whose three branches or bands are descended from three brothers. This bond of kinship is sufficient to preserve a good understanding among them." They can hardly be said to have a general name for the whole community, though they sometimes speak of themselves as *Sawketakix*, or "men of the plains," and occasionally as *Netsepoyè*, or "people who speak one language."

SECTION A.—MATHEMATICS AND PHYSICS

Discussion on the Kinetic Theory of Gases.—A most valuable and interesting discussion took place in this section on the kinetic theory. As at present applied the theory gives a much larger ratio for the specific heats of a gas than experiment allows. And the more complex a gaseous molecule becomes, the greater, according to theory, must be the ratio of its intrinsic to its translational energy. The object of the discussion was to determine whether the theoretical conclusions were legitimate, or the experimental facts incorrectly observed. It would seem that the theoretical conclusions are not correct, because they are founded upon inadmissible assumptions; and also that the facts require more thorough investigation.

Prof. Crum Brown opened the discussion upon lines already indicated in our present volume, p. 352. The ratio of the specific heat of mercury vapour at constant pressure to that at constant volume is 5/3. This gives, on the dynamical theory, only three degrees of freedom to the molecules: which must be the three translational freedoms. To prevent rotation, the molecules may be regarded as perfectly smooth, rigid, and spherical. But then the radiation cannot be accounted for. Similarly in diatomic gas the ratio is 7/5—giving three translational and two rotational freedoms; but again, not accounting for vibration of the atoms, either on the one hand, as parts of the molecules, or, on the other hand, in themselves.

Boltzmann's theorem asserts that the energy of a molecule is equally distributed amongst the different degrees of freedom. So if, in addition to the six degrees of freedom of a rigid body in space, the molecules have twenty or thirty others, it would seem that the dynamical theory must be abandoned, as there would not be sufficient energy for translational motion. The suggestion that radiation is caused not by vibration of the particles, but by disturbance of the ether due to the motion of the molecule through it, is scarcely admissible.

Difficulties again arise from the theoretical conclusion that energy of each kind is distributed among the molecules according to some form of the law of probability. For them, in a mixture of gases, we should always have some molecules in a condition favourable for combination. Also there should be no such sharp temperature and pressure limits for combination as exist—*e.g.* in the case of phosphorus and oxygen. Hydrogen and oxygen can be kept very long at a temperature near that of combination, without any chemical action occurring.

Prof. G. D. Liveing, in a paper on kinetic theory, said that the first doctrine leading to difficulties arises from assumptions, and is not a necessary part of the theory. The final distribution is the result not only of circumstances which vary, but of laws of force which are determinate. So there will be a tendency finally to limitation of the distribution of the energy in the different degrees of freedom. The dissipation of energy is the result of such laws limiting the reversibility of transmutations. Boltzmann's result will *not* follow if we consider other laws in addition to the conservation of energy. Indeed, the probability for it would be *nil*. Boltzmann also does not distinguish different kinds of motion—such as those of liquefaction, vaporisation, and dissociation. Those of translation and vibration even are often classed together. Yet the former three take place only after a certain accumulation of energy in the system; and the same may be true of the different vibrational degrees of freedom.

The constancy of the specific heats of some gases for large ranges of temperature indicates a constant *proportional* distribution of energy among the different degrees of freedom. But the proportion need not be that of equality. It is quite possible that mercury vapour at those temperatures at which its specific heat has been measured has no sensible vibrational energy. Experiments upon the emissivity of the more perfect gases show that they have, at ordinary temperatures, much less vibrational than translational energy; so that they may have only one, or, at most, two modes of vibration. The theoretical relation between the number of degrees of freedom in gases and their specific heats possibly requires revision. Still, it only limits the number of degrees sensibly exercised at the temperatures at which the specific heats were measured.

As regards the distribution of energy amongst the molecules, it is almost impossible to evade the conclusion that great differences of motion will exist, even although no particular law of distribution be assumed. Still, it is quite possible that there may be laws regulating the actions in encounters which prevent the excessive accumulation of any one kind of motion. Again, some molecules at 100° may have the average translational motion of molecules at 600°, but not that of vibration. So that very few molecules may have, at the same time, excess of motion of both kinds. Further, since this excess of energy is acquired at the expense of neighbouring molecules, the probability of there being at the same place two atoms of hydrogen and one of oxygen, in a mixture of these gases, in the average condition of those at the higher temperature, is infinitesimal. And yet again degrees of freedom exercised at the higher temperature alone may never be exercised by any molecule at the lower temperature on the average.

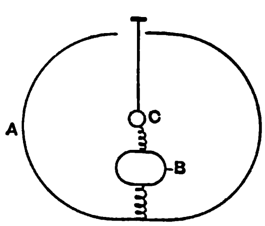
Differences of pressure in the two masses of the same gas at the same temperature are on the dynamical theory only differences of average free paths, so that it is difficult to imagine how any of the molecules in the more compressed gas can be said to be in the state, as to pressure, of the average molecules in the less dense gas. The free path of a molecule of the denser gas may at any instant be the same as the average free path of the molecules of the less dense gas; but its *average* free path will not be the same as theirs, and it is this that determines the pressure. In a system consisting of phosphorus and oxygen the possibility of chemical combination implies the possibility of an atom of phosphorus acquiring the same motion of translation, both as to speed and direction, as several atoms of oxygen, and of their jointly taking up the vibrational motions proper to an oxide of phosphorus at the temperature of the system, and that the transformations of energy involved in all this should be attended on the whole with a degradation. Since a diminution of the pressure of a gas means a degradation of its energy, this may facilitate combination when the mere fact of the molecules having instantaneous free paths of greater or less length would not suffice to produce such a result.

Sir W. Thomson remarked that Boltzmann's theorem was true in one particular case, but a proof of this case could be arrived at without the aid of the theorem, so that this does not prove the truth of the theorem. On the other hand, he had never seen any reason for believing in it at all. If we take an absolutely elastic globe and cause it to rebound between two parallel absolutely smooth and hard planes in a region where gravity does not act, it will go on moving between the two. But he does not believe that this will continue for ever. The translational energy of the ball will get transformed into energy of higher and higher modes of vibration, so that at last the ball will come to rest, as it will be impossible for this energy to be retransformed into translational energy.

Prof. J. J. Thomson said that he thought the reason that the ratio of the specific heats of a gas, as found by experiment, did not agree with the value given by Boltzmann's theorem, was because Boltzmann's theorem was not true.

Boltzmann, in his theorem about the distribution of energy in a gas the molecules of which consisted of dynamical systems with n degrees of freedom, assumed that there were no limits to the velocity which any co-ordinates could have, and therefore that the limiting velocity which any co-ordinate could have was independent of the velocity of any of the others. Now it was easy to see that in some cases there must be limits to the velocities, for, take the case of a molecule consisting of two atoms attracting each other with a force varying inversely as the square of the distance between them, then, if the relative velocity exceeded a certain value, the atoms would describe hyperbolas about their common centre of gravity, and the distance between them would increase indefinitely—in other words, the molecule would break up. Again, if we considered the case of a series of balls connected together by springs and fastened to a system which vibrated much more quickly than the natural period of vibration of the balls, then, if all the impacts fell on this system, the dynamics of the case, as investigated by Stokes and Sir William Thomson, showed that any disturbance would not be equally distributed among the balls, but that the energy in the balls would diminish in geometrical progression as we went away from the system at the end. It seemed, to say the least, rash in a case of this kind to assume that the velocity of any of the balls far away from the system was independent of those preceding it.

He had devised a molecule which it was easy to see would not obey Boltzmann's theorem. A was an envelope to the



bottom of which a feeble spring was fixed, the other end of which was attached to a heavy weight, B. To this weight a strong spring was attached, to the other end of which a light weight, C, was fixed. A rod of small mass was fastened to C, of such a length that it only extended beyond the envelope when the springs were stretched. This system would have two periods of vibration—a quick one corresponding to the upper sphere, and a slow one corresponding to the lower one. Then if all the molecules were stated, so that the amplitude of the quick vibration of C was much greater than the slow one, it was easy to see that the mean energy of the upper sphere would be greater than the mean energy of the lower ones, while, according to Boltzmann's theorem, these two quantities ought to be the same.

It might be mentioned that any co-ordinate which only entered the expression for the energy through its differential coefficient could be eliminated from the expression occurring in Boltzmann's theorem and the method applied to the remaining co-ordinates, so that, even if Boltzmann's method was unobjectionable the result need not apply to co-ordinates of this kind.

With regard to the second of the difficulties mentioned by Prof. Crum Brown, he thought that the point raised presented no difficulty if we took Williamson and Clausius's view of chemical combination. According to this view it was necessary to consider the number of molecules dissociated as well as the condition of the molecules; and though, if we took two gases at any temperature, it was true that there were a finite number of their molecules whose energy did not differ much from the mean energy of the molecules at the temperature at which these combined, yet it did not follow that a finite proportion of these were dissociated, and if there were not we could not expect them to combine. If the collision between two molecules in nearly the same condition was more efficacious in splitting up the molecules into atoms than a collision between molecules in widely different conditions, then we should not expect a finite proportion of the molecules in any state widely different from the mean to be dissociated.

Prof. W. M. Hicks said that one of the greatest objections to Boltzmann's theorem appeared to him to be the difficulty in believing that the mean energy of any vibration whatever of an atom was susceptible of unlimited increase, and referred to the case of a vortex ring inside a rigid spherical shell, where such energy could not be made to exceed a particular limit. As a matter of fact it was not proved that Boltzmann's theorem must correspond to the actual state, but only that an arrangement given by his theorem, if a possible one, was a permanent one. He stated that if the momenta could not exceed definite limits, Watson's proof could easily be modified to show that the energy was not distributed equally amongst the degrees of freedom. On the other hand, it was not permissible to assume all momenta consistent with the equation of energy as existent. As an example, the case of a system of mutually attracting spheres might be taken. Here the equation would admit of the infinite velocities due to infinitely near approach of the centres, which would in the actual case be prevented by the finite size of the spheres. Further, any particular system might possess other integrals of the equations of motion, which would introduce further limitations.

Prof. Osborne Reynolds remarked that the kinetic theory is only supposed to be true in as far as the assumptions on which it was based represented the actual circumstances. In these assumptions no account whatever was taken of any resistance to which the molecules in their motions might be subjected, other than that which arose from the mutual encounters. Whereas it was perfectly well known and certain that there must be such resistances connected with the radiation of heat—these resistances, applying only to motions of certain character, *i.e.* to the vibratory motions, whatever these may be. Neglecting these resistances, the kinetic theory points to the conclusion that the mean energy in each one of these vibratory motions would be the same as in each one of the translatory motions. In the same way, neglecting resistance, a pendulum continuously struck at varying intervals with a hammer of a given weight and moving at a given speed would possess the same mean energy whether the intervals were to be measured by years or seconds. But experience at once showed that with friction, the shorter the interval between the blows and the smaller the friction, the greater would be the mean energy of the pendulum. So, taking resistance into account, it would follow from the kinetic theory that the mean energy in the so-called degrees of freedom would be greatest in those in which the diffusion of energy was greatest and the resistance least, while it would be least in those in which the rate of communication was least and the resistance greatest. Hence, in any gas, the mean energies of translation, in which there is most rapid communication and no appreciable resistance, will be much greater than the mean energies of vibration to which there is all the resistance consequent on the radiation, and in all probability but little communication.

The same answer applies to difficulties raised as to the distribution of motion. The assumed distributions leave out of consideration all resistances, and resistance, however slight, would cut off the extreme velocities.

Mr. H. B. Dixon said that, by a series of observations made on a mixture of oxygen and hydrogen at intervals of 1000 hours, he had obtained evidence of combination at temperatures below that of dissociation.

Constant Gravitational Instruments. — Sir W. Thomson showed and explained constant gravitational instruments for measuring electric currents and potentials. In one instrument for measuring currents he employs the principle that a mass of soft iron of dimensions and shape not differing too much from a sphere, experiences, in a field of magnetic force, a pull from a place of weaker to a place of stronger force. The variation of the field is produced by variation in the dimensions of the conductor through which the current passes. In an instrument for measuring high potentials he used one pair of opposite quadrants placed vertically. The quadrants are connected to one pole of the instrument whose potential is required, and the needle, the lower end of which can be weighted, is joined to the other pole.

On the Dilatancy of Media composed of Rigid Particles in Contact, by Prof. Osborne Reynolds.—In the account which Prof. Reynolds gave of his paper, he did not submit a complete dynamical theory, but discussed a very fundamental property of granular masses. To this property he gives the name of *dilatancy*. It is exhibited in any arrangement of particles where change of bulk is dependent upon change of shape. In the case of fluid matter, as we know it, change of shape and volume are independent. In solids they are sometimes not separable. With granular masses the result is different—change of shape *always* produces change of volume. And further, in every case, if change of volume is prevented any change of form is impossible.

If we suppose the component granules to be spherical, no granule can change its position without disturbing the adjacent ones —for the granules are all supposed to be perfectly rigid, and to be absolutely in contact—and the internal particles are fixed if the external ones are. In illustration Prof. Reynolds showed a model of connected spherical bodies arranged in crystalline form. This model showed the arrangement of the particles corresponding to (say) the condition of least possible density of the whole mass (about one-half the density of the separate spheres). The shape could then be altered to that which corresponds to maximum density—the change taking place by sliding of the particles one upon another. Between the extreme states there are intermediate stages of equilibrium corresponding to maximum-minimum positions, where alteration in one direction produces decrease of density, and in the other increase of density.

In a complete treatment of the problem, friction must be closely considered; but in the experiment shown it is not of consequence, the result being independent. The above statements will be true of any continuous mass of granules if we hold the boundaries.

This principle of the dilatancy of such granular media explains many phenomena of common occurrence. For example, take a sack of corn; if set on end, it remains perfectly flexible, but if placed on its side it becomes hard, and its shape will not alter. Now take an indiarubber sack, fill it with corn—it remains perfectly flexible in all positions. The reason for this difference of behaviour is that in the former case the boundary of the granular mass is inextensible, while in the latter it allows increase of internal volume. So if it be possible with an extensible envelope, to impose a maximum volume upon the contents, effects similar to those obtained with the inextensible boundary may be expected: and this can be done. If we place some shot (No. 6 was used in the experiment) in a thin indiarubber bag, and add a certain amount of water, we obtain the result wished. For if the amount of water added be such that the spaces between the granules when in close arrangement are all filled by it, while with a wide arrangement the amount is not enough, a point will be reached in passing from the first to the second arrangement such that any further change of shape, and consequently of volume, would produce a vacuum. When this stage is reached the whole mass becomes perfectly hard. Prof. Reynolds illustrated this in a very beautiful manner by means of a ball of shot to which a glass tube open at the end was fitted. With a close arrangement of the shot, the water, which was coloured, stood high in the tube; but when pressure was applied to the bag, the level was lowered. This was shown also by the lecturer with a ball containing sand instead of shot. The water level sank till the whole was at maximum density, and, still more pressure being applied, the level again rose, the maximum having been passed. In these experiments about 6 per cent. of the water was free at the top of the ball with the close arrangement of granules. When another ball containing 20 per cent. of free water was used, the hard condition could only be approximated to by pressure, and then passed. So long as the maximum is not passed in this case the ball springs back to its original state when the pressure is released. But if the maximum be passed, it will not spring back. If some of the water be now let out, the maximum cannot be passed, except by shaking, and, if the flattened ball be then turned on edge, it will bear a pressure of a hundredweight without change of shape.

When the dilatant material, such as shot or sand, is bounded by smooth surfaces, the layer of grains adjacent to the surface is in a condition differing from that of the grains within the mass. This layer can slide between the one succeeding it and the surface, so that its displacement will cause much less dilatation than would be caused by the sliding of a layer within the mass. Hence, if two parts of the mass are connected by such a surface, certain conditions of strain may be accommodated by a streaming motion of the grains next the surface. Thus, if into a glass funnel partially filled with shot and held in a vertical position more shot be forced from below, the particles will flow up all around the sides—not rising in the centre as might have been thought.

As the foot presses upon the sand, when the falling tide leaves it firm, that portion of it immediately surrounding the foot becomes momentarily dry. When this happens the sand is filled, completely up to its surface, with water raised by capillary attraction. The pressure of the foot causes dilatation of the sand, and so more water is required. This has to be obtained either by depressing its level against the attraction or by drawing it through the interstices of the surrounding sand. As this latter requires time, for the moment the capillary forces are overcome, and the surface of the water is lowered below that of the sand, leaving it dry until a sufficient supply has been obtained from below, when it again becomes wet. On raising the foot we generally see that the sand under and around it becomes wet for a little time. This is because the sand contracts when the distorting forces are removed, and the excess of water escapes at the surface.

In referring to the results which might be expected to follow from a recognition of the property of dilatancy the author said that it places a hitherto unknown mechanical contrivance at the command of those who would explain the fundamental arrangement of the universe, and one which seems to promise great things besides possessing the inherent advantage of great simplicity. He then proceeded to explain, in a general way, how bodies in such a medium would—in virtue of the dilation caused in the medium—attract each other at a distance, with a force depending on the distance, which might well correspond with the force of gravitation. Further, owing to the existence of a region close to the body in which the density varies several times from maximum to minimum, the mutual force might undergo a change from attraction to repulsion, and this more than once as the bodies approach—a condition which seems to account for cohesion and observed molecular force far better than any previous hypothesis.

The transmission of distortional waves becomes possible if the medium be composed of small grains with large grains interspersed. The separation of two such sets of grains leads to phenomena closely resembling the phenomena of statical electricity. The susceptibility of such a medium for a state in which the two sets of grains are in conditions of opposite distortions may explain electrodynamic and magnetic phenomena, while the observed conducting power of a continuous surface for the grains of a simple dilatant medium closely resembles the conduction of electricity.

In remarking upon Prof. Reynolds's paper Sir W. Thomson pointed out an interesting question. Take a cube of spheres in the condition of maximum volume, and let every sphere touching the boundary be glued to it to prevent slipping. Other states are possible in the interior, but can we pass *continuously* to another condition, the boundary being held firm? Prof. Reynolds replied that he believed that he had got the result that it could not be done if we have a continuous medium. As other problems for solution, Sir W. Thomson suggested the theory of the hour-glass—what fixes the constant time for the sand running? and why does a substance sink deeper in a quicksand than in a viscous fluid of the same density?

On Calculating the Surface-Tensions of Liquids by means of Cylindrical Drops or Bubbles, by Prof. Pirie.—There are two methods by which the surface-tension of liquids are calculated. One involves the measurement of the height to which the liquid rises in a cylindrical tube of known diameter. The other involves the measurement of the height of a certain point of a drop of the liquid above a flat surface upon which it is placed. This point is the point of contact of the tangent plane when it becomes vertical. The former method is objectionable, because the results might be vitiated by the presence of a very small quantity of grease in the tube, or by electrification, &c. The latter, too, is not in a satisfactory state. Gay Lussac's results were in no degree different from those obtained by the ordinary method. Quincke's measurements are good, but his mathematics are misleading. To obviate the mathematical difficulties the author makes use of long drops—that is, drops obtained by placing portions of the liquid upon a concave cylindrical surface. The advantage is that the differential equation used in the calculation is immediately integrable. In remarking upon this paper Prof. Stokes said that Worthington has shown, by extending Quincke's result, that the theory agrees with experiment.

On the Surface-Tension of Water which contains a Gas dissolved in it, by Prof. Pirie.—This question is important, for no liquid is usually free from gas in solution. Prof. Pirie finds that the surface-tension is unaltered so long as the specific gravity of the water is unaffected by the dissolved gas. It is strongest in the pure liquid.

On the Thermodynamic efficiency of Thermopiles, by Lord Rayleigh.—The question has often arisen whether or not the dynamo may be replaced by an arrangement of thermopiles. There is a great difficulty due to the conduction of heat. Let t and t_0 be the temperature of the hot and cold junctions; e the electromotive force of one pair per degree Centigrade, and E the total E.M.F., hence we have

$$ne(t-t_0)=E.$$

From this equation the author obtains by means of Joule's law the expression

$$\frac{n^2e^2(t-t_0)^2}{4R_0}$$

for the useful work done externally. And again, if r_1, r_2, σ_1, σ_2, represent the specific electric resistance and the cross-sectional area of the metal bars, while l is their length,

$$R_0=nl\left(\frac{r_1}{\sigma_1}+\frac{r_2}{\sigma_2}\right).$$

To obtain the efficiency the above work must be compared with that done by the apparatus regarded as a perfect heat engine working between the same temperature. The ratio is

$$\frac{4J}{te^2}\left(\frac{r_1}{\sigma_1}+\frac{r_2}{\sigma_2}\right)\left(\frac{\sigma_1}{r'_1}+\frac{\sigma_2}{r'_2}\right).$$

where v'_1, v'_2 are the specific thermal resistances. The efficiency therefore is independent of $(t-t_0)$, of n, and of l; and also of the *absolute* values of σ_1, σ_2, r_1, r'_1, r_2, and r'_2.

Putting in numerical values for a thermopile of iron and German silver, Lord Rayleigh got 300 as the value of the above ratio. Since e^2 is involved, this number may be somewhat reduced; but high values of e are usually associated with high internal resistance. There is therefore no possibility of the thermopile becoming a useful generator of electricity on a large scale.

On Molecular Distances in Galvanic Polarisation, by Mr. J. Larmor.—Mr. Larmor's method involves the electro-chemical equivalent of the liquid used, and so differs from the two methods previously adopted. He has obtained extremely accordant results.

Cooling of Wires in Air and Vacuum, by Mr. J. T. Bottomley.—Mr. Bottomley finds that the medium has a most marked cooling effect. An electric current passed through a wire, when surrounded by air at atmospheric pressure, heated it only to 80° C. But when the air-pressure was $\frac{1}{19(10)^6}$ of an atmosphere, the wire became red hot. The temperature did not alter much until the pressure became 1-100th of an atmosphere.

An Account of Levelling Operations of the Great Trigonometrical Survey of India, by Major A. W. Baird.—This paper opened with an account of the methods formerly used in the determinations of relative height by the survey. The errors affecting these methods and the means adopted for their elimination were then pointed out. Various lines of level carried out to connect tidal stations lying north and south indicated a difference of sea-level at the stations. This difference cannot be due to false levelling of the instruments produced in consequence of the illumination of the spirit-level by the sun, for the same end of the line was not always brought out highest, and along one line no difference of level was perceptible. The discrepancy in one case amounted to three feet along the line from Bombay to Madras. The two weakest parts of this line were re-levelled, giving the same results as before. Consequently it would appear that the error is caused by local attractions influencing the instruments in greater degree than the more distant ocean.

On the Rainfall of the British Islands, by Mr. A. Buchan.—Mr. Buchan pointed out that the greatest differences in local climates arise from differences in the rainfall. For example: the mean temperatures of Skye and the Moray Firth coasts for any month are not much different, but the rainfall in Skye is about four times that at the Moray Firth. The former is one of the latest and poorest grain-producing districts in Scotland, and the latter is just the reverse. The inquiry was based on observations of rainfall made at 1080 stations in England and Wales, 547 in Scotland, and 213 in Ireland. They extend from the year 1860 to the year 1883. The regions of heaviest rainfall, giving an average of 80 inches or upwards annually, were four: Skye and a large portion of the mainland to the south-east as far as Luss, on Loch Lomond; the greater part of the Lake District; a long strip, including the more mountainous part of North Wales; and the mountainous district in the south-east of Wales. The West Highlands is the most extensive region of heavy rainfall in the British Islands. Its mountainous coast-line faces the rain-bringing winds of the Atlantic, and the air, being cooled in its passage up the lochs and valleys, the moisture is precipitated. At Glencoe, in this district, the heaviest rainfall in Scotland occurred—128·5 inches. The smallest rainfall was in a large portion of the south-east of England. The average rainfall for the last half of the period from 1860 to 1883 was comparatively high, chiefly in the eastern districts.

On a Remarkable Occurrence during the Thunderstorm of August 6, 1885, by Mr. W. H. Preece.—A house at St. Cuthbert's, ten miles from Wolverhampton, is connected with that town by telephone, and is also lighted by electricity. The dining-room was lighted by a single lamp in multiple arc with some others. The telephone wire was connected to the lightning-conductor as an earth. When the storm occurred, the dining-room lamp flashed up and went out, while a loud report was heard. The lightning-rod made bad earth, and it is believed that it had been struck, and that part of the discharge had entered the telephone circuit and then sparked across to the electric-light circuit. It did not seem to have divided, but to have passed entirely along the one branch, including the dining-room light, the platinum wire of which was volatilised and deposited on the interior of the glass, forming a good mirror.

Meteorology of Ben Nevis, by Mr. A. Buchan.—Mr. Buchan remarked that Ben Nevis possesses great advantages as a meteorological station because of its great height and its summit being only about four miles horizontally distant from a sea-level station. Also it is in the track of the Atlantic storms, which exercise so great an effect on the weather of Europe, especially in autumn and winter. The observations made on the mountain are for the purpose of determining more fully the great movements of the atmosphere and the dependence of the weather upon them. Mr. Buchan called attention to the great importance of abnormal values in the thermometric and hygrometric observations especially. The recurring periods of warmth characteristic of Ben Nevis do not occur at lower stations. The *föhn* peculiar to Switzerland occurs on Ben Nevis, and is always associated with heavy rainfall in the neighbourhood. When a cyclone prevailed at the foot of the mountain there is an anticyclone at the top, and *vice versâ*.

On some of the Laws which Regulate the Sequence of Mean Temperature and Rainfall in the Climate of London, by Dr.

Courteney Fox.—The laws enunciated in this paper are deduced empirically from observations extending over the last seventy years. Even as detached laws they are of great value; but their importance is more evident when we consider that, as the author remarks, it is from such material that the future science of meteorology must be built up by cautious induction. Given that a certain month of season is in certain condition as regards temperature or rainfall, Dr. Fox seeks to determine what may be predicted of the succeeding period as regards these qualities. He finds that, if a spring or a summer be very cold, the succeeding season will be cold; and warm autumns succeed very warm summers. The fact of a very dry August being followed by a wet September is unique. The following table shows other results obtained.

Characteristics.	Month.	Month following.
Very cold	Jan., April, June, July, Aug., Sept., Dec.	Cold
Very warm	Jan.	Dry
	June, July, Aug.,	Warm
Very dry	June, July,	Warm
Very wet	Jan., March. April,	Warm
	May, July	Cold

In addition the author records what follows when a given month has marked temperature and moisture characteristics simultaneously.

Characteristics	Month	Month following
Warm and wet	Nov., Dec.,	Wet
	Jan.,	Warm
Warm and dry	June, July,	Warm
	Aug.,	Wet
Cold and wet	July, Aug.,	Cold
Cold and dry	Dec.,	Cold
	Nov.	Dry

A very cold and very wet summer is succeeded usually by a cold autumn.

Domestic Electric Lighting, by W. H. Preece, F.R.S. Electrician G.P.O.—After referring to the full details of the lighting installation of his house in Wimbledon, given to the section at the meeting at Montreal, Mr. Preece referred generally to the experiences he had gained during the past twelve months. The secondary batteries upon which he had mainly relied exceeded his expectations in the services they rendered. They returned 70 per cent. of the energy put into them without any apparent diminution whatever in their E.M.F. They showed no signs of deterioration and gave no trouble whatever. He used his gas engine for charging only two days a week. He had experienced no fault with the wiring of his house. He had used only the very best materials, and had attended personally to the insulation of the system. It was periodically tested and found to be good. He referred in severe terms to the cheap and nasty wire which was so frequently and ignorantly used, and feared that the prejudice against the electric light would increase when failures from this cause arose. None but the very best materials should be used, and the joints should be seen to by experts. He had devoted considerable attention to the problem of distributing light, and had succeeded so far that while his rooms were beautifully illuminated the eye was not irritated by regarding a bright source of light. The lamp he used was a 50 volt 10 candle power glow lamp, and it was, as a rule, so fixed that the eye never saw it. He had arrived at the use of these lamps after careful consideration and many trials of other lamps. They secured greater safety in the leads, and involved less capital in batteries through the use of low E.M.F. He ran his lamp at an E.M.F. about 2 per cent. less than the normal E.M.F. He did this to secure long life to his lamps. The breakage had been very small. The E.M.F. and current which will give a lamp a normal life of 1,000 hours and a certain candle power should be determined by every maker. The sixth power of the current will give the candle power and the twenty-fifth power the life with any other current. The great advantage of batteries is that the proper current once determined can never be exceeded, and thus efficiency is ensured. If lamps are run too low there is a waste of power, if too high there is a waste of lamps. We are now gradually acquiring a thorough knowledge of the number of Watts which should be expended in each lamp to secure the maximum economic efficiency. He had introduced into the charging lead and into the discharging lead a Ferranti meter, so that he was able to record exactly the quantity of electricity passed through the batteries and that passed through the lamps. This beautiful meter is based on Ampere's laws which determine the attraction and repulsion of currents. A small phosphor-bronze vane is immersed in a bath of mercury, through which the current flows radially, fixed in a magnetic field. The mercury rotates and carries with it the vane. The rate of rotation varies directly with the strength of current and the number of rotations are recorded by a counter, which can be read off directly. So far he was perfectly satisfied with its performance. As regards expense, excepting the first cost, he did not find much addition to his expenditure for illumination. His electric light was costing him about 50*l*. a year for gas, wages, oil, and lamps. It was the cheapest luxury he indulged in. The great advantages were the comfort and cheerfulness it engendered, and as cheerfulness was the main element of health he thought that the electric light would prove a serious rival to the doctor. There was no one who valued health and comfort who should neglect to apply the electric light to his home, when it was brought, as it has been by the success of the secondary batteries, within his means. It was said that he, as an expert, could make things go which would fail in ordinary hands; but he mentioned several cases where coachmen, butlers, gardeners, and grooms had been found perfectly competent and intelligent enough to attend to everything.

Discussion on Standards of White Light.—This discussion was not so well sustained as the discussion on the kinetic theory. All the speakers agreed with the adoption of the pentane standard for commercial purposes. For scientific purposes a definition in terms of energy was deemed necessary. The eye cannot be used as an accurate instrument. On this point Prof. Stokes referred to the fact that if two equal areas differently coloured seem to have equally intense illumination, we have only to alter the size of the common area to destroy the apparent equality of intensity.

On Photometry with the Pentane Standard, by Mr. A. Vernon Harcourt.—Mr. Harcourt described the construction of the pentane standard light, and the method of using it for photometric purposes. In the course of his remarks he referred to the meaning of the expression "white light." Any so-called standard of white light is more nearly a standard of yellow light. He had never got a satisfactory definition of the expression, but supposed it to be such light as we have in ordinary daylight.

The Constitution of the Luminiferous Ether on the Vortex Atom Theory, by Prof. W. M. Hicks.—The simple incompressible fluid necessary on the vortex atom theory is quite incapable of transmitting vibrations similar to those of light. The author has therefore considered the possibility of transmitting waves through a medium which consists of this fluid modified so as to contain small vortex rings closely packed together. The rings are supposed to be composed of the same material as the rest of the fluid, to be very small compared with the wave-length, and to be at distances from one another also small compared with the wave-length. Their motion of translation is also taken to be so comparatively slow, that very many waves can pass over any one before it has much changed its position. Such a medium would probably act as a fluid for large motions. The vibration in the wave front may be (1) swinging, such as a ring oscillating on a diameter; (2) transversal vibration of the ring; (3) vibrations perpendicular to the plane of the rings; (4) apertural vibrations. Of these (3) seems to be impossible. If r be the radius of the rings, l the distances of their planes, w their cyclic constant, and v the velocity of translation, the author found

$$\text{For (1)} \ldots\ldots v \propto \frac{w}{l}\left(\frac{r}{l}\right)^4,$$

$$\text{For (2)} \ldots\ldots v \propto \frac{w}{l}\left(\frac{r}{l}\right)^2,$$

whilst for (4) in case of rings arranged parallel to a wave-front—

$$v \propto \frac{wr^2l^2}{(l^2 + 4r^2)^{\frac{5}{2}}}.$$

On a Photometer made with Translucent Prisms, by Mr. J. Joly.—In this photometer each side of the prism is illuminated by one of the lights to be compared, the edge being turned to the observer. The great advantage here is that the two illuminated parts are placed in sharp juxtaposition.

On a Point in the Theory of Double Refraction, by R. T. Glazebrook.—The author suggested that the theory of double refraction given by Lord Rayleigh, in which the ether is supposed to have an effective density different in different directions, might be modified so as to agree with Fresnel's theory, if it be not necessary to assume that the ether offers an infinite resistance to compression, but only that, as compared with its rigidity, its compressibility is very great, and further that in a crystal the light vibrations are normal to the ray, not to the wave normal, as was pointed out by Boussinesq and referred to by Ketteler in some of his papers.

On a New and Simple Form of Calorimeter, by Prof. W. F. Barrett.—The bulb of a thermometer is made in the shape of a double cup. In this cup is placed the substance whose specific heat (say) is to be determined. The stem of the thermometer is horizontal, and rests on a fulcrum so that the weight of the substance may be determined by using the apparatus as a balance. Special precautions are taken in determining the temperature of the substance when placed in the cup, and to prevent evaporation, &c. The specific heat is then given by the ordinary equation,

$$WS(T - \theta) = C(\theta - t),$$

the constant C being determined by experiment once for all.

Section B—Chemistry

On the Non-Existence of Gaseous Nitrogen Trioxide, by Prof. Ramsay.—After pointing out the inconclusive character of Lunge's argument in support of the existence of gaseous nitrogen trioxide, inasmuch as the use of any reagent may either decompose the gas or react with the products of its dissociation—viz. NO and $N_2O_4(NO_2)$, as though they consisted of N_2O_3 itself, the author shows the only criterion of the existence of this gas to be its vapour density. He finds that NO_2 may be mixed with NO without effecting any change in volume, and therefore no combination, or only a very slow combination, can take place between these gases. The vapour density of the first portion of the gas obtained by distilling liquid N_2O_3 is found to be 22·35, a result which accords fairly well with what the density should be, supposing it to be a mixture of N_2O_4, NO_2, and NO, having the empirical composition N_2O_3. Supposing the gas weighed to contain no N_2O_4, an assumption not warranted by facts, and consist of NO and NO_2, then, in order to make the specific gravity 22·35, 17·63 per cent. of N_2O_3 must be added to the mixture. These facts the author considers as deciding the point against the existence of gaseous nitrogen trioxide.

Observations on some Actions of a Grove's Gas Battery, by Prof. Ramsay.—The action of an ordinary Grove's gas battery can be explained by supposing that, at the point of contact between the platinum, hydrogen, and liquid, a decomposition of the water molecule takes place, its oxygen uniting with the hydrogen gas to form water, whilst the hydrogen is liberated from molecule to molecule until the free gas arrives at the point of contact of the platinum, the oxygen, and liquid; here it unites with the oxygen gas, forming water. If the liquid in the battery be coloured with indigo sulphuric acid, the author finds the indigo in contact with the hydrogen to undergo no changes, whereas that in contact with the oxygen is discoloured, a change probably due to the oxidation of the indigo to isatine. Hydrogen, therefore, in uniting with oxygen, does not bleach indigo. Now if, in the ordinary gas battery, the acid be replaced by a saturated solution of sodium chloride and hydrogen, and chlorine be substituted for hydrogen and oxygen, the indigo is found to be bleached on both sides, the bleaching taking place from above downwards, and taking place at once on admitting the chlorine, but some time is required before the reduction by the hydrogen is evident. These experiments show that when hydrogen unites with chlorine it is in a more active state than when it unites with oxygen. To explain this difference the author suggests that, when a molecule of hydrogen unites with a molecule of chlorine, atomic hydrogen exists for a moment, and this, in presence of indigo, reduces it to indigo-white. In the case of hydrogen and oxygen the union of two molecules of the former with one molecule of the latter may be effected without the hydrogen assuming the atomic condition, whereas the oxygen must assume the atomic or nascent condition, to which the bleaching of the indigo may be ascribed; or it may be that ozone or hydrogen peroxide are formed. These phenomena may, therefore, be regarded as chemical evidence corroborative of the following method of expressing the union of these gases with one another:—

$$H_2 + Cl_2 = HCl + HCl. \qquad 2H_2 + O_2 = H_2O + H_2O.$$

On the Spontaneous Polymerisation of Volatile Hydrocarbons at the Ordinary Atmospheric Temperatures, by Sir H. E. Roscoe, LL.D., F.R.S.—The attention of the author was drawn by Mr. Staveley, of West Bromwich, to a camphor-like solid, formed from the more volatile liquid hydrocarbons, produced by decomposing crude phenol at a red heat. The change from the liquid to the solid state was, at first, supposed to be due to the influence of the oxygen of the air, but investigation has shown the solid to be a hydrocarbon having the formula $C_{10}H_{12}$, and the change to be one of polymerisation. This solid hydrocarbon undergoes a further polymeric change when heated in a sealed tube at 180°. The author finds also that the first runnings of ordinary coal tar, which distil below 30°, are, on keeping in sealed tubes, converted spontaneously into this solid hydrocarbon $C_{10}H_{12}$.

On some New Vanadium Compounds, by J. T. Brierley.—The compounds described form a series of well-defined crystalline salts of purple or dark green colour, possessing a metallic lustre, which contain both the oxides V_2O_4 and V_2O_5, and may be regarded as vanadate-vanadites. These salts are formed by adding a caustic alkali to the dark green liquid formed by adding hypovanadic sulphate to a solution of an alkaline metavanadate. The composition of the sodium, potassium, and ammonium salts are represented by the following formula:— $2V_2O_4 . V_2O_5 . 2Na_2O + 13H_2O$., $2V_2O_4 . V_2O_5 2K_2O + 6H_2O$, and $4V_2O_4 . 2V_2O_5 . (NH_4)_2O + 14H_2O$.

The Essential Food of Plants, by T. Jamieson, F.C.S., F.I.C.—Whilst no doubt exists as to the essential character of the elements of carbon, hydrogen, oxygen, and nitrogen as constituents of the food of plants, the evidence in support of the elements phosphorus, potassium, magnesium, calcium, sulphur, iron, and chlorine to be regarded in this light cannot be considered conclusive. A little consideration shows the two elements, iron and chlorine, have but little claim to be considered as essential to the food of plants, and the experiments, of which an account was given in this paper, were made by the author with the view of vindicating the right of the five remaining elements to be so considered. These investigations were conducted at an experimental station in Sussex and also at one in Aberdeenshire, the nature of the soil in both cases being specially favourable. The method adopted consisted in observing the effects on plants grown in similar soil and under similar conditions, when supplied with manures, containing all these elements and comparing the results with those obtained when one or other of these elements was withheld. These experiments seem to provide proof that sulphur must be discarded from the list of essentials, while some doubt is thrown on even lime and magnesia. At the same time striking confirmation is afforded of the essential characters of both phosphorus and potassium.

A Plea for the Empiric Naming of Organic Compounds, by Prof. Odling, M.A., F.R.S.—Verbal translations of the structural formulæ assigned to organic compounds possess certain advantages as names for the several compounds. Thus, they are applicable to all organic compounds of which the structural formulæ are made out; they are the only sort of names applicable to complex isomeric compounds; and their use cannot be dispensed with wholly in the case of even less complex compounds. Notwithstanding these advantages, structural names constitute unsuitable names for general use, more especially as applied to fundamental hydrocarbons, alcohols, and acids. They are objectionable for this use by reason of their length, complexity, and want of ready indicativeness; by the circumstance of their being based on conceptions of chemical constitution of a kind pointed out by experience as eminently liable to change; and by the further circumstance of their representing a one-sided and, so far, an untruthful notion of the bodies designated. Structural names, expressing other than a distorted view of the constitution of all but a few of the most simple of organic bodies, are impracticable by reason of their length and complexity. Hence, to avoid the distortion inseparable from the use of any single structural name for an organic body, the only expedient is the assignment to each body, in proportion to its complexity, of an indefinite number of structural names, a proceeding almost tantamount to not assigning it any particular name at all. Although from their number and complexity, organic bodies can only be designated by names which do in some measure describe and characterise them, the primary purpose of a name is undoubtedly to designate, and not to describe. Accordingly, with a view to the prompt mental association of object with name, brief empiric names, based on the origin and properties of bodies, are, wherever practicable, to be preferred to structural names. As regards isomeric bodies, they may to a large extent be advantageously distinguished from one another by means of significant letters or syllables prefixed to the name common to the different isomers. But the suggested use of the particular letters α, β, γ, each in a special sense; also a general resort to the particles hydro-, oxi-, and hydroxi- as name-components; and, more especially, the innovation of substituting the word "hydroxide" for the long-established word "hydrate" are practices open to grave objection.

The Periodic Law, as illustrated by certain Physical Properties of Organic Compounds, by Prof. Thos. Carnelley, D.Sc.—In this paper the author shows that the physical properties of the normal halogen and alkyl compounds of the hydrocarbon radicals exhibit numerous relationships, which, with one exception, are similar to those which he has shown to exist between the normal halogen or the alkyl compounds of the elements. It appears that the physical properties of the following four classes of compounds obey the same rules:—(1) The halogen compounds of the elements—*i.e.* of elements with elements. (2) The alkyl compounds of the elements. (3) The halogen compounds of the hydrocarbon radicals. (4) The alkyl compounds of the hydrocarbon radicals—*i.e.* of hydrocarbon radicals with hydrocarbon radicals. The relationships referred to have been tested in no less than 6117 cases, 5 per cent. only of which are exceptions.

Suggestions as to the Cause of the Periodic Law, and the Nature of the Chemical Elements, by Prof. Thos. Carnelley, D.Sc.—The truth of the periodic law of the chemical elements is now generally allowed by most chemists. Nevertheless, but little has been done towards attaining a reasonable explanation of the law. The object of this paper, therefore, is to offer a few suggestions on this subject. Granting the truth of the periodic law, we cannot help theorising as to its cause, and thence by a natural step as to the nature of the elements themselves. Even long before the discovery of the law many chemists had pointed out certain numerical relationships existing between the atomic weights of bodies belonging to a given group, and had hence supposed that the elements belonging to the several natural groups were not primary, but were made up of two or more simpler elements. These conclusions, however, were more or less fragmentary, and referred only to particular groups of elements. In the light of the periodic law the author has made a general extension of the fragmentary conclusions of Dumas, and has brought that law into juxtaposition with an extended generalisation of the analogy of the elements with the hydrocarbon radicals. His conclusions are based on the relationships which he has observed to obtain between certain physical properties and the atomic weights of the elements, and those of their compounds (see previous paper). A careful consideration of the points submitted leads almost irresistibly to the conclusion that the elements are analogous to the hydrocarbon radicals in both form and function. This is a conclusion which, if true, would further lead us to infer that the elements are not elements in the strict sense of the term, but are built up of (at least) two primary elements, A (= carbon at. wt. 12), and B (ether at. wt. −2), which by their combination produce a series of compounds (viz. our present elements), which are analogous to the hydrocarbon radicals. If the above theory of the constitution of the elements be true, the periodic law would follow as a matter of course, and we should therefore be able to represent the elements by some such general formula as $A_n B_{2n+(2-x)}$, analogous to that for the hydrocarbon radicals, $C_n H_{2n+(2-x)}$, in which n = the series, and x the group to which the element or hydrocarbon radical belongs.[1] Assuming the truth of the theory here advanced, it is interesting to observe, that whereas the hydrocarbons are compounds of carbon and hydrogen, the chemical elements would be compounds of carbon with ether, the two sets of bodies being generated in an exactly analogous manner from their respective elements. There would hence be three primitive elements—viz., carbon, hydrogen, and ether. Finally, it may be stated that this theory would remove the chief objections which have been urged against the periodic law, whilst the existence of elements of identical atomic weights and isomeric with one another would be possible. May not Ni and Co, Ru and Rh, Os and Ir, and some of the rare earth metals be isomers in this sense?

The Value of the Refraction Goniometer in Chemical Work, by Dr. J. H. Gladstone, F.R.S.—The principal points illustrated and enforced in this communication were (1) that the index of refraction and length of spectrum are important physical properties of any substance; (2) the specific refraction and specific dispersion may be serviceable: (*a*) in determining the purity of a substance, (*b*) in the analysis of such a mixture as ethyl and methyl alcohols, (*c*) as a guide in the investigation of organic compounds, (*d*) as arbiter between rival views as to the constitution and structure of particular chemical compounds.

Refraction of Fluorine, by G. Gladstone.—From a comparison of the observations on fluorspar, cryolite, and several artificial fluorine compounds, the author shows the refraction equivalent of fluorine to range from 0·3 to 0·8, the mean of the whole series of determination being 0·6. Thus, taking the highest estimate, the specific refraction of this element is scarcely equal to half that of any other substance.

Note on the Conditions of the Development and of the Activity of Chlorophyll, by Prof. Gilbert, LL.D., F.R.S.—An account of some experiments made in conjunction with Dr. W. J. Russell, which show a close connection to exist between the formation of chlorophyll and the amount of nitrogen assimilated by plants; the amount of carbon assimilated is not, however, in proportion to the chlorophyll formed, unless a sufficiency of mineral substances, required by the plants, is available. In cases where both nitrogenous and mineral manures were applied a lower proportion of nitrogen assimilated and chlorophyll formed over a given area was observed, which is no doubt due to the greater assimilation of carbon and consequent greater formation of non-nitrogenous substances, although the amounts of nitrogen assimilated and chlorophyll formed were as great, if not greater.

On the Action of Sodium Alcoholates on Fumaric and Maleic Ethers, by Prof. Pardie, Ph.D., B.Sc.—By the action of *sodium methylate* on *ethylic fumarate*, *methylic methoxysuccinate* is formed, from which *methoxysuccinic acid* can be obtained, a crystalline solid melting at 101°–103°; this same acid is obtained from the products of the reaction of sodium methylate on *ethylic maleate* or *hydric methylic maleate*. Similarly an *ethoxysuccinic acid* is obtained by the action of sodium ethylate on *ethylic fumarate*, also by its action on *hydric ethylic maleate*. Thus fumaric and maleic acids yield alkyloxy-succinic acids, which are identical with one another, or, if not identical, resemble one another so closely that their isomerism must be of the same character as that of substances which differ from one another only in their optical and crystallographic characters.

On Sulphine Salts derived from Ethylene Sulphide, by Orme Masson, M.A., D.Sc. (Edin.).—Ethylene sulphide, when heated at 160°, is converted into diethylene sulphide $S(C_2H_4)_2S$, an ethereal solution of which, when mixed with methyl iodide, unites with the latter to form *diethylene sulphide methyl sulphine iodide* $S(C_2H_4)_2S.CH_3I$, which is a crystalline compound soluble in water, but insoluble in alcohol or ether. From this compound a series of the *sulphine* salts have been prepared, which resemble the salts of trimethyl sulphine in their behaviour when heated, but differing from these compounds in the ease with which they are decomposed by caustic alkalis with the formation of *diethylene sulphide methyl sulphine hydroxide* $(C_2H_4)_2S_2CH_3OH$. The compounds obtained by Dehn (*Annalen*, Supp. iv. 83) by heating together ethyl sulphide, ethylene bromide, and water together in sealed tubes, and styled "sulphinic salts" by him, were, in all probability, dimethylene sulphine-methyl-sulphine derivatives.

On an apparently new Hydrocarbon from Distilled Japanese Petroleum, by Dr. Divers and T. Nakamura.—A description of a yellow solid hydrocarbon found amongst the final products of the distillation of the petroleum from the wells at Sagara. The hydrocarbon melts at 280°-285°, and has a composition expressed by the formula $(C_4H_3)_n$.

The Composition of Water by Volume, by Dr. A. Scott, M.A., D.Sc.—After pointing out the desirability of renewed determinations of the exact proportions in which hydrogen and oxygen combine with one another, inasmuch as neither of these

[1] Cf. Abney's researches on the infra-red absorption spectra of carbon compounds (*Proc.* Roy. Soc., 31, 416), also the article on the Decomposition of Didymium by Welsbach in NATURE, vol. xxvii. p 435.

gases obey Boyle's law exactly, the author gave a description of the apparatus he had employed in making such determinations, which allowed the use of considerable volumes of these gases. The results obtained show the ratio not to be exactly that of 1 vol. of oxygen to 2 vols. of hydrogen ; but the proportions are 1 : 1·994 or 1 : 1·9935 ; or, if the impurity be supposed to exist in the oxygen alone, then the ratio is 1 : 1·996. The gases were examined as to their purity, the results indicating the presence of ·2 c.c. to ·3 c.c. of foreign gas in the 450 c.c. used.

In a communication entitled *On Solutions of Ozone and the Chemical Action of Liquid Oxygen*, Prof. Dewar gave a description of the apparatus and method employed by him in the liquefaction of such gases as oxygen, &c., and after discussing the conditions required for the successful conversion into the liquid state of the so-called permanent gases, he gave an account of some experiments made with liquid oxygen. At – 130° liquid oxygen loses the active characters possessed by this element in the gaseous state ; it is without action on phosphorus, sodium, potassium, solid sulphuretted hydrogen, and solid hydriodic acid. Other substances appear to undergo similar changes at very low temperatures ; thus liquid ethylene and solid bromine may be brought in contact without any action taking place, whereas gaseous ethylene and liquid bromine unite directly at the ordinary temperatures. Hautefeuille and Chapuis by subjecting a mixture of carbonic anhydride and ozone to great pressure obtained a blue liquid, the colour of which is due to the ozone. If ozonised air be passed into carbon disulphide at – 100°, the liquid assumes a blue colour, which disappears if the temperature be allowed to rise, and at a certain point a decomposition, resulting in the production of sulphur, takes place. The best solvent for ozone is a mixture of silicon tetrafluoride and Russian petroleum. These solutions of ozone are without action on metallic mercury or silver. Prof. Dewar, in remarking on the liquefaction of nitric oxide, stated that a comparison of its curve of liquefaction with that of methane shows the pressure to increase more rapidly with the temperature in the case of nitric oxide than in other gases, a fact which would appear to indicate, that at low temperatures the molecule of nitric oxide is of greater complexity, and probably exists as N_2O_2. An account was given of some of Cailletet's experiments on the electrical conductivity at low temperatures, which seemed to indicate that as the limit – 220° was approached ordinary electrical conductors become almost perfect conductors.

On the use of Sodium or other Soluble Aluminates for Softening and Purifying Hard and Impure Water, and Deodorising and Precipitating Sewage, Waste Water from Factories, &c., by F. Maxwell Lyte, F.C.S., F.I.C.—The advantages attending the use of sodium or other soluble aluminates for the above purposes are dependent upon their easy decomposition with the production of a precipitate of hydrated alumina, which removes organic matter, and further by their use the temporary hardness may be completely destroyed, and the permanent hardness reduced.

Some New Crystallised Combinations of Copper, Zinc, and Iron Sulphates, by J. Spiller, F.C.S.—The author gave an account of the preparation of a large series of double sulphates of copper and iron, zinc and iron, and copper and zinc.

In a communication on *Barium Sulphate as a Cementing Material for Sandstone* Prof. Clowes pointed out that, although Bischof mentioned instances of foreign sandstones in which the material cementing the sand grains together was barium sulphate, it appeared that up to the present time no such sandstone had been met with in the United Kingdom. Having learned that opinions differed regarding the calcareous nature of certain new red sandstone beds in the neighbourhood of Nottingham, he undertook to examine the chemical composition of these sandstones, and procured specimens of the sandstone from different levels. On being analysed, the sandstone was found to contain barium sulphate in varying proportions, at present being determined, while some of the lower beds also contained calcium carbonate. In some of the sandstone beds the barium sulphate was very unequally distributed, forming a network or a series of small masses more or less spherical in shape. In such sandstone the sand grains between the sulphate streaks and patches were quite loose, the result being that the weathered surface presented a honeycombed appearance. To explain the presence of the barium sulphate he suggested that it might have been deposited along with the sand ; but if such had been the case it had certainly undergone a physical change, as it now existed in a firm, compact, and crystalline condition. It would, therefore, appear that it had been either deposited from aqueous solution or that it had been rendered crystalline by a slow percolation of a solvent liquid through the sedimentary deposit, or owed its origin to the action of water containing calcium sulphate passing through sandstone cemented originally with barium carbonate.

NOTES

BOTANISTS will learn with very great regret of the death of Mr. Edmond Boissier, the learned and indefatigable author of the "Flora Orientalis," and many other important works on Systematic Botany. We have received no particulars, but we imagine his death must have been somewhat sudden, for the event was quite unexpected by his friends in this country. As recently as the month of August Prof. Oliver heard from him, the communication relating to the Supplements to the "Flora Orientalis," on which the deceased botanist has been for some time engaged, and in which he wished to incorporate the botanical results of Dr. Aitchison's latest investigations in Afghanistan. Boissier's career as a botanist may be said to have commenced with his travels in Spain in 1837, when he collected the materials published in his "Voyage Botanique dans l'Espagne," a richly illustrated work which appeared at intervals from 1839 to 1845. He subsequently travelled and botanically explored various parts of South-eastern Europe and Asia Minor. Independently of his larger works he published, separately, diagnoses of the exceedingly large number of undescribed species he found from within the limits of his "Flora Orientalis," the first volume of which appeared in 1867, and the last in 1881. This work alone is sufficient to place the author in the first rank of a school of distinguished systematists, now alas fast disappearing without leaving a corresponding rising generation to take up the work where they have left it. Like the late Mr. Bentham, M. Boissier was in a position to give his undivided attention to the science he had chosen, and like him he laboured unceasingly; and it is to be hoped that the supplement to the "Flora Orientalis" is in a sufficiently forward state for publication. Among other things the vast genus *Euphorbia* furnished materials for several valuable works, including a monograph of all the species, and a folio volume containing figures of 120 species. Mr. Edmond Boissier was a Foreign Member of the Linnean Society, having been elected in 1860: and from his constant readiness to give others the benefit of his extensive knowledge, he enjoyed the esteem and admiration of a wide circle of botanists.

THE death is announced, at the age of seventy-eight years, of Mr. John Muirhead, one of the very few survivors of the early days of telegraphy, and closely connected with its practical development. Mr. Muirhead, in conjunction with Mr. Latimer Clark and Mr. W. M. Warden, of Birmingham, founded the house now known as Latimer Clark, Muirhead, and Co., more than a quarter of a century ago. It was from this manufactory that Mr. Muirhead introduced the form of battery which bears his name, a form so eminently portable and practical that it has become the model for most of the existing batteries, while continuing itself to be largely employed.

A *Times* telegram dated Philadelphia, September 27, states that the President of the United States has asked Prof. Alexander Agassiz to accept the post of Superintendent of the Coast Survey.

A REMARKABLE memoir on the development of the sternum in birds, prepared by Miss Beatrice Lindsay, of Girton College, and communicated to the Zoological Society of London by Dr. H. Gadow at their meeting on June 16 last, will appear in the forthcoming number of the Society's *Proceedings*. Miss Lindsay, after close investigation of the embryonic condition of different stages in five types of bird-structure (the ostrich, guillemot, gull, domestic fowl, and gannet), has come to the conclusion that the keel of carinate birds is a special outgrowth of the true sternum peculiar to birds, and is not homologous with the episternum or interclavicle of reptiles, as has been held by Götte and others. There are no traces whatever in the embryonic stages of the ostrich, according to Miss Lindsay's observations, of the existence of any rudiments of the clavicles or keel. It follows that the view held by some morphologists that the ostrich may be a degraded descendant of some carinate form can no longer be supported.

THE Edinburgh International Industrial Exhibition will be opened on May 4 next.

A CORRESPONDENT of the *Times* in a recent article on the new Electorate, describes the fishermen at Staiths, a village on the Yorkshire coast, lying between Whitby and Saltburn. The people, he says, are imbued with all manner of quaint superstitions. They have a firm belief in witchcraft, the witch being wholly unconscious of his or her power of evil. Until recently—and it is said that the custom is still secretly maintained by some of the older inhabitants—it was customary, when a smack or coble had had a protracted run of ill-fortune, for the wives of the crew and owners of the boat to assemble at midnight, and, in deep silence, to slay a pigeon, whose heart they extracted, stuck full of pins, and burned over a charcoal fire. While this operation was in process the unconscious witch would come to the door, dragged thither unwittingly by the irresistible potency of the charm, and the conspirators would then make her some propitiatory present. Again, it is of frequent occurrence that, after having caught nothing for many nights, the fishermen keep the first fish that comes into the boat and burn it on their return home as a sacrifice to the Fates. All four-footed animals are considered by the Staiths folk as unlucky, but the pig is the most ill-omened of quadrupeds. If when the men are putting their nets into the boats the name of pig is by accident mentioned, they will always desist from their task and turn to some other occupation, hoping thus to avert the evil omen, and in many cases will renounce the day's expedition altogether. The sight of a drowned dog or kitten, too, as he goes towards his coble will always keep a Staiths fisherman at home; and, what is still more curious, if as he walks to his boat, his lines on his head or a bundle of nets on his shoulder, he chances to meet face to face with a woman, be she even his own wife or daughter, he considers himself doomed to ill-luck. Thus, when a woman sees a man approaching her under these circumstances she at once turns her back on him. If a fisher sends his son to fetch his big sea boots, the bearer must be careful to carry them under his arm. Should he by inadvertence place them on his shoulder his father will inevitably refuse to put out to sea that day. An egg is deemed so unlucky that the fishermen will not even use the word, but call it a roundabout; and, fearless as are the fishers in their daily struggling with the dangers of the sea, yet so fearful are they of nameless spirits and bogies that the writer was assured he could not find in the whole fishing colony of Staiths a volunteer who for a couple of sovereigns would walk by night to the neighbouring village, a couple of miles distant.

WE have received the report of Miss Pogson, the meteorological reporter to the Government of Madras, for the year 1884-85. It contains remarks on the various stations scattered over the Presidency, together with the usual tables. Part of the observer's work is to train learners, who afterwards take charge of the local stations. One of these, it is interesting to notice, is on the Laccadives, which islands are inaccessible during a great part of the year. The assistants in most cases are native officials.

ALL the legal steps have been taken by the French Government for entering into possession of the late M. Giffard's fortune, which is to be devoted to the good of science. The fortune is valued at 200,000*l.*, after paying about 100,000*l.* in legacies to friends, family, or scientific societies. The decree is ready and will shortly appear in the *Journal Officiel*. Several projects have been proposed already for utilising this large sum of money, but it is very likely nothing will be done before taking the advice of the French Academy of Sciences.

ON September 12, just after sunset, a remarkable mirage was seen at Valla, in the province of Sudermania, Sweden. It appeared first as a great cloud-bank, stretching from south-west to north, which gradually separated, each cloud having the appearance of a monitor. In the course of five minutes one had changed to a great whale blowing a column of water into the air, and the other to a crocodile. From time to time the clouds took the appearance of various animals, and finally that of a small wood. Subsequently they changed to a pavilion, where people were dancing, the players being also clearly visible. Once again the spectacle changed, now into a lovely wooded island with buildings and parks. At about nine o'clock the clouds had disappeared, leaving the sky perfectly clear. The air was calm at the time of the display, the temperature being 6° C.

THE aquarium at the Inventions Exhibition has lately been entirely restocked, the latest arrivals being a fine selection of bass weighing 10 lbs., some large specimens of Crustaceans, and an assortment of flat-fish of all descriptions. There is also on view a diversified collection of foreign freshwater fish presented by the General Import Company.

CAPT. VIPAN'S aquarium of foreign fishes at Stibbington Hall, Wansford, is a most valuable one, and includes unique and rare specimens of fish from all parts of the world, which are retained with the utmost care, the temperature of the water being regulated to suit the natural necessities of the various fish. This aquarium is considered to be one of the most unique in the United Kingdom, and increases in value annually on account of periodical additions to the collection.

THE taxidermist who has had charge of the work upon the body of "Jumbo," who was recently crushed between two trains, states that the elephant's stomach contained many English coins—gold as well as silver and bronze. His tusks had by the collision with the train been driven nearly through the skull. According to later accounts as to the accident, Jumbo at the last moment faced and charged the locomotive. The elephant's skin was found to be an inch and a half thick, and it weighed 1537 lbs. The skeleton weighs 2400 lbs., and the total weight of the body was over 6 tons.

MESSRS. SWAN SONNENSCHEIN AND CO. announce, for the season 1885-6, the following publications:—"A Treatise on Animal Biology," by Prof. Adam Sedgwick, Fellow and Lect. of Trin. Coll., Camb. (illustrated); "Practical Botany," by Prof. Hillhouse, of Mason Coll., Birm., based upon the work of Prof. Strasburger (largely illustrated); a translation of Profs. Nægeli and Schwendener's work, "The Microscope in Theory and Practice," with several hundred woodcuts; an "Alpine Flora," a pocket handbook for botanists and travellers, by Mr. A. W. Bennett, B.Sc., M.A.; an illustrated "Handbook of Mosses," by Mr. J. E. Bagnall; a "Star Atlas," by the Rev. T. H. Espin; further parts of Mr. Howard Hinton's "Scientific Romances"; an entirely new and partly re-written edition of Prof. Prantl and Vines's "Text-Book of Botany"; "From Paris to Pekin over Siberian Snows," an account of the Asiatic wanderings of M. Meignan, by Mr. William Conn; "The Wanderings of Plants and Animals," an adaptation from the German work of Prof. Victor Hehn, by Mr. James Stallybrass, tracing (chiefly by means of etymology) the history and the migration of European plants and animals to their home in Asia.

MESSRS. CROSBY LOCKWOOD AND CO. make the following announcements for the approaching publishing season:—"Electro-Deposition," by Alexander Watt, author of "Electro-Metallurgy"; "The Prospector's Handbook, a Guide for the Prospector and Traveller in Search of Metal-bearing or other valuable Minerals," by J. W. Anderson, M.A., F.R.G.S.; "The Engineman's Companion, a Practical Educator for Enginemen, Boiler Attendants, and Mechanics," by Michael Reynolds; "The Combined Number and Weight Calculator," by Wm. Chadwick, Public Accountant; "Our Temperaments, their Study and their Teaching, a Popular Outline," with illustrations, by F.R.C.S.E.; "The Artist's Tables of Pigments," by H. C. Standage; "Land and Marine Surveying," by W. Davis Haskoll (entirely new edition); "The Metal Turner's Handbook, a Practical Manual for Workers at the Foot Lathe," by Paul N. Hasluck (second edition, revised), being the first volume of a new series of "Handbooks on Handicrafts."

THE "Sun" Knife-cleaner has some points which deserve notice. It is supported on a light cast-iron standard, the upper portion of which is bored out and faced to make the bearing where alone perfect fit is required. A cast-iron spindle is fitted into this bearing, and supports upon a flattened face two spring disks made of cast steel finely tempered, dished in the centre and having rays upon them like the spokes of a wheel, which turn slightly outwards at their ends, so as to form a tapered space adapted to the wedge form of the length of the knife. These springs are so mounted upon the spindle that the rays of the one are opposite to the space, between the rays of the other. The spindle is terminated by a screw upon which a thumb nut is fixed to hold the handle in position and keep the working parts together. By means of this screw the springs can be pressed more or less closely together as required. Leather rings are riveted to the inner faces of the springs, and form the surfaces upon which the knives are cleaned and polished; the rivets are in the dished portion of the springs and so out of the way of the knife-blade; the polishing powder is supplied through a hole in the face of the front spring. The knife whilst being cleaned is supported below a wrought-iron piece cast into the standard and passed in and out of the machine. The difficulty in cleaning a knife is due to its double wedge form. A knife is a long wedge from the tip to the shoulder, and a short wedge from the edge to the back, and it is evident that the pressure brought to bear upon it must be of an elastic character, so as not to grind the knife away. As regards the length of the knife this is effected by the outward taper of the rays of the springs. The two leather rings between which the blade is passed in and out being pressed against the blade of the knife by the rays of the springs as described, it is evident that there is an elastic pressure upon it; the spring on the one side diminishes in its bearing pressure, as that on the other side increases, and hence an equable pressure is applied to all parts of the blade, as is proved by the excellent polish produced. A small portion of powder being supplied through the hole in the front spring, the knife is placed with its edge downwards below the wrought-iron support and passed slowly in and out of the machine between the leather disks with the left hand, whilst the right hand is employed in turning the handle of the machine in the direction of the hands of a clock. In this way from one inch to two inches in depth of the surface of each leather (depending upon the size of the machine) presses elastically upon the blade. This being the reatest frictional resistance at any moment between the blade nd the polishing surfaces, the labour of cleaning is reduced to a minimum, while the knife can be polished to the shoulder owing to the leathers being bevelled. Special to ls have been designed for cutting and bending the wrought-iron supports in one operation, for cutting and bevelling the leathers, and riveting and fitting them to the springs. These machines are supplied in four sizes.

IN contrast to the weather in Southern Norway during May and June (NATURE, vol. xxxii. p. 354) the weather of July was warmer and more normal, the mean temperature of the month—viz. 17·1° C. being 0·5° above the normal, 16·6°. This is chiefly due to the southern winds prevalling in the first part of the month. On July 21, however, the weather changed, northern and north-western winds prevailing, with clear and dry air, and in consequence of the great radiation, the temperature fell several times very low during the second part of the month. The minimum temperature—viz. 6·4° C.—was registered at Christiania on the night of the 22nd., and the highest—viz. 29° C.—on the 6th. The rainfall was 40 per cent. below the normal. With the exception of the coast towards the Naze, the month has been cold throughout the land on the whole, the most unfavourable parts being the west coast, where the temperature was 1° C. below the normal mean. In the mountains and in East Finmarken it sank several times below 0°. The rainfall in the southern and eastern parts was below the average, but in th northern and north-western parts it was above it. The greatest rainfall was registered in Finmarken, where, in Alten, for instance, it was 142 per cent. above the average.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Paterson; a Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazons, presented by Mr. F. J. Hammond; two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mr. F. Debenham and Miss Lucy McArthur; two West Indian Agoutis (*Dasyprocta cristata*), seven Crab-eating Opossums (*Didelphys cancrivora*), two Rough Terrapins (*Clemmys punctularia*), two Brazilian Tortoises (*Testudo tabulata*), two Teguexin Lizards (*Teius teguexin*), two Tuberculated Iguanas (*Iguana tuberculata*), nine Giant Toads (*Bufo aqua*) from Trinidad, presented by Mr. F. J. Guy; two Palm Squirrels (*Sciurus palmarum*) from India, presented by Mr. A. Bellamy; a Great Kangaroo (*Macropus giganteus* ♂), a Rufous Rat Kangaroo (*Hypsiprymnus rufescens*) from New South Wales, a Roan Kangaroo (*Macropus erubescens* ♀) from South Australia, presented by Mr. C. Czarnikow, F.Z.S.; a Common Crossbill (*Loxia curvirostra*), British, presented by Mr. H. S. Eyre; a Green Lizard (*Lacerta viridis*) from Jersey, presented by Mr. G. V. Colliver; a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, two Bonnet Monkeys (*Macacus sinicus*) from India, two Ælian's Wart Hogs (*Phacochærus africanus* ♂ ♂) from Africa, deposited; a Garnett's Galago (*Galago garnetti*) from East Africa, a Harnessed Antelope (*Tragelaphus scriptus* ♀), an Elate Hornbill (*Ceratogymna elata*) from West Africa, a Puff Adder (*Vipera arietans*) from South Africa, a Lacertine Snake (*Cœlopeltis lacertina*), European, an Aldrovandi's Lizard (*Plestiodon auratus*) from North-West Africa, purchased; a Leopard (*Felis pardus*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, OCTOBER 4-10

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 4

Sun rises, 6h. 8m.; souths, 11h. 48m. 37·5s.; sets, 17h. 29m.; decl. on meridian, 4° 31′ S.: Sidereal Time at Sunset, 18h. 29m.

Moon (New on October 8) rises, 1h. 10m.; souths, 8h. 31m.; sets, 15h. 41m.; decl. on meridian, 12° 2′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 10	11 18	17 26	0 43 N.
Venus	9 55	14 17	18 39	19 4 S.
Mars	0 15	8 0	15 45	18 47 N.
Jupiter	4 13	10 38	17 3	4 12 N.
Saturn	21 35*	5 43	13 51	22 18 N.

* Indicates that the rising is that of the preceding day.

Oct.	h.	
6	17	Jupiter in conjunction with and 1° 25′ north of the Moon.
7	20	Mercury in conjunction with and 0° 29′ north of the Moon.

HEREDITY

At the February meeting of the Swedish Anthropological Society Prof. Wittrock read a paper on the hereditability of colour of the eyes. The speaker had been requested by Prof. Alphonse De Candolle, of Geneva, to make observations on this point, which, together with those made in Switzerland, North Germany, and Belgium, had formed the material for M. De Candolle's paper, "Hérédité de la couleur des yeux dans l'espèce humaine" (*Archives des Sciences Physiques et Naturelles*, 3e période, t. xii., Genève, 1884). From the same the remarkable fact was derived that brown eyes were more common in men than women; of the individuals examined 41·6 per cent. of men and 44·2 per cent. of women had brown eyes. Further, in families where the parents had the same colour of eyes 80 per cent. of the children of parents with brown eyes had brown eyes, whilst of children of parents with blue eyes 93·6 per cent. of them had eyes of that colour. The unconformity was no doubt due to atavisme or the hereditary influence of ancestors. Of the children of parents of whom the father had brown and the mother blue eyes 53·3 per cent. had brown, whilst where the reverse was the case 55·9 per cent. had blue eyes. As the percentage of brown-eyed children of parents with bi-coloured eyes was highest, it seemed as if brown eyes were always on the increase to the detriment of blue ones. It appeared also from these researches that women with brown eyes have better prospects of marrying than those with blue. 52 per cent. of the married women had brown eyes, and only 48 per cent. of them blue—a circumstance which is the more remarkable as the number of women with brown eyes in Italian Switzerland is only 44 per cent. Another remarkable discovery was that the average number of children of parents with eyes similar in colour was 2·7, whilst that of those with different colour was 3·18, which was an additional proof of the fact that children of parents with similar organisation were as a rule of weak constitution. Comparing the colour of the eyes of the children where the parents were bi-coloured, with those of each of the latter, it was discovered that the eyes of the father were inherited by 48·8 per cent. of the children, and those of the mother by 51·2 per cent., which, divided between sons and daughters, showed that 47 per cent. of the former and 49·5 per cent. of the latter inherited the eyes of the father, whereas 53 per cent. of the sons and 50·5 per cent. of the daughters inherited those of the mother. Since Prof. Candolle had published his paper, he (the speaker) had continued his researches in Sweden, and from the material he had collected he had discovered results differing from Prof. Candolle's. Of the individuals reported to him 29·6 per cent. of the men and 30·7 per cent. of the women had brown eyes, so that even in that country the latter were more numerous than the former, but this was no doubt due to the circumstance that he had been most anxious to obtain particulars from bi-coloured parents. In accordance with Candolle's results, 75·6 per cent. of children of parents both with brown eyes inherited this colour, whilst of those with blue eyes 97 per cent. inherited that colour. It was but natural that this should be the case in Sweden, where blue eyes predominated. As regards the bi-coloured parents the case was different in Sweden too. If the father had brown and the mother blue, 59·9 per cent. of the children had brown eyes, whilst where the reverse was the case 53 per cent. of them had brown ones. These figures were the reverse of Candolle's. But of *all* bi-coloured parents 56 per cent. of the children had brown eyes, *i.e.* that in Sweden too the latter are on the increase. He could not say what *rôle* the colour of the eyes played in the selection of a wife in Sweden, as he had no statistics of the distribution of brown eyes in general, but there was a tendency similar to that stated above, as, of the parents embraced by these researches, the majority of wives had brown eyes. With reference to the number of children in Sweden of con-coloured and bi-coloured parents, that of the former was 4·49 and that of the latter 4·03, whilst 52·6 per cent. of the children inherited the eyes of the father and 47·4 per cent. those of the mother; of the sons 51·8 per cent. inherited the eyes of the father, and 48·2 per cent. those of the mother, which figures as regards the daughters were respectively 53·5 and 46·5 per cent. This shows that in Sweden the eyes are not predominantly inherited from the mother alone, and that the offspring of equally-constituted parents should not be weaker. The speaker stated in conclusion that he is continuing his researches. He excludes children under ten years of age from the same, and classifies blue-grey or grey eyes as blue.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Prof. W. Grylls Adams, F.R.S., will deliver a Course of Lectures at King's College, London, on Heat and Light, during the Academical Year 1885-6. A Course of Practical Work in Electrical Testing and Measurement, with especial reference to Electrical Engineering, will be carried on under his direction in the Wheatstone Laboratory. There will also be a Course of Lectures on Mechanics and the Principles of Energy. The Wheatstone Laboratory is open daily from 1 to 4, except on Saturdays. For further particulars apply to Prof. Adams, King's College, London.

The following appointments have recently been made at the Victoria University, Owens College, Manchester:—To the Professorship of Mathematics: Mr. Horace Lamb, M.A., F.R.S., late Fellow of Trinity College, Cambridge, and Professor of Mathematics in the University of Adelaide. To the Professorship of Anatomy: Mr. Alfred H. Young, M.B., F.R.C.S.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 21.—M. Bouley, President, in the chair.—On the development of cholera in India, by M. Gustave Le Bon. In support of Prof. Peter's view that European differs from Asiatic cholera only in the greater intensity of the causes producing it, the author argues that both forms might break out spontaneously in any country through the volatile germs arising from putrified organic matter. In his former researches he showed that, apart from these germs, there exists a series of volatile alkaloids which, when introduced by respiration, produce almost fulminating effects. These researches throw much light on the accidents attending the exhumation of bodies long buried and on the spread of typhoid or analogous fevers. The facts recently observed by M. Le Bon during a sudden outbreak of cholera at Kombakonum, in the south of India, tend to confirm this hypothesis. In India itself cholera rages almost exclusively amongst the native populations; the English, who reside in large cantonments, where sanitary arrangements are scrupulously attended to, being seldom attacked. That cholera and intermittent fevers are propagated chiefly by bad water is a point on which opinion is unanimous in that country, and the author's personal experience places it beyond all reasonable doubt.—Elements of Brooks's comet, by M. R. Radau. These elements, according to observations made at Cambridge and Paris, are found to be:—

$$T = 1885\text{, August } 10{\cdot}30457\text{; mean Paris time.}$$

$$\left.\begin{array}{rl} \pi - \Omega = & 43\ \ 0\ 47 \\ \Omega = & 204\ 33\ \ 7 \\ i = & 59\ 22\ 30 \end{array}\right\}\text{ Mean equinox of } 1885{\cdot}0.$$

$$\log q = 9{\cdot}87694$$

—Note on a new stellar spectroscope, by M. Ch. V. Zenger. This instrument is constructed on a new principle, and chiefly intended to measure simultaneously and accurately the angle of position and the distance of double stars situated very close together.—On the process of fertilisation in the Cephalopods, by M. L. Vialleton.—On the anatomical organisation of the urns in *Cephalotus follicularis*, by MM. Jules Chareyre and Edouard Heckel.

BERLIN

Physiological Society, July 31.—Prof. Fritsch spoke on the functions of the sebaceous glands, raising a protest against the conception, represented quite recently by Herr Unna, that these glands served only to lubricate the hairs, while the globiform glands, commonly called the sudoriparous glands, lubricated the skin and induced the formation of the subcutaneous fat, and that, finally, the perspiration was discharged by the sweat-pores, or, rather, the extreme ends of the straight canals into which the sweat found its way out from intercellular spaces through the stomata. A whole series of anatomical, histological, and physiological grounds were brought forward against this view both by the speaker and, in the course of the discussion on the subject, by Prof. Du Bois-Reymond, Prof. Waldeyer, Dr. Gad, and Dr. Lassar. All known observations and experiments were, on the contrary, they maintained, in favour of the view that the sebaceous glands provided fat for the skin, while the globiform glands had the production of sweat assigned to them.—Dr. Weyl reported on the results of a chemical examination of the cholesterin, the composition of which had not hitherto been ascertained, although this substance had been discovered more than a hundred years ago, and had since been traced in the most varied organs of the animal body and even in plants. The most searching investigation down to the present of cholesterin had been made by Herr Zwenger, who, by treatment with sulphuric acid and nitric acid, had found combinations which he had distinguished and chemically characterised as cholesterylene and cholesterone. By repeating these experiments Dr. Weyl had achieved much purer derivatives of the cholesterin, in particular chloric and bromic combinations, in very pure crystals, which rendered exact elementary analysis possible. This led to the result that the derivatives of cholesterin were found to be hydrocarburets belonging to the great class of the terpenes—that is, they were products of condensation or polymerisations of the simple terpene (C_5H_8). Even though it were not yet possible to state precisely the number of the C_5H_8 which had become polymerised in the several cholesterin derivatives, the speaker yet thought he had sufficient ground for assuming that the composition $(C_5H_8)^5H_2O$ was the one proper to the cholesterin itself. Substances which, both by their reactions and their percentage compositions, were denotable as terpenes, might also be obtained from the choleic acid, a circumstance which pointed to the more intimate relation between cholesterin and choleic acid.—Dr. Biondi communicated the results of an investigation carried out by him in the Institute of Prof. Waldeyer with a view to throwing light on the origin of the spermatozoids in the seminiferous canals—a question on which the views of physiologists were so widely divergent. By appropriate use of appliances for hardening, fixing, and colouring, among which the advantages of Flemming's fluid had to be mentioned with quite special prominence, Dr. Biondi arrived at results which corroborated none of the views formerly put forth, but which explained the earlier observed facts. In accordance with these results it had been endeavoured diagrammatically to distribute the contents of the seminiferous canals into columns, which, proceeding from the wall towards the central cavity, might be grouped into three layers. In the first stage of development, a stage always met with, in particular, in animals not yet ripe, the extreme layer lying on the wall of the canal consisted of round, primitive cells, the second layer, proceeding inwards, of round mother-cells, which were very rich in caryokinetic figures, and the third innermost layer consisted of a larger number of small round daughter cells. In a second stage of development observable in ripe glands the nucleus of the daughter cells were seen converted into spermatozoids, the exterior half of the nucleus becoming the head and the other interior half the middle part and tail of the spermatozoon. The protoplasm of the daughter cells took no part in this transformation, and enveloped the bodies of the spermatozoa, making them cohere into bundles from which the tails of the spermatozoa projected towards the central canal. These masses of protoplasm enveloping the bodies of the spermatozoa altogether resembled the figures described by the earlier observers as "Spermatoblasten." In this stage the above diagrammatically assumed column consisted, from the outside inwards, of the primitive cell, the mother cell, and the bundle of spermatozoa. In the next stage of development the formation of the spermatozoa, arising always in the same manner from the nucleus of the daughter cells, was pushed farther outwards, so that the column now consisted of but one large round cell on the outside and bundles of spermatozoa on the inside. The formation of the seminal corpuscles advanced still further, and at last the whole column, as far as the wall of the canal, consisted of spermatozoa, the bodies of which were agglutinated into bundles by masses of protoplasm, their tails being directed inwards. Primitive cells out of neighbouring columns now intercalated themselves between the wall of the canal and the spermatozoa, pushing the latter towards the middle. By the development of the mother and daughter cells the spermatozoa were quite pressed and discharged into the central canal. The process thus described then began anew. It must, however, be observed that in nature there was no separation into columns and layers such as was here diagrammatically described. It was only for the sake of clear representation that the processes succeeding each other in time were thus exhibited as divided in space. Dr. Biondi had examined this structure of the seminiferous canals, and this development of the spermatozoids in the bull, the swine, the cat, the rabbit, the guinea-pig, the rat, and other mammalia; and in all these cases he had found alike the same results. Prof. Waldeyer testified that Dr. Biondi had attained to these results quite independently and had communicated and demonstrated them to him as early as February of this year. It was only on his advice that Dr. Biondi had further examined a longer series of animals before publishing his results. A few days ago, continued Prof. Waldeyer, he had received a letter from Prof. Grünhagen in Königsberg, in accordance with which he (Prof. Grünhagen) had attained to the same results on spermatogenesis as had Dr. Biondi, to whom, of the two independent discoverers, was due the title of priority.—Dr. Blaschko briefly explained a series of microscopic preparations he exhibited, which served to show that between the epidermis and the cutis there lay no cementing substance; but just as it was long known that in the case of the epidermis cells they had processes grooving themselves digitately into one another, so here, too, the processes of the epidermis and cutis cells were seen to intertwine with one another and form a network, the meshes of which were particularly large in an œdematous skin.—Dr. Lassar demonstrated microscopic preparations of skin which he had excided from a patient suffering under lichen ruber. In the copious protoplasm (the exudation of the inflammation) surrounding the canals of the epidermis there were seen, after colouring with fuchsine and Bismarck-brown, an uncommonly large number of micrococci, distinguishing themselves particularly by their remarkable smallness.

CONTENTS

THURSDAY, OCTOBER 8, 1885

MR. GRIEVE ON THE GAREFOWL

The Great Auk, or Garefowl (*Alca impennis*, Linn.), *its History, Archæology, and Remains.* By Symington Grieve, Edinburgh. 4to, pp. x. 141, and Appendix, pp. 58. (London: Jack, 1885.)

AGREEABLY to the wish of the editor of NATURE that I should notice in its pages the lately-published volume whose title stands above, I undertake a responsibility of a kind which is for me as delicate as can be imposed upon anybody. It has long been no secret that for more than five-and-twenty years—since, indeed, the premature death, in 1859, of my friend and fellow-traveller, the late Mr. JOHN WOLLEY—I have had it in hand to prepare and eventually to produce a monograph of the presumably extinct species of bird, into the investigation of whose history he had thrown himself with all the energy of his character. During that time I am not conscious of having ever lost an opportunity of adding to my store of information on the subject, in doing which I was for several years assisted by the zeal of the late Mr. G. D. Rowley; and, though always having in view the ultimate publication of the monograph originally contemplated by Mr. Wolley, I never hesitated to supply any inquirer with the particulars for which he asked—as may be seen on reference to the publications of Dr. Victor Fatio[1] and of Prof. Wilhelm Blasius[2]—both of whom I rejoice to think I was able in some measure to help. Nevertheless, each attempt to elucidate the natural history of the Garefowl only added to the number of still unanswered or unanswerable questions relating to it; and, amid numerous other occupations or duties, I have with difficulty been able to keep myself abreast of the ever-increasing contributions to the subject—many (I may say most) of them proving on investigation to have little or no foundation; and those which had the least, or none at all, generally giving the greatest trouble.

Apology, I feel sure, is needed for an introduction so egotistical as that contained in the foregoing paragraph; yet without it, or something like it, I fear my remarks on the book before me may be misunderstood. The force of circumstances has compelled me to set up a very high standard; and, when that standard has not been approached by any writer on the subject, it is almost impossible for me not to see his shortcomings, though many another man might find in him no fault at all. I therefore wish at once to record my opinion that in the present work the author has done the best that in him lies, and especially that his book, so far as it goes, is an honest book. If, after working at the subject for more than a quarter of a century, a man still finds himself unable, from one cause or another, to publish the results of his labour, it does not follow that he should be hard upon anybody else who, with perhaps as many distractions, makes a praiseworthy attempt to set before the world what is known of the lost species, though he may not have devoted to the task a tenth of the time. Moreover, Mr.

[1] *Bull. Soc. Orn. de la Suisse*, ii. pt. 1, pp. 5-70, 73-85.
[2] *Ver. f. Naturw. zu Braunschweig*, iii. pp. 89-115; *Journ. für Orn.*, 1884, pp. 58-176.

Grieve begins his preface with the words: "In submitting these pages to the public, the author has fears that they will not bear severe criticism." I regret to say that regard to truth obliges me to declare that this is so; but I have no wish to be the severe critic, and it will be best here to describe the plan and scope of the work, which is obviously well chosen. Mr. Grieve begins with a very appropriate dedication to Prof. Steenstrup, that venerable biologist who first wrote a history[1]—he modestly called it only a "contribution" to a history—of *Alca impennis* that was in accordance with facts, and was worthy of the subject, of science, and of himself. The amount of indebtedness to him, due from all his successors in the investigation—but not always acknowledged—is not to be overrated. Hard as they may have found their work, it has almost entirely lain in clothing the form that he constructed; and, though there has been plenty of false tailoring, his outlines have proved to be true in almost every particular. In the dedication Mr. Grieve very justly states that he has not "much to relate that is new to British ornithologists;" but his desire has been "to bring within the reach of all, materials that at present are difficult of access."[2] These preliminaries over, the geographical range of the species—first in American and then in European waters—is entered upon, care being taken to warn the reader against the popular misconception that it was ever a bird of the high north, and then is given a description of its remains as found in the New World and in the Old. Under the last category come four chapters treating respectively of the discovery of its bones in Caithness, and in Oronsay, of the period to which the kitchen-midden on that island containing them presumably belongs, and of the single fragment found near Whitburn-Lizards, on the coast of Durham, by Mr. Hancock, which fragment, being the greater portion of the maxilla of what seems to have been an exceptionally large example, now in the Museum at Newcastle-on-Tyne, is very delicately figured (p. 64). After this Mr. Grieve enters upon a consideration of the bird's habits and of the regions in which it lived, and then proceeds to catalogue at some length (pp. 76-114) its existing remains—whether bones, skins, or egg-shells. Then follow three chapters on the uses to which the bird was put by man, on the names by which it has been known, with their possible origin and meaning, and on the period during which it lived. No fewer than nine appendices are added—all more or less of the nature of *pièces justificatives*—while an excellent index, with remarks on the accompanying chart, completes the volume, which is illustrated by several woodcuts and a couple of coloured plates representing the two eggs that doubtless came to Edinburgh in 1819 with Dufresne's collection, when it was bought by the University there, and, having been transferred to the Museum of Science and Art in the northern capital, were first publicly noticed by Major Feilden in 1869.

There cannot be a dispute as to the great pains which the author has taken with this work, but it would be inexpedient here to attempt any criticisms of its details, to an abundance of which exception may be taken. The

[1] *Vidensk. Meddel. Naturh. Forening i Kjöbenhavn*, 1855, pp. 33 to 118.
[2] Here may be added that, if report speaks truly, so strong has been this desire on the part of the author, that the book is sold to the public at less than cost price.

A A

fact seems to be that up to a certain point the story of the Great Auk can be worked up and told by any one willing to labour at it. Beyond that point the difficulties begin. Mr. Grieve appears to be hardly aware of the existence of these difficulties, though some of them have been hinted at, if not pointed out, by his predecessors. The most serious charge that can be brought against him is that he has needlessly raised fresh difficulties for future investigators. Mistakes that have taken years of labour to correct, and the correction of which has been published, are again set agoing, just as if no progress in that direction had been made; and, even worse than this, some new assertions, or at least suggestions, are hazarded that have, I am persuaded, no firm ground. No doubt on some of these points I may be prejudiced; but according to my knowledge I perceive that on too many questions Mr. Grieve has been unable to distinguish between good evidence and bad. However, there is in this book a distinct gain to all historians of the Garefowl, and that is the information here first placed on record by Mr. Champley of Scarborough, who is known to have interested himself for many years in all that concerns this species.

I most sincerely wish that I could accord higher praise to this work than I have been able to do, for Mr. Grieve's enthusiasm in the cause deserves greater success. It is seldom that any one but a Fennimore Cooper or a Charles Kingsley feels the romance that clings around the history of an expiring race. Most men—men of science especially—nowadays believe in the survival of the fittest, and are content to let the dead bury their dead. The moral lesson I do not venture to draw, and in conclusion have only to ask pardon of the readers of NATURE for putting myself so forward in this article.

ALFRED NEWTON

"THE WAVE OF TRANSLATION"

The Wave of Translation in the Oceans of Water, Air, and Ether. By John Scott Russell, M.A., F.R.S. (London: Trübner and Co., 1885.)

THE late Mr. J. Scott Russell was one of the most prominent and gifted naval architects which this country possessed in the middle of the present century. His name will long be remembered as the builder of the *Great Eastern*, the early advocate of the longitudinal system of framing iron and steel ships: the ingenious and eloquent expounder of the "wave-line" principle of design; and for many improvements in the theory and practice of iron steamship construction. His personality was at once striking and attractive, and his abilities were of an original and versatile kind. He was the author of a massive work upon naval architecture; and of numerous papers read before various learned societies. No one exercised greater influence than Mr. Scott Russell in promoting the cause of scientific education in naval architecture, and in stimulating and helping students, by numerous speeches and writings, to acquire a general and clear knowledge of the laws upon which the qualities of ships depend.

Mr. Scott Russell's writings were always interesting. He possessed the rare faculty of making the driest and most complicated of subjects intelligible, and even fascinating. Where he may not be correct in the hypotheses, or justified in the sweeping generalisations, he sometimes hastily put forward, he is usually suggestive, and provocative of thought upon the part of his readers. He was a vigorous and clear—though with a tendency to be a too rapid—thinker; and there are no writings upon naval architecture which have the power of fixing the attention and stimulating the intellect in a greater measure than those of Mr. Scott Russell.

We regret to say that the present work is not likely to add to the reputation of its author. It exhibits *les défauts de ses qualités* in their most pronounced form; and if we were asked for an example of Mr. Scott Russell at his very weakest and worst we could hardly do better than refer to that portion of this book which has not been before published. One-half of the volume is devoted to a reprint of the Report made by Mr. Scott Russell to the British Association in 1842-43, in which a description is given of the "solitary wave of translation," which he discovered for himself in 1834, and the properties of which he did much to investigate and make known. This Report is not only printed *in extenso*, but Part I. of the work consists exclusively of extracts from it. The same matter appears twice over—once as Part I. of the book, and once as portions of the British Association Report. The Report describes the knowledge possessed by Mr. Scott Russell in 1843 of "the varieties, phenomena, and laws of waves, and the conditions which affect their genesis and propagation." This may be interesting from a biographical point of view, but its present scientific value is not great. Many things have happened since the date of this Report, such as the theoretical investigations of Airy, Stokes, Rankine, Froude, eminent French mathematicians, and others; and numerous observations have been made of the forms and properties of waves by scientific officers of our own and foreign navies. These constitute a mass of information which the present work completely ignores.

One half of the book is taken up with the reprint of the British Association Report referred to, and with those extracts from it of which Part I. is made up. The remaining half contains the only new matter now published. This is divided into two sections, one being "on the analogy between the solitary wave in water and the sound wave in air," and the other "on the great ocean of ether and its relation to matter." The less said of these chapters the better. The following is an instance of how Mr. Scott Russell frames a theory or invents a hypothesis: "I am so impressed with the truth of this law, that the velocity of this solitary wave in any fluid is due to the depth of the fluid in which it moves, whether thick or rarefied, that I hazard the hypothesis, that in the unknown element which pervades the universe, and which, though unknown, is the cause and medium of the most familiar phenomena of everyday life, proceeding on the same basis of calculation as in the air and water occurs, we shall find that the ethereal ocean should be given a height of 5,000,000,000 miles, and that the corresponding velocity of the solitary wave through that ocean would be 1,000,000,000 feet per second."

An atomic theory is framed upon the following basis: "The law of attractive force in the atom, in conformity with the law of Newton, is according to the *square of the* *nearness*, and I propose to take as the law of repulsive force, the *cube of the nearness*. I think I am justified in taking this as the true law of repulsion of atoms of matter, because I find from the researches of eminent chemists that all free gases do so expand as to double their bulk by an increase of the distance of the particles, in the ratio of the cube of their nearness, or as 111 cube to 367." Then the theory of heat that is put forward appears to be a kind of material theory: "We may therefore define heat as *the effort of ether to resist crowding*. . . . Ether existing all around us in a normal state may be called *free ether*. Ether enclosed by force in limited space surrounded by material atoms is imprisoned or stored ether; its greater or less degree of crowding or storing means degrees of heat, and the quantity of crowding among the atoms indicates the specific heat of these atoms, and sometimes the specific heat of that kind of matter."

One more extract and we have done:—"Even Sir Isaac Newton's calculations of the speed of sound fell 100 feet short of the truth, and therefore corresponded to an error of a mile in the height of the atmosphere, and he could invent nothing better to account for the error than this sudden inflammation of the atmosphere. To this the reply is that the existence of the solitary wave of translation was not known to Newton, that the nature of its genesis and propagation could not therefore be calculated; but that present knowledge of the nature and laws of this wave completely explain and accurately measure its phenomena without the introduction of any hypothesis contradicted by fact."

We have said enough to show the character of this treatise, and we will conclude by repeating that we are sorry to see a posthumous work by so eminent a man as the late Mr. Scott Russell, containing nothing more to justify its publication than a reprint of his well-known, and imperfect, views in 1843, upon wave motion, and a fanciful interpretation of great physical laws. It is a pity that greater skill and discretion were not brought to bear upon the production of this volume.

OUR BOOK SHELF

Publication of the Norwegian Commission of the Measurement of Degrees in Europe. (1) Geodetical Operations, Part IV. (2) Tidal Observations, Part III.

THE first of these publications contains an account of the northern portion of the trigonometrical work undertaken to connect the side Stokvola-Haarskallen with the side Spaatind-Næverfjeld. The former side is directly connected to the base measured in 1864 near Levanger, as described in Parts I. and III. of the "Geodetical Operations."

A trigonometrical survey of this part of the country had already been made in 1835-6 by Gen. Broch, and it was at first hoped that this survey could be utilised, but on closer investigation it was found that the observations were not of sufficient precision to meet the requirements of the Commission for the Measurement of degrees in Europe, for which this work was to a great extent undertaken. The old stations were, however, utilised in the northern part of the triangulation; there the signals were well-built masonry cylinders. In the southern portion, however, the stations had in many cases entirely disappeared and had to be reconstructed. A careful description of each station is given, and in every case, with one or two exceptions, the signal could not be placed at the centre of the station; the usual measurements for reduction were therefore made, and apparently with more than usual care. The observations were taken with a 10-inch universal instrument made by Olsen and with a 12-inch theodolite made by Reichenbach. It would appear that the graduation of these instruments is not of a very high order; at any rate, the differences in the readings are rather large, frequently exceeding 10″: but in extenuation it must be said that the instruments were too small for the work and that the observations were made under considerable difficulties, owing to sea-fog and snow. There is nothing special to remark in the method adopted to adjust the observations, it being the usual method founded on the principle of least squares. It is shown that the mean error of the finally-adjusted angles is

$$0''\cdot547 \pm 0'\cdot029.$$

A diagram of the triangulation is given, from which it is seen that most of the triangles are well-conditioned; a few, however, are more elongated than they should be for good work, the triangle Munken, Stokvola, Haarskallen, especially so; for instance, the angle at Munken is $5^{\circ}\ 12'\ 57''\cdot416$. It should also be observed that several of the stations are determined by only two intersections. The longest side measures about sixty miles.

The second publication is the third report of the Norwegian tidal observations, and contains the results of the work done at Oscarsborg in 1880-1 and at Stavanger, Bergen, Kabelvaag, and Vardö in 1883. This report is simply a continuation of Reports I. and II., already noticed in NATURE; it contains nothing but tables, and there is nothing in it that calls for special notice.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On the Influence of Wave-Currents on the Fauna of Shallow Seas

FOR many years past I have endeavoured, without much success, to call attention to the widely-spread influence of waves on the bottoms of shallow seas. To the geologist this action signifies denudation, and accounts, among other things, for the wholesale destruction of marine fauna so often exemplified in the rocks. To the zoologist it signifies a factor in evolution of immeasurable magnitude.

On seeing the abstract of Prof. Moseley's lecture on the fauna of the sea-shore in NATURE, I troubled you with my letter of July 6; now that the full report has appeared, equally reticent as to the significance of wave-currents, I ask leave to add somewhat to my former letter.

The difficulty in arousing interest in this subject arises from the fact that, though the phenomena of wave-disturbance are well known to mathematicians, natural history text-books commonly agree in asserting either the non-existence, or unimportance, of such disturbance. Thus the question has remained unheeded.

My own experience in the matter is as follows:—Holding the orthodox view of the peaceful repose existing on the sea-bottom, I commenced cruising, some twenty years ago, on that excellent natural experimental tank, Torbay. I soon found, to my surprise, that the local fishermen and dredgers were as confident that the waves greatly disturbed the bottom as naturalists were of the reverse. Having kept my eyes open in this direction, I submitted a paper to the Devonshire Association in 1878, descriptive of the levelling action of the waves on the six-fathom area of Torbay (*Trans. Dev. Assoc.*, vol. x. p. 182).

With the kind assistance of Lord Rayleigh I was enabled to show that theory and observation were in complete accords a to the energy evinced by the waves in the particular instance under consideration.

Having learned from Lord Rayleigh that wave-action at the sea-bottom takes the form of reciprocal currents, I was led to make some experiments and observations on the formation of ripple-mark. In the course of this investigation I was soon impressed with the conviction that these alternate currents held at their mercy the marine fauna exposed to their attacks, and that the zoological side of the problem was at least as important as the geological. Accordingly, an outline of the subject in its zoological aspect was included in a paper on ripple-mark read to the Royal Society in 1882 (*Proc.* R.S., vol. xxxiv. p. 1).

Having come into possession of confirmatory evidence of the action of waves at a depth of forty fathoms in the English Channel, I submitted the facts to the British Association at Southampton in the same year, 1882. This paper, sent in to Section A, was handed on to Section C, a mathematical friend suggesting to me the reason, and a very good reason too, that mathematicians required no evidence on the point contended for. However, the transfer only went to prove that the geologists were as sceptical as to the existence of wave-action at forty fathoms, as the physicists were satisfied as to that fact. This paper, amplified, appeared in the *Transactions* of the Devonshire Association for 1883 (vol. xv. p. 353).

The zoological aspect of the question was submitted to the British Association at Southport in 1883; and again to the Linnean Society in 1884, in a paper "On the influence of wave-currents on the fauna inhabiting shallow seas." In this paper, profiting by experience, I made no attempt to prove the fact of wave-action from observation, but relied entirely on a valuable letter with which I had been favoured by Prof. Stokes, Sec. R.S. Neither at the British Association nor at the Linnean Society was any exception taken to my arguments in support of the importance of wave-action on the fauna affected; nor, so far as I am aware, has my position been shaken since. Now that Prof. Moseley's important lecture has appeared, discussing the fauna of the sea-shore without reference to the ever-regulating wave-currents, there is considerable risk that less experienced students of natural history will in like manner pass over this promising field of research as not worthy of their attention.

Prof. Moseley states, and states truly, that the littoral fauna is adapted in various ways to withstand "the action of the surf, the retreat of the tides, the numerous enemies"; but, beyond the reach of surf and tidal fall, agents which only affect the narrow belt of sea contiguous to the shore, the alternate currents set up by ocean waves search out the armour and test the defences of all small animals living on those extensive marine areas, exposed to the ocean swell, where the depth of water does not exceed fifty fathoms.

With respect to enemies, the waves themselves are perhaps the most formidable, as they attack and occasionally destroy whole colonies at once, whereas predatory foes rather affect the individual. For instance, let such helpless mollusks as *Aplysia* or *Pleurobranchus* wander over the sandy bottom of Torbay, as they sometimes do: the first easterly gale will sweep them out of existence. In fact, the waves so invariably prevent *Aplysia punctata* growing to its full size on the British coast, that a full-grown specimen taken in protected Guernsey waters has been considered a distinct species—viz. *A. depilans*. Similar large specimens have occurred under the shelter of the Torquay harbour works, but these, by a series of odontophores and shells, I have been able to connect with the common *A. punctata*.

Prima facie it would appear that the shells of certain mollusks are more especially adapted to resist animate foes; but a close examination will often prove the contrary. Take the cases of the oyster, mussel, venus, and limpet: these mollusks are all helpless in the presence of their living enemies: the oyster perishes by the attacks of boring-sponges; the mussel is destroyed wholesale by starfishes; the venus is perforated by carnivorous gastropods at their leisure; whilst the limpet, easily detached when taken unawares, is said to be destroyed by birds. All four are, however, admirably adapted to resist wave-currents, each in its respective habitat.

The conclusion that the shells of mollusks are so constructed as to have comparatively but little reference to living foes is supported by the interesting fact mentioned by Prof. Moseley, that hard shells tend to disappear in pelagic and deep-sea regions. That is to say, they disappear where predatory enemies abound, but where the great non-predatory enemies, the waves, are powerless or not existent. Occasionally we find the supposed protection against living enemies to be greatly in excess of requirements—*e.g.* the case of the solen, whose power of burrowing is far greater than requisite for escape from birds, but which is none too great for the evasion of waves and currents tearing away the sand in which the mollusk dwells.

Wave-action tends to differentiate species. This can be seen in such obvious cases as *Cardium aculeatum* and *C. norvegicum*, *Venus dione* and *V. chione*. One of each of these pairs has chosen the mooring method of defence with anchor-like spines, the other that of facile penetration with smooth, unresisting shell surfaces. As these two methods are opposite in action and any compromise tends to inefficiency, the wave-currents must necessarily influence the mollusks in the direction of divergence.

Instances of habits and forms protective against wave-currents could be multiplied almost *ad infinitum*, and, as the subject is a very interesting one, I still live in hopes that it may yet be taken up and worked out by trained observers qualified for the task.

ARTHUR R. HUNT

Torquay, September 28

Prehistoric Burial-Grounds

THE account given in this week's NATURE (p. 518) of the discovery of a prehistoric burial-ground at Pitreavie has recalled to my memory the description of a similar find made in the eleventh or twelfth century by the monks of Noyon, and related to us us by Guibert, who was abbot of this foundation at the time. I believe that it is the earliest detailed account of any such discovery that has come down to our days; and it will be noticed that the leading features of this cemetery are almost exactly identical with those of the Pitreavie one. I am not aware that this passage has attracted the attention of modern writers upon prehistoric times.

Guibert, the author quoted, was born in 1053 and died in 1124, having been Abbot of Noyon for about twenty years. After stating his own conviction that his monastery was extremely old, he continues:—

"Quam opinionem, si nulla litteralis juvaret traditio, suppeteret profecto affatim peregrina, et non, putamus, Christiani nominis sepulchrorum inventa contextio. Circa enim ipsam et in ipsa basilica tantam sarcophagorum copiam conjunxit antiquitas, in multam loci famositatem tantopere expetiti, cadaverum inibi congestorum commendat infinitas. *Quia enim non in morem nostrorum ordo disponitur sepulchrorum, sed circulatim in modum corollæ sepulchrum unius multa ambiunt, in quibus quædam reperiuntur vasa, quorum causam nesciunt Christiana tempora.* Non possumus aliud credere nisi quod fuerunt gentium, aut antiquissima Christianorum, sed facta gentili more."

GUIBERTI Novig. *de Vita Sua*, L. ii. cap. i.

I may add that in Guibert's time there was a very old written tradition which ascribed the foundation of Noyon to a certain "rex insulæ Britanniæ," who was (so ran the legend) a contemporary of our Lord's. This tradition is, of course, worthless from a historical point of view, but certainly testifies to the extreme antiquity of the place; and shows that, long before Guibert's time, the inhabitants of Noyon had dim recollections of their prehistoric greatness, which naturally, in an age of Christian credulity, centred around the era of our Lord.

T. A. ARCHER

158, Walton Street, Oxford, September 30

MARS, JUPITER, AND SATURN

WITH Mars, Jupiter, and Saturn in the morning sky the telescopist has a varied assortment of brilliant objects to which he may devote his attention. The great distance of Mars during the ensuing opposition will have the effect of limiting the apparent diameter to a low value, but the chief markings are so conspicuous as to be visible notwithstanding this inimical effect. Indeed during the preceding opposition, which was equally unfavourable, some of the more delicate features appear to have been recovered. At Milan Signor Schiaparelli has partly confirmed his previous results as to the singular duplication of the "canals," and Mr. Knobel has obtained a series of valuable sketches, which are reproduced in the last volume of the *Memoirs* of the Royal Astronomical Society. With regard to Jupiter the declination of the planet will be somewhat less than during the opposition of 1884-5, but the configuration of the belts and the peculiarities of the variable spots will doubtless continue to be exhibited with nearly similar prominence as in previous years. Saturn, situated in Gemini, and having considerable N. declination, will present a grand display, the rings being still widely open and inviting that close and systematic scrutiny which is so much needed either to affirm or negative some of the questionable details suggested by recent observations.

Observers of Mars are extremely fortunate in possessing such valuable memoirs and charts as those of Schiaparelli, Terby, Green, and others, which form a comprehensive and accurate basis of future reference and comparison. The seeming permanency of the chief lineaments on Mars and their distinctness of outline have permitted observers to assign their forms and positions with great nicety. But this has been found practically impossible in respect to any of the other planets of our system. Their markings are of so variable a tendency or so uncertain and ill-defined, owing probably to their atmospheric character, that it is out of the question to frame representative views that will serve to express the appearances observable at any future time. We have accumulated a vast number of delineations, including many peculiar forms, but these exhibit so much discordance as to prove that any attempt to arrange them with the same consistency as those of Mars must for the present be utterly futile.

What is essentially required in furtherance of our knowledge of areographic features are delineations in which the more delicate alternations of light and shade are faithfully portrayed. The ensuing opposition, though not offering the most favourable inducements for attaining this end, may yet be utilised as likely to afford its share of corroborations to old features and perhaps indicate some modification of the outlines attributed them by former observers. Mr. Marth's valuable ephemerides in the *Monthly Notices* supply the data wherewith the passages of certain prominent markings across the central line may be readily calculated from night to night. Drawings effected at the telescope and subsequently attested by the charts, or independent projections made on the basis of the new drawings and then compared with previous work will be important as furnishing fresh confirmations and additions to old records. Whatever plan is adopted, observers must not regard existing delineations as *perfectly* reliable and prejudice the judgment by endeavours to discern the outlines of the spots precisely as they have already been figured. Our work should be pursued apart from such influences, the aim being rather to correct and extend past results, than to follow them with implicit faith and mould our new seeings on the same pattern. Though much has been accomplished by the consecutive labours of the many able and earnest students of Martian features, the present state of our knowledge is not only incomplete, but considerable uncertainty exists as to the more difficult formations comprised in the physical aspect of this planet.

Jupiter, with so great a diversity of atmospheric phenomena, some of them rapidly variable, and all influenced by the quick rotation of the planet, gives prospect of being the subject of increased investigation. Late in the preceding opposition the great red spot which had so nearly disappeared and had, during the winter of 1884-5, assumed the appearance of a red ellipse with interior light cloud, showed unmistakeable evidences of increasing condensation. The ellipse grew perceptibly darker, and the central light cloud disappeared, so that at the end of the opposition the spot had almost regained the striking aspect it presented a few years ago. The question now is has this well-known feature continued to gain ascendancy during the time the planet has been lost in the sun's rays? Observations in October will furnish a definite answer to this question, and the planet should be confronted with our best telescopes as early as possible, so that the necessary evidence may be obtained. The spot will pass the central meridian of Jupiter at about the following times, and ought to be well seen in small instruments unless some great changes in an unexpected direction have affected its position or appearance in the interim since the last observation made here on the evening of July 8:—

Date 1885		Red Spot Central h.	m.	Date 1885		Red Spot Central h.	m.
Oct. 7	...	18	34	Oct. 29	...	16	48
12	...	17	43	31	...	18	26
17	...	16	52	Nov. 3	...	15	56
19	...	18	30	5	...	17	34
24	...	17	39	7	...	19	13
26	...	19	17	10	...	16	43

With reference to the white spots bordering the dark belts, and the other definite markings, they will doubtless be remarked as heretofore. Their singular vagaries of motion and appearance call for renewed study. The varying intensity and colour of the belts and their disposition in latitude should be carefully assigned on several dates during each opposition. If this method could be persistently followed during many years it would supply the material either for tracing out periodical recurrences, or proving such changes to be intermittent in character.

During the past opposition of Jupiter much attention was directed to the transits of the satellites and their shadows. When near mid-transit, III. and IV. are often seen as black spots, I. is visible as a grey spot, while II. is rarely, if ever, visible otherwise than as a bright spot. These anomalies have never received a satisfactory explanation, and further observations are much required as to the relative tints of the satellites when on Jupiter and the variations noticeable in different transits.

Saturn, though not presenting such an extent of conspicuous detail as Jupiter, is yet equally deserving of systematic study. The rings and numerous array of satellites compensate for lack of detail in the belts. The outer division in the ring, called after Encke, supplies us with a crucial test object, and one which perhaps has originated more difference of opinion amongst observers than any other planetary detail of which the existence is well assured. Either this division must be liable to fluctuate at short intervals or the evidence afforded by various telescopes is most conflicting, and suggests how careful we should be before accepting individual results when not corroborated or supported by undeniable testimony.

During the last few oppositions a very definite narrow dark belt has bounded the southern side of the equator, and this has attracted more comment than usual owing to its compact and very obvious appearance. This belt exhibits no distinct spots, though one or two observers have delineated it with marked condensations. The fainter belts nearer the pole are so very feeble that their existence is sometimes questionable. Indeed the features of this planet are of extreme delicacy, and require not only very steady air but a thoroughly good eye and instrument to trace them in their more minute forms. Some of them are doubtless variable and have given rise to the contradictions we have referred to. As to the satellites they comprise test objects for telescopes of all calibre. The identification of these bodies may be suitably effected at any hour by means of Mr. Marth's ephemerides (*Monthly Notices*, June, 1885).

W. F. DENNING

RADIANT LIGHT AND HEAT[1]

III. (Continued)

Absorption—Terrestrial Applications.

LET us next consider the absorption spectra of substances, that is to say, the absorption lines which substances at ordinary temperatures produce in the spectrum of light from a high temperature source, such as the sun or the electric arc. This absorption may either be general or selective; it may be spread over a large portion of the spectrum, or it may act specially over a very limited district or line. It is in the latter case that we derive most advantage by studying absorption spectra, and there are many substances which may be known at a glance by means of their peculiar absorption. Professor Stokes has shown, for instance, that blood may at once be distinguished from other solutions of similar tint by means of the characteristic dark bands which it produces. By means of a spectrum microscope Mr. Sorby thinks that the thousandth part of a grain of blood may be detected, and the same observer asserts that wines of different vintages can easily be distinguished from one another in the same way. It thus appears that the absorption spectrum may in many cases furnish us with an efficient and simple means of ascertaining adulteration, for the presence of inferior substances which escape detection by the taste or sight will at once be recognised when spectrum analysis is employed. Russell, Gladstone, Abney, Festing, and others have studied with much success the spectra of solid and liquid bodies.

The absorption spectra of gases and vapours at low temperatures have been studied by various physicists, and amongst them by Janssen, Roscoe, Schuster, and Lockyer. Brewster, as we have seen, was the first to observe the effect produced on the solar spectrum by nitrous acid gas; other gases have since been tried in the same way, and many of these give out channelled or fluted absorption lines similar to those given out by nitrous acid gas. In fine, various researches lead us to conclude that gases, and more especially vapours, are in a state of greater molecular complexity at a low than at a high temperature, for at a low temperature they have a prominent absorption for many kinds of rays, whereas at a high temperature they have no such strong absorptive power, but absorb and radiate only a few definite spectral lines.

This simplification produced in spectra by the rise of temperature has been greatly insisted on by Lockyer, and will again come under our review when we have discussed the celestial applications of spectrum analysis.

Meanwhile, I cannot do better than quote the words of Lockyer in his Treatise on the Spectroscope and its applications (NATURE Series):—"We may state generally (says that observer) that beginning with one element in its most rarified condition, and then following its spectrum as the molecules come nearer together, so as at last to reach the solid form, we shall find that spectrum become more complicated as this approach takes place, until at last a continuous spectrum is reached."

Before concluding this division of my subject, it will be necessary to allude to the absorptive effect produced by the earth's atmosphere on the light and heat of the sun. This is a point of great practical as well as scientific importance, more especially if we reflect that the atmosphere is a covering of variable composition, and that the variable element (aqueous vapour) is one which no doubt exercises a large absorptive influence upon the rays of the sun. But there is another element of variability in the sun itself, for we more than suspect that the amount of radiant energy which we receive from our luminary depends to some unknown extent upon the state of his surface, and may thus be different in years characterised by a maximum number of sun spots, and in years characterised by a small number of these phenomena. An additional complication is introduced by the suspicion that one of these causes of variability may react upon the other in such a way that in those years when the radiation of the sun is intrinsically most powerful (if there be such) an abnormally large amount of aqueous vapour may be dissolved in the air, so that we may have on such occasions an increased absorption as well as a large intrinsic radiation, and the one of these causes may thus, to a great extent, cover or conceal the other.

Bearing these points in mind, I shall divide my remarks into two sections. I shall treat, *in the first place*, of the means which we have at our disposal for estimating the whole amount of radiant energy which reaches us from the sun at any station, whether this be near the level of the sea or at an elevation above it.

In the second place, I shall allude to the means we have at our disposal for estimating the amount of any one kind of radiant energy that reaches us from the sun.

An instrument by means of which we may ascertain the amount of the sun's radiant energy is called an *Actinometer*.

I have recently suggested such an instrument for measuring the heating effect of the sun, which has been tried at various stations, and appears to work well. It consists of a thick hollow cube of brass, surrounded with felt, and then again with a covering of polished brass. Into the interior of this chamber a suitable thermometer is inserted, its bulb being exactly in the centre. There is a small hole in one of the sides, through which the heat of the sun condensed by a lens is made to fall upon the bulb of the thermometer, the instrument having a motion in altitude and azimuth so as to enable it to catch the sun readily. The exposure is made for a definite time, as given by a good chronometer.

Instruments of this kind have been established in various places and at various elevations, and we shall certainly be able to derive from them information of importance as regards the meteorology of the place. To what extent we shall be able by their means to separate between the two apparent causes of solar variability, namely, that due to an intrinsic change in the sun itself, and that due to a change in the constitution of the earth's atmosphere, is perhaps an open question. It may be hoped that such an instrument may at least enable us to advance the problem, even if it prove insufficient to bring it to a complete solution.

Again, Professor Sir Henry Roscoe has invented an instrument intended to record the effect of the sun in blackening chloride of silver. He is able to prepare a paper of a standard sensitiveness, which, by an automatic arrangement, is exposed for known intervals of time. This is an instrument from which we shall no doubt obtain valuable information, more especially as the more refrangible rays of the sun play an important part in terrestrial economy. Still, however, it does not at first sight escape the objection above mentioned, or enable us to discriminate between the two apparent causes of solar variability—the celestial and the atmospheric.

It has been remarked by the Solar Physics Committee, in their report to the British Government (page 66) that by comparing with a standard certain definite regions of the solar spectrum, unabsorbed by any of the constituents of the earth's atmosphere, we might be able to ascertain any variation in the quantity or in the quality of the true solar radiation. This leads me to inquire what means we have at present of estimating the amount of any particular kind of ray which we receive from the sun. In the first place, we have the recent extension by Captain Abney of the powers of photography, in virtue of which it is not too much to assert that we can now obtain a complete map of the solar spectrum, with its absorption lines extending greatly beyond the visible spectrum on either side. We have also the invention and successful construc-

[1] Continued from p. 425.

tion by Professor Langley of his Bolometer, which is an instrument for detecting and measuring small quantities of radiant heat much more sensitive than the thermopile. It depends upon the fact that the electrical resistance of a metal is increased as it rises in temperature. Suppose, now, that two circuits conveying equal and opposite currents meet in a galvanometer, the needle will of course remain at rest. If, however, a portion of one of these two circuits be heated, its resistance will be increased, and the current passing through it will thus be diminished. The two opposing currents will now no longer balance each other, and in consequence the galvanometer needle will be deflected.

In the bolometer the two circuits each contain a sheet of extremely thin platinum foil, so that a very small quantity of radiant heat falling upon these may produce a considerable result. These sheets may be compared to the two faces of the pile, and if the one be heated we shall have a current in the one direction, while if the other be heated we shall have a current in the opposite direction. By this instrument Professor Langley has determined with much precision the exact distribution of energy in the solar spectrum. But he has done more than this: he has carried his instrument up to the top of Mount Whitney, in America, and has thus procured us much information regarding the absorbent effect of the various constituents of the earth's atmosphere.

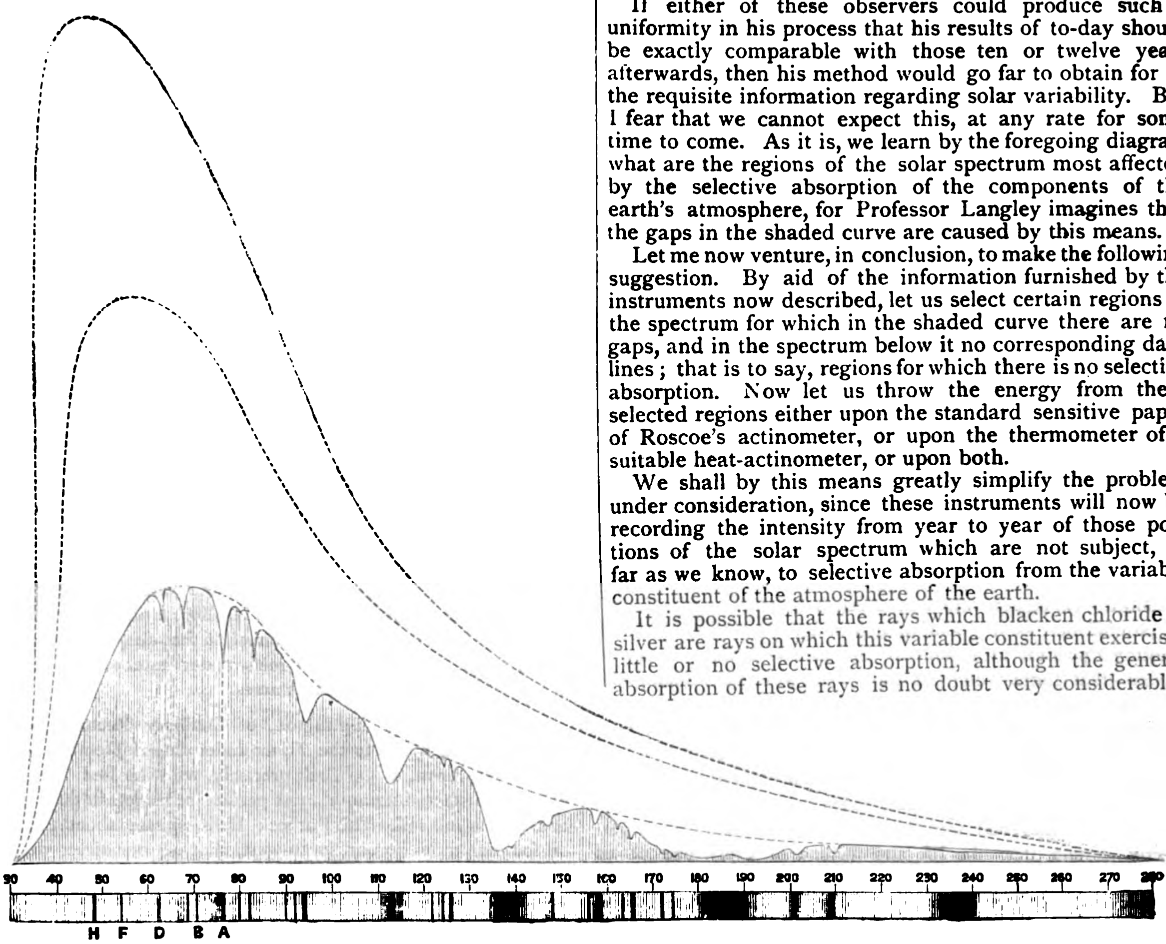


Fig. 10.

The following diagram (Fig. 10) exhibits the result of his researches. In it the lower band represents the solar spectrum as obtained by a perfect method. The shaded curve above the spectrum represents the observations made by Professor Langley with his Bolometer at the foot of the mountain. We have next a dotted curve derived from observations at the top of the mountain, and, finally, another representing the probable curve of solar energy above the limits of the atmosphere. It follows from these curves that if we could view the sun beyond the limits of the atmosphere the light would be decidedly blue.

There can be no doubt that the improved process of photography devised by Captain Abney, and the Bolometer of Professor Langley, furnish us with excellent differential instruments by which we may compare at any place and moment the relative distribution of solar energy over the various parts of the spectrum.

If either of these observers could produce such a uniformity in his process that his results of to-day should be exactly comparable with those ten or twelve years afterwards, then his method would go far to obtain for us the requisite information regarding solar variability. But I fear that we cannot expect this, at any rate for some time to come. As it is, we learn by the foregoing diagram what are the regions of the solar spectrum most affected by the selective absorption of the components of the earth's atmosphere, for Professor Langley imagines that the gaps in the shaded curve are caused by this means.

Let me now venture, in conclusion, to make the following suggestion. By aid of the information furnished by the instruments now described, let us select certain regions of the spectrum for which in the shaded curve there are no gaps, and in the spectrum below it no corresponding dark lines; that is to say, regions for which there is no selective absorption. Now let us throw the energy from these selected regions either upon the standard sensitive paper of Roscoe's actinometer, or upon the thermometer of a suitable heat-actinometer, or upon both.

We shall by this means greatly simplify the problem under consideration, since these instruments will now be recording the intensity from year to year of those portions of the solar spectrum which are not subject, as far as we know, to selective absorption from the variable constituent of the atmosphere of the earth.

It is possible that the rays which blacken chloride of silver are rays on which this variable constituent exercises little or no selective absorption, although the general absorption of these rays is no doubt very considerable; in this case no special adaptation to the chemical actinometer would be necessary.

To conclude, I think we may entertain a well-grounded hope that by patience and persistence in these or similar means, we shall ultimately arrive at a definite solution of this very interesting and important problem.

Balfour Stewart

(*To be continued.*)

NOTES

The Geological Congress met last week at Berlin. England was represented by Messrs. Geikie, Hughes, Bauermann, Hinde, Marr, Topley, White, Woodall, Lieut.-Col. Tabuteau, and

Capt. Shelley. Altogether there were 248 members, representing Germany, Austria, Belgium, Spain, the United States of America, France, India (Mr. Blanford), Italy, Japan, Norway, Holland, Portugal, Roumania, Russia, Sweden, and Switzerland.

MR. W. H. WHITE, who has succeeded Sir N. Barnaby as Director of Naval Construction, has entered upon his duties at the Admiralty.

WE regret to learn of the death of Walter Weldon, F.R.S., the eminent technical chemist, in his fifty-third year. Mr. Weldon's name is well known in connection with the Weldon process for the regeneration of the manganese peroxide used in the generation of chlorine, and with the consequent revolution in the production of bleaching-lime, affecting favourably such important industries as the cotton and paper trades.

THE Annual Exhibition of the Photographic Society was opened on Monday; the exhibits are up to the average of recent years.

SIR JOHN LUBBOCK unveiled on Thursday last, at Birmingham, a marble statue of the late Sir Josiah Mason, which has been placed in the square between the Science College and the Town Hall. Referring to the Mason College, Sir John said that such an institution was all the more needed on account of the extraordinary manner in which science is still neglected in our public schools. There were, indeed, according to the Technical Commission, only three schools in Great Britain in which science is fully and adequately taught. The majority of schools devoted to it less than three hours out of forty. Scientific men claimed for it six hours, which, with the same number for mathematics, ten for modern languages, and two for geography, would still leave no less than sixteen for classics. He advocated the general teaching of science, because it would add to the interest and brightness of life, would purify and ennoble the character, and because, with our rapidly-increasing population, it was almost a necessity, if our people were to be maintained in comfort. As regards the first point, it was quite a mistake to regard science as dry and uninteresting. Sometimes it might destroy a poetical idea, such as the ancient Hindoo theory of rivers—that Indra "dug out their beds with his thunderbolts and sent them forth by long continuous paths." But the real causes of natural phenomena were far more striking, and contained more real poetry than any that had occurred to the untrained imagination of mankind. Not our happiness only, but in many cases our very life itself depended on our knowledge of science. Huxley had well asked, "Whether, if it were perfectly certain that the life and fortune of every one of us would one day depend on our winning a game of chess we should not all learn something of the game. Yet it is a very plain truth that the life and fortune of every one of us depend on our knowing something of the rules of a game infinitely more difficult. It is a game which has been played for untold ages, every man and woman of us being one of the two players. The chessboard is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. The player on the other side is hidden from us. We know that his play is always fair, just, and patient. But also we know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well the highest stakes are paid with overflowing generosity, but one who plays ill is checkmated—without haste, but without remorse." The national necessity for science was most imperative. Even now we required to purchase food to the amount of 150,000,000*l.* a year. A century hence our coal would be approaching exhaustion, our population would be trebled, and we should require, to speak moderately, 400,000,000*l.* to pay for food. Nothing but the development of scientific training and appliances would enable us, under these circumstances, to maintain our population in happiness and comfort. We had, in fact, the choice between science and suffering.

MR. H. H. JOHNSTON appeals in the *Times* for subscriptions to make good the loss which Mr. H. O. Forbes has sustained while embarking at Batavia for his exploring journey in New Guinea. The boat which was carrying all his baggage on board ship suddenly capsized, and the unfortunate explorer in a few seconds lost all his equipment, a loss which it would probably take about 1000*l.* to replace. Mr. Forbes, it may be remembered, was subsidised by the Royal, the Scottish, and the Australian Geographical Societies, while the British Association at Aberdeen has made a grant of 150*l.* to help to replace his loss. What excellent work Mr. Forbes is capable of doing for science is shown in his recently-published work on the Malay Archipelago. He lost no time in getting to Brisbane, and has doubtless there obtained on credit such articles as will enable him to go on with his work, as according to the latest news he is again on his way to New Guinea. Subscriptions may be sent to the Secretary, Royal Geographical Society, Savile Row, W.

IN a few days the rock in the Hell Gate entrance to New York harbour, from Long Island Sound, is to be blown up by a party under the command of General Newton, United States Engineer. For nine years the work of excavation has been in progress. The rock has been honeycombed with chambers, the surface being still supported by columns of rock, into which dynamite cartridges have been fitted. Some 45,000 of these cartridges cased with copper have been laid. The work of distributing the cartridges began in July, 1884, and has just been completed, 275,000 lbs. of dynamite having been used. The explosion is to be brought about by means of an automatic detonator, placed upon Flood Rock, an electric connection with the land being established. It is expected that the explosion will pulverise the whole of the rock, without making much commotion in the water, or doing harm beyond a distance of 1000 feet. The *débris* will afterwards be removed, so as to make a channel 26 feet deep at low water. Flood Rock and the adjacent reefs under water which will be destroyed cover a space of nine acres.

THE Rev. M. F. Billington, of Chalbury Rectory, Wimborne, Dorset, writes to the *Times* under date September 29:—"This afternoon, at 5 o'clock precisely, we witnessed from this hill, of 360 feet altitude, a most perfect reflection in the clouds of a ship in full sail. The Purbeck Hills, situate about thirteen or fourteen miles to our south-west, shut out our direct view of the sea in that direction, and in all our long experience of many beautiful views of the coast line we have never before observed this curious phenomenon. It lasted for about three minutes, and then slowly faded out of sight."

ON September 29, between 8 and 9 p.m., a mirage somewhat similar to that described last week (p. 541) was again observed by many persons at Valla in Sweden. The entire lower part of the north-western horizon shone with a lurid glare, above which was a cloud-bank assuming the most remarkable forms. From time to time animals, trees, and shrubs were seen. Soon a bear changed into an elephant, and soon a dog into a horse. Later on groups of dancers were seen, men being distinguished from women. Further north the cloud formed an oak forest, in front of which was a valley, and nearer still a park with sanded paths. At about 9.30 the cloud sank into a mass, and the phenomenon disappeared.

THE Royal Microscopical Society will meet at King's College, W.C., on Wednesday, the 14th inst., at eight o'clock, when the following papers will be read:—Dr. Maddox: On the Feeding of Insects with Bacilli. Mr. T. B. Rossiter: On the Gizzard of the Larvæ of *Corethra plumicornis*.

ARRANGEMENTS are being made for the establishment of a Zoological Garden in Christiania.

DURING last week a series of experiments were carried out upon North Sea trawling vessels with a view to lighting them by electricity. The attempt was on the whole satisfactory. The introduction of electric light into fishing-boats would prove invaluable, but the heavy expenditure involved in such a scheme would exclude its general usage.

THE United States Fish Commission report a great decrease in the halibut and cod fisheries of America. The cause for this is attributed either to low temperatures of water or the destruction of fry by reckless fishing. A general falling off of flat-fish is reported from Germany this year, and a diminution in the herring fishery is recorded from Belgium. The increased number of fishermen off Holland and the destruction of immature fish has produced a bad effect upon the fishery of that place.

THE National Fish Culture Association have made arrangements to import a large consignment of carp from Germany for the purpose of acclimatising them to the waters of the United Kingdom. Numerous applications have been made from all parts for supplies of these fish, which are far superior to our own species. In Germany, China, France, and America carp farming is extensively prosecuted with highly satisfactory and remunerative results.

WE have received the report for the summer session of 1885 of the Queenwood College Mutual Improvement Society. It describes in detail the various excursions of the session, and would make an admirable guide for the parts of Hampshire and the Isle of Wight visited.

WE have received from the author a pamphlet containing a geological sketch of the Island of Antigua, by Mr. Purves, which was originally contributed to the *Bulletin* of the Royal Museum of Natural History of Belgium. Prior to this paper the only information on the subject was contained in a paper by Dr. Nugent, published in 1819, and by Prof. Hovay, published in the *American Journal of Science* in 1839. The pamphlet is illustrated by a geological sketch map.

THE Queen has been pleased to grant to Prof. W. Chandler Roberts, F.R.S., of the Royal Mint, authority to use after his paternal name the name of his uncle, the late Major N. L. Austen, J.P., of Haffenden and Combourne, in the county of Kent.

THE additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus* ♂) from Ceylon, presented by Mr. Septimus Smith; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. S. T. K. D. Potter, F.R.G.S.; six Indian Fruit Bats (*Pteropus medius*) from India, presented by Mr. W. Jamrach; two Canadian Skunks (*Mephitis mephitica*) from North America, presented by Dr. C. Hart Merriam, C.M.Z.S.; a Common Badger (*Meles taxus*), British, presented by Lord Egerton of Tatton, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquata*) from India, presented by Mrs. Douglas; a Common Barn Owl (*Strix flammea*), British, presented by Miss Linda Raven; two Common Guinea-Fowls (*Numida cristata*), British, presented by Mr. C. H. Hopwood, M.P.; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by Mr. A. Duncan Fraser; four Hog-nosed Snakes (*Heterodon platyrhinos*), a Say's Snake (*Coronella sayi*), two —— Snakes (*Coluber alleghaniensis*), an American Black Snake (*Coluber constrictor*) from Indiana, North America, presented by Mr. F. J. Thompson; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, a Great Bird of Paradise (*Paradisea apoda*) from the Aroo Islands, a Common Cormorant (*Phalacrocorax carbo*), British, an Emu (*Dromæus novæ-hollandiæ*) from Australia, a Gigantic Salamander (*Megalobatrachus maximus*) from Japan, deposited.

OUR ASTRONOMICAL COLUMN

THE SATELLITES OF URANUS AND NEPTUNE.—In Appendices I and II. of the Washington Observations for 1881, Prof. Asaph Hall has published the results of his investigation of the orbits of the outer satellites of Uranus, *Oberon* and *Titania*, and the satellite of Neptune. The satellites of Uranus were amongst the first objects observed with the 26-inch refractor of the Naval Observatory, after it was mounted in November, 1873. The first series during the oppositions of 1874 and 1875 were discussed by Prof. Newcomb, with the view to the determination of the mass of the planet, and the formation of tables of the motions of the satellites, which were published in the Washington Observations for 1873. Remarking that as the earth would be nearly in the plane of the orbits in the year 1882, and observations made about that year would probably afford a good determination of the position of this plane, Prof. Hall commenced a new series in March, 1881, which were continued through the four oppositions until the end of May, 1884; these observations were made with magnifiers of 606 and 888; in fair conditions of the atmosphere the outer satellites are stated to be easily observable with the Washington instrument. A comparison of the measures with Prof. Newcomb's tables showed that those tables required but small corrections, which were found by equations of condition in the usual manner. It should be mentioned that the tables were founded mainly upon Prof. Newcomb's own measures; those by Prof. Hall in the years 1875 and 1876 are included in his recent discussion.

For the position of the nodes and inclination of the orbits of the satellites, Prof. Hall finds—

$$N = 165^\circ{\cdot}81 + 0^\circ{\cdot}0142t$$
$$I = 75^\circ{\cdot}30 - 0^\circ{\cdot}0014t$$

t being the number of years from 1883·0.

The mean value of the mass of Uranus by the observations of *Oberon* is $\frac{1}{22603}$, and by those of *Titania*, $\frac{1}{22833}$, or, combining the values with their respective weights, the final result is $\frac{1}{22682}$. This value, though somewhat smaller than those previously obtained, Prof. Hall thinks is as good as he could obtain with the filar-micrometer of the large refractor, and he does not consider that there would be much gained by a continuation of the measures. He mentions that during the oppositions of the planet from 1881 to 1884, which were especially favourable for the search after new satellites, he made careful examination on several good nights along the orbit plane of the known satellites, without finding any new ones.

The orbits of *Oberon* and *Titania* appear to be sensibly circular.

Prof. Hall's discussion of the elements of the orbit of the satellite of Neptune is founded upon his own observations during the oppositions of 1875 and 1876, and those of 1881—84; in addition, he has made use of Prof. Holden's measures in the interval 1874 December—1878 November, and has also discussed those of Lassell and Marth taken at Malta in 1863 and 1864. Prof. Newcomb's elements are corrected by the formation of equations of condition and their solution, as in the case of the satellites of Uranus. The following are the principal results:—

$$N = 184^\circ{\cdot}32 + 0^\circ{\cdot}0095t$$
$$I = 120^\circ{\cdot}05 + 0^\circ{\cdot}0005t$$

t being counted from 1883·0.

Comparing the observations of 1881—84 with those of Lassell and Marth, the periodic time is found to be 5·876839 mean solar days; that deduced by Mr. Hind, which was adopted by Prof. Newcomb in his tables, is 5·8769 days; the small difference would produce a change of about 5° in the true position of the satellite in its orbit at the beginning of next century, and Prof. Hall leaves it to future observations to decide whether his correction is required.

The values of the mass of Neptune from his measures at different oppositions, and from those of Lassell and Marth and of Holden differ sensibly. The mean result from Hall's own observations is $\frac{1}{19092}$; he remarks that his distances are generally smaller than those of other observers, and believes that, in order to eliminate the effect of such personal equation from the determination of the mass of a planet, the only way will be to increase the number of observers and to take a mean of their results. Hall's value approaches nearly to that found by Prof. Newcomb, $\frac{1}{19380}$.

On favourable nights examinations of the region about Neptune were made, but no other satellite was detected.

VARIABLE STARS (1).—The following Greenwich times of geocentric minima of Algol have been deduced from elements corrected by the later observations of Schmidt:—

		h. m.			h. m.
November	8	15 7	December	7	7 16
	11	11 56		18	18 33
	14	8 45		21	15 22
	17	5 34		24	12 11
	28	16 49		27	9 0
December	1	13 38		30	5 49
	4	10 27			

(2) R Leonis will now be approaching a maximum; there would appear to be indications of a sensible perturbation in the period during the last twenty years or more. (3) V Piscium, one of Argelander's supposed variables, is now favourably placed for observation; his estimates vary from 6·7 m. to 9 m.; the position of this star for 1885·0 is in R.A. 1h. 48m. 18s., Decl. + 8° 12′·9. (4) Argelander's formula of sines makes a maximum of *Mira Ceti* due on December 19, but it may probably occur earlier.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, OCTOBER 11–17

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 11

Sun rises, 6h. 20m.; souths, 11h. 46m. 41·8s.; sets, 17h. 14m.; decl. on meridian, 7° 11′ S.: Sidereal Time at Sunset, 18h. 36m.

Moon (three days after New) rises, 9h. 40m.; souths, 14h. 28m.; sets, 19h. 13m.; decl. on meridian, 15° 18′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 55	11 35	17 15	4 35 S.
Venus	10 17	14 23	18 29	21 28 S.
Mars	0 11	7 49	15 27	17 44 N.
Jupiter	3 54	10 16	16 38	3 38 N.
Saturn	21 8*	5 16	13 24	22 18 N.

* Indicates that the rising is that of the preceding day.

Phenomena of Jupiter's Satellites

Oct.	h. m.		Oct.	h. m.	
12	4 37	IV. ecl. disap.	14	4 50	I. tr. egr.
13	4 51	I. ecl. disap.	16	4 7	II. tr. ing.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Oct.	h.	
11	12	Venus in conjunction with and 6° 23′ south of the Moon.
16	10	Mercury in superior conjunction with the Sun.
17	2	Venus at greatest distance from the Sun.

GEOGRAPHICAL NOTES

ACCORDING to the report by Lieut. Wissmann on his last exploration in the Congo region, the Lower Kassaï constitutes a magnificent fluvial artery, frequently of enormous breadth, and leads without obstacle into the heart of the new Congo State. Between the station of Kwamouth and the confluent of the Lulua and above the station of Luluaburg the Kassaï, with a breadth of about 600 kilometres, is everywhere open for navigation. It runs through a country of wonderful fertility, presenting alternately plains and virgin forests, and inhabited by a dense population. With about one exception the travellers have been received everywhere with eagerness by peaceable tribes, all disposed to trade. During the forty-two days employed in the voyage from Luluaburg to Kwamouth the health of the expedition was excellent. There was no loss of life, except that two natives were drowned in the rapids of the Lulua. The five white men and the 200 Negroes of the Expedition arrived all in good health at Léopoldville on July 16.

THE current number of *Petermann's Mittheilungen* contains the conclusion of M. Thoroddsen's paper on a lava desert in the interior of Iceland. It supplies certain geographical and scientific observations of the writers, such as the superficial dimensions, height, &c., hydrography, climate, geology, volcanoes, glaciers, botany, and zoology of the interior of Iceland. Herr Hassenstein describes, with a large map, Bohndorff's journeys in Central Africa between 1874 and 1883. The usual geographical information for the month, and account of the literature concludes the number.

THE most interesting contribution, however, to *Petermann* this month is a short prefatory sketch on the history of the great geographical house of Perthes of Gotha, September 11 being the centenary of its foundation. In 1801 the first geographical work was published by Perthes, and in 1809 he published a large atlas by Prof. Heusinger. Under the second proprietor, Wilhelm Perthes, who was head of the establishment between 1816 and 1853, the publications of the house assumed their geographical and cartographical character. In 1817 appeared the first edition of Stieler's Atlas, consisting of fifty maps, and between 1823 and 1831 a supplement of twenty-five more was added This Atlas has now for nearly seventy years been the principal work published by the house of Perthes. It has been kept up to date, and the number of the maps, which in 1862 was 84, grew in 1871 to 90, and in 1879 to 95. The total number of maps, old and new, amounts to 197. Besides Stieler, Berghans (1797-1884), Spruner and Sydow supported Perthes. In 1832 Berghans's great atlas of the extra-European countries appeared. It was a financial failure, but it carried the name of the house abroad, and laid the foundation of its world-wide fame. In 1838 the publication of the same author's Physical Atlas in 93 maps was completed. Between 1837 and 1852 Spruner's Historical-geographical Atlas appeared, and was followed by various editions. Wilhelm Perthes died in 1853, and Bernhardt Perthes reigned in his stead for only four years, leaving a posthumous son, the present Justus Perthes. Petermann, who died in 1878, commenced his celebrated *Mittheilungen* in 1855. The publications of the house since that date are well-known to all geographers; Behm's "Geographical Year-Book," and Behm and Wagner's "Population of the Globe," are works of world-wide celebrity.

ON Friday last, after an absence of nearly three years, the Danish exploration expedition to the east coast of Greenland, under Lieutenants Holm and Garde, returned to Copenhagen in the ship *Constance* from Godthaab. We have from time to time given particulars of the progress of this expedition, the chief object of which was to penetrate as far north along the east coast as possible, and to attempt to reach certain native settlements known to exist between latitudes 65° and 66° N. The expedition has fulfilled all expectations, besides the collection of a valuable scientific material, Lieut. Holm having wintered in lat. 65°-66°, the highest point reached being lat. 66°08′ N., the northernmost ever reached by Europeans. Lieut. Holm is stated to have made some very valuable geographical and ethnographical discoveries, having spent last winter among East Greenlanders never before visited by Europeans. He has named the stretch of coast explored, King Christian IX.'s Land.

A WRITER who has travelled widely through Tonquin and Southern China describes, in a recent number of the *République Française*, the route from Lao-Kai, on the Red River, to Mengtsze in Yunnan. Premising that the river from the mouth to Lao-Kai, on the Tonquin border, is tolerably well known, he refers to the various routes for getting into South-Western China, but is far from enthusiastic about any of them, although he thinks that France in Tonquin has as much chance of getting the China trade as any of her rivals in the south. The writer then describes the route along the river from Lao-Kai to Manhao, the head of the Red River navigation. From this point the road to the plateau of Yunnan is said to be mountainous and difficult in the extreme. The article is of special value at the present moment, when the question of trade routes into South-Western China has assumed so much prominence.

THE BRITISH ASSOCIATION

SECTION C—GEOLOGY

Some Results of a Detailed Survey of the Old Coast-Lines near Trondhjem, Norway, by Hugh Miller, F.G.S., H.M. Geological Survey.—During a short visit to Norway in October, 1884, it appeared to the author that the best way to help to a solution of the vexed questions connected with the coast-terracing of Norway was to execute a careful survey of a few square miles of some suitable coast-region upon a sufficiently large scale. The neighbourhood of Trondhjem is remarkably well suited to this purpose. The map employed was partly a municipal chart on the scale of 1-10,000, and partly an enlargement of the Ordnance map. The limit of all the terraces and marine deposits is the famous "strand line" west of the town, a double range of old coast-cliff cut in the rock of the mountain-side. Its upper line is 580 feet above the sea, and answers to the "marine limit" over Norway generally. Numbers of level terrace-lines have been incised—chiefly in greenish clays, like brick-clays—all along the arable slopes east of the town between this rock-terrace and the sea. Above the Bay of Leangen, two miles east of town and river, and far beyond all erosive influence of the latter, thirty of these lines were mapped one above another in the first 300 feet of ascent, a distance of one and a half mile. Many of these are small but extremely distinct, the earthy clays being well suited to retain sharp impressions of successive sea-margins, which these unequivocally are. The present coast-line, neatly etched out by the waves in Trondhjem and Leangen Bays, is the key to these tiers of older ones. It also resembles them in having made little or no impression where the coast becomes rocky, the lines of incision in both cases stopping short at once when they reach the harder material. The old coast-lines are most numerous in well-sheltered positions. Thus a single pair of large terraces in an exposed situation east from Christiansten, where they face the open water of the fjord and the prevalent north-westerly storms, is represented in the recess above Leangen Bay by ten or twelve. The same fact is brought out on rising from this recess to the higher and more exposed ground. Thus, while thirty-three or thirty-four terraces are mapped below 350 feet (approximate) elevation, only nine or ten appear between that level and the rock-terraces of the upper marine limit, the numerical average height of the terraces thus rising by more than a half. In recesses of the coast further east, but beyond the map, these upper terraces seem to be preserved in considerably greater numbers. The number actually mapped was forty-three, or, with the two rock-terraces, forty-five. The largest number of terraces hitherto described at any one place in Norway seems to have been eighteen. Some of the general conclusions of the author are as follows:—(1) These terraces are all post-glacial, *i.e.* formed since the rock-glaciation of the district. This is confirmed by the condition of the high coast-cliff, which has been cut in ice-rounded rock, but is not itself glaciated. It appears, however, from the fauna of the raised shell-banks of the country (as worked out by Sars and Kjerulf), in which recent shells do not rise above 380 feet, that the seas of the upper levels were still glacial; and, though the Trondhjem fjord was free from land-ice, other deeper fjords and higher coasts may still have had glaciers coming into conflict with the sea, and producing the glaciated rock-terraces described by Sexe. All the evidence obtained discountenances Sexe's view that these rock-terraces were cut out by glaciers, as well as Carl Petersen's that they were rasped out by floating ice coasting the shores. On the clay terraces coast-ice has left no more sign of its presence than the winter freezing of our British rivers leaves upon our river-terraces. (2) If the country was upraised by a succession of elevatory jerks, as supposed by most geologists from Keilhau downwards, most of these would seem to have been small—much smaller, at least, than is supposed by Kjerulf. It is improbable that even Leangen Bay was secluded enough to contain a record of all the original coast-lines. The longer pauses and greater storms may have effaced an unknown number by a process of excision exemplified in all its stages by the map. It is hard to say, in fact, where the subdivision would end if all were preserved. The smaller terraces remind the eye of the incised lines and little planes engraved on the sandbanks bordering the rivers after a flood, in which case there is no periodicity in the subsidence of the waters. (3) The preservation or excision of the terraces thus seems to depend as much upon local circumstances—exposure to storms, resistance of coast-line, &c.—as upon anything else. It is impossible at present to predicate which of them shall in any given place remain. Whether elevation by jerks, therefore, be postulated or not, all hope of correlating these terraces throughout the country must be deferred until their heights have been accurately determined by level. The measurements hitherto made, not even excepting those of Profs. Kjerulf and Mohn, are probably inadequate for the purpose. This observation seems to apply also to the terraces graven in rock. In their aneroid measurements of the upper strand-line at Trondhjem these observers differ by 55 feet. (5) On entering the mouth of the Trondhjem Valley the terraces come under an influence other than that of the sea-waves. The valley was worked out, in deposits partly levelled out by the sea, according to the laws of river-terracing under the accelerating influences of a falling sea-level. The processes of automatic river-terracing are beautifully exemplified within the district mapped in the deep lobe-shaped curve of the river just before it enters the sea. The terraces have been added one after another to the point of the lobe of land thus surrounded, which is known as Oen.

The Glacial Deposits of Montrose, by Dr. J. C. Howden.—These consist, in order of age—(1) a marine clay containing fossils of a purely Arctic type, apparently the bottom of a deep sea. Above this is seen the estuarine clay, beneath which, however, are often found deposits of peat. Over the estuarine clay is a bed of stratified sand, and above that a dense non-fossiliferous Carse Clay, varying in thickness from 4 to 6 feet. The sequence of these deposits was held by the author to indicate interglacial periods.

Irish Metamorphic Rocks, by G. H. Kinahan, M.R.I.A.—This paper is an epitome of what is known as to the age of the Irish Metamorphic rocks.

Barium Sulphate as a Cementing Material in Sandstone, by Prof. Frank Clowes, D.Sc.—The author described the "Hemlock stone" and other similar blocks of Lower Keuper sandstone in the neighbourhood of Nottingham. They stand out in hard masses from the more easily denuded sandstone around them. Analysis has shown that the cementing material of the upper part is barium sulphate. This being practically insoluble withstands denudation and protects the lower part from waste, this lower part being mainly cemented by calcareous matter. Bischof has proved the occurrence of barium sulphate as a cementing material in some foreign sandstones, but the fact is probably new in Britain.

On Deep Borings at Chatham. A Contribution to the Deep seated Geology of the London Basin, by W. Whitaker, B.A., F.G.S., Assoc.Inst.C.E.—A few years ago the Admiralty made a boring in the Chatham Dockyard extension, to the depth of 903½ feet, just reaching the Lower Greensand, and in 1883-84 followed this by another boring near by. After passing through 27 feet of Alluvium and Tertiary beds, 682 of chalk, and 193 feet of Gault, the Lower Greensand was again reached; but, on continuing the boring, was found to be only 41 feet thick, when it was succeeded by a stiff clay, which, from its fossils, is found to be Oxford clay, a formation not before known to occur in Kent. At its outcrop, about seven miles to the south, the Lower Greensand is 200 feet thick, and is succeeded, a little further south, by the Weald Clay, there 600 feet thick. Not only, however, has this 600 feet of clay wholly disappeared, but also the whole of the next underlying set of deposits, the Hastings beds, which crop out everywhere from beneath the Weald Clay, and are also some hundreds of feet thick. More than this, the Purbeck Beds, which underlie the Hastings Beds near Battle, are absent, and also the Portlandian, Kimmeridge Clay, Corallian, &c.; beds which have been proved above the Oxford Clay in the sub-Wealden Boring, to the great thickness of over 1600 feet. We are therefore faced with a great northerly thinning of the beds below the Gault, a fact agreeing in the main with the evidence given of late years by various deep wells in and near London. Three other deep borings have been made or are being made near Chatham, all of which have passed through the Chalk into the Gault, and one has gained a supply from the sand beneath. The practical bearing of the Chatham section is, however, to enforce the danger of counting on getting large supplies of water in the London Basin from the Lower Greensand by means of deep borings at any great distance from its outcrop. Even if Lower Greensand occur at all in such places, it will probably be in reduced thickness, and therefore with reduced water-capacity.

American Evidences of Eocene Mammals of the "Plastic Clay" Period, by Sir Richard Owen, K.C.B., F.R.S., G.S., &c.—In the year 1843 a fragment of a lower jaw with one entire molar of a mammal was dredged up off the Essex coast. A canine tooth of the same was found in a well-sinking near Camberwell, in piercing the "plastic clay." The author had described the above as belonging to an animal of the Lophiodont family, and proposed for it the generic name Coryphodon. Shortly afterwards De Blainville had noticed certain fossils as "probably Coryphodont," but had referred them to *Lophiodon anthracotherium*. Ten years later Prof. Hébert had recognised two species of *Coryphodon* in the plastic clay of France. Explorations by Leidy, Marsh, and Hayden, in the "Mauvaises Terres" of Nebraska had led to the discovery of a large hoofed mammal allied to *Coryphodon*, to which the name *Titanotherium* had been given, and Prof. Cope has now recognised, from Evanstown, Wyoming, seven species of *Coryphodon*. From these materials, which have been rendered accessible to European palæontologists by the superb volume of reports recently issued by the United States Government, the author is enabled to give a general description of this family of hoofed mammals of large size which flourished in early Eocene times. To the details of this the major part of the paper is devoted.

Some Results of the Crystallographic Study of Danburite, by Dr. Max Schuster.—In studying the characters of the faces and the structure of the Danburite crystals found in Switzerland the author has met with vicinal faces of a peculiar kind, for which he proposes the term "transitional faces" (*Tschermak Min. Mittheil.*, vi., 1884, p. 511). Attention is called to the fact that these faces are easily affected by those causes which produce an unequal development of faces otherwise symmetrically disposed, and an illustration is given of the way in which their indices are numerically related to those of the principal faces of the crystal.

Notice of an Outline Geological Map of Lower Egypt, Arabia Petræa, and Palestine, by Edward Hull, LL.D., F.R.S., F.G.S.—The map exhibited was enlarged from that which accompanies the author's book, "Mount Seir, Sinai, and Western Palestine," giving a narrative of the expedition sent out into these countries by the Palestine Exploration Society in 1883-84. It embraces a region extending from the valley of the Nile on the west to the table-land of Edom (Mount Seir) and Moab, including the Jordan, Arabah Valley, and the mountains of Sinai. Its northern limit is the Lebanon. The main lines of fault and dip of the strata are also indicated. A topographical and geological map of the Arabah Valley on a scale of about six miles to one inch was in preparation, and would accompany the Geological Report now in the press for the Palestine Exploration Society.

A Preliminary Note on a New Fossil Reptile recently discovered at New Spynie, near Elgin, by Dr. R. H. Traquair, F.R.S.—Of this most important fossil the author had as yet only seen a photograph submitted to him by Prof. Judd, the President of the Section. This photograph represents pretty nearly a vertical longitudinal section of a reptilian skull, of which one very prominent feature is the presence of a large conical tusk in the upper jaw, projecting downwards and forwards, immediately behind the premaxillary part of the skull. This tusk is seen only in impression, but the cast of the internal cavity which is well shown indicates that it grew from a permanent pulp. No evidence of any other teeth is visible, and the whole appearance of the skull as seen in the photograph, with the position and shape of the tusk, indicate that the reptile here represented, if not actually belonging to the genus Dicynodon, is certainly a member of the group of Dicynodontia. Geologists will not underrate the importance of this discovery in its bearing on the question of the age of the reptiliferous sandstone of Elgin.

On the Average Density of Meteorites compared with that of the Earth, by the Rev. E. Hill, M.A., F.G.S.—The average density of the meteorites which fall on the earth is attempted to be calculated. Different methods give as results 4·55, 4·58, 4·84, 5·71, the last value being influenced by the size of one particularly large metallic specimen. The average density of the earth is usually regarded as 5·6. Meteorites are samples of the materials of space. A mass of them would aggregate into a body of density not widely differing from that of the earth. The densities of the other planets are not inconsistent with a like origin. Consequently any theory of the genesis of the earth from pre-existing materials involves a probability that an important part of its nucleus is metallic.

On the Occurrence of Lower Old Red Conglomerate in the Promontory of the Fanad, North Donegal, by Prof. Edward Hull, LL.D., F.R.S., Director of the Geological Survey of Ireland.—The district in which the Old Red Conglomerate occurs is formed of ridges and valleys of metamorphic rocks, consisting of beds of quartzite, schist, crystalline limestone, and trap, chiefly diorite. It lies between Lough Swilly and Mulroy Bay, and is washed on the north by the waters of the Atlantic. The remarkable tract of the Old Red Conglomerate, recently discovered by the officers of the Geological Survey, is far remote from any mass of the same formation, and it is unrepresented on any geological map hitherto published. The beds consist of red and purple sandstones and conglomerates, made up chiefly of quartzite pebbles and blocks, but also containing others of limestone and trap; all derived from the surrounding metamorphic series. They occupy an area of over two miles in length and half a mile across, extending along the northern base of Knock Alla, a ridge of quartzite which traverses the promontory from side to side. The beds dip against the base of the mountain, against which they are let down by a large fault, and they terminate along their northern edge by an unconformable superposition on beds of quartzite and limestone. They reach a total thickness of about 800 feet. From the position of these beds it becomes evident that they are unconnected with any of the recognised basins of Lower Old Red Sandstone, either in Scotland or Ireland, and may, therefore, be regarded as having been formed in an isolated basin, which, following the example of Dr. Geikie, I may be allowed to name "Lake Fanad." The tract will be a new feature on geological maps of Ireland.

On Bastite-Serpentine and Troktolite in Aberdeenshire; with a Note on the Rock of the Black Dog, by Prof. T. G. Bonney, D Sc., LL.D., F.R.S., Pres.G.S.—Bastite-serpentine (as noticed some time since by Prof. Heddle) occurs near Belhelvie and on the shore near the Black Dog. The author describes the microscopic structure of this, showing that it consists of olivine and its alteration products, enstatite in various stages of alteration, and a mineral of the spinellid group. Associated with this in the Belhelvie district is a fairly normal troktolite, consisting of a plagioclastic felspar allied to anorthite, olivine, more or less altered, and a little diallage. It closely resembles the typical Volpersdorf rock, but has rather less magnesia and more alumina, corresponding chemically more nearly with a rock described by the author from Coverack Cove, Cornwall. He is of opinion that the two rocks differ somewhat in age, though probably the earlier was still at a high temperature when the latter was intruded, and he inclines to the view that the serpentine is the older rock of the two. The Black Dog has been incorrectly described as consisting of "crystals of *talc* matted in such confusion as to form both a tough and hard rock." The rock really consists of quartz, sillimanite, two kinds of mica, an iron oxide (hematite?), and most probably some dichroite, with perhaps a little kyanite. In short, the rock presents a very close resemblance under the microscope to some specimens of the well-known "cordierite gneiss" of Bodenmais.

On the Re-discovery of Lost Numidian Marbles in Algeria and Tunis, by Lieut.-Col. Playfair, H.M. Consul-General for Algeria and Tunis.—The author explained that the name itself was a misnomer, as they are not found within the limits of Numidia proper, but in the province of Africa and in Mauritania. Most of the "Giallo antico" used in Rome was obtained from *Simittu Colonia*, the modern Chemton, in the valley of the Medgérda, the quarries of which are now being extensively worked by a Belgian company; but the most remarkable and valuable marbles are found near Kleber, in the province of Oran, in Algeria. There, on the top of the Montagne Grise, exists an elevated plateau, 1500 acres in extent, forming an uninterrupted mass of the most splendid marbles and breccias which the world contains. Their variety is as extraordinary as their beauty. There is creamy white, like ivory; rose colour, like coral; Giallo antico; some are as variegated as a peacock's plumage; and on the west side of the mountain, where there has been a great earth-movement, the rock has been broken up and re-cemented together, forming a variety of breccias of the most extraordinary richness and beauty.

On some Rock-Specimens from the Islands of the Fernando Noronha Group, by Prof. A. Renard, LL.D.—The rock-specimens described in this communication were collected by Mr. J. G. Buchanan, during the voyage of the *Challenger*. The islands have been described by Darwin in his "Geological Observations on Volcanic Islands" (2nd edition, p. 27). The author, after having explained the geological structure, gives lithological descriptions of the chief types of the rocks, which may be referred to the phonolites (St. Michael's Mount). These phonolites are composed of sanidine, augite, nepheline, hornblende, magnetite, nosean, and titanite. The rocks of Rat Island are basalts with nepheline. The constituent minerals are augite and olivine. The ground-mass is almost entirely composed of nepheline. Biotite and apatite occur as accessory constituents. The little island known as Platform Island is also basaltic, with a doleritic texture. It is composed of labradorite, augite, olivine, magnetite, and biotite. This rock has undergone alterations.

Preliminary Note on some Traverses of the Crystalline District of the Central Alps, by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., Pres. G.S.—During the past four years I have made several traverses of the Central Alps from north to south, and venture to lay before the Section the general results as bearing in some respect on the geology of the Highlands. (1) The ordinary rules of stratigraphy as learnt from most lowland districts are commonly quite inapplicable to the Alps. The most highly crystalline and the older beds often form the higher parts of a mountain region, the newer the lower. The newer beds frequently appear to underlie and dip regularly beneath the older. Gigantic folds, overturns, and overthrust faults abound. The true stratigraphy of a district can only be worked out by the exercise of patient and cautious induction from observations extended over a wide area. (2) The non-crystalline rocks of the Alps are of various ages. There are some of Carboniferous age, but the great period of continuous deposition generally begins with some part of the Trias. The conglomerates, which often occur at the base of the non-crystalline deposits, indicate that the principal metamorphism of the crystalline series was anterior to both these epochs. There is at present no reason to suppose that either in the Central Alps or for some distance on each side are there any representatives of the earlier Palæozoics. I believe that the conglomerates at the base of the Carboniferous contain fragments of the later crystalline rocks of the Alps as well as of some of the earlier—though I do not assert that these crystalline rocks have undergone no modifications since Carboniferous times. (3) In the heart of the principal Alpine chains, and apparently at the base of everything, are coarsely crystalline gneisses. These differ little from granites, except that they generally—almost always—exhibit a certain foliation, and occasionally seem to be interbedded with thin seams of micaceous schists or flaggy fine-grained beds. (4) On examination we find reason to believe that both the latter are generally due to crushing. Their strike agrees with that of the apparent foliation in these older rocks, and with that of a foliation which is also present in the newer crystalline rocks. This corresponds with the strike of the main physical features of the district, and with the cleavage in the included troughs of sedimentary rock. It runs for great distances with remarkable uniformity. (5) This apparent foliation is due to the devolopment of extremely thin films of a micaceous mineral. In many cases it causes the rock to bear the aspect of a highly micaceous schist; yet, on examining a transverse section, the rock is distinctly seen to be a crushed gneiss—*i.e.* though so conspicuous, it is a mere varnish. As it thus differs materially from a true foliation, it would be convenient to give it a name, and I should propose to call it the "sheen surface." It is, in fact, a kind of "cleavage foliation," that is, a foliation due to cleavage, and subsequent to it. (6) The pressure which has produced this "sheen surface" has in many cases affected the orientation of the minerals, which are present in the true "foliation" layers of the more distinctly foliated, *i.e.* mineral-banded, rocks. (7) In the crystalline schists very commonly the "sheen surface" corresponds with the original foliation surface, as in the slates the cleavage sometimes does with the bedding. This is due to the fact that the axes of the great folds often make a very high angle with the horizon. (8) Thus a non-foliated crystalline rock may be rendered to some extent foliated by pressure (followed by a certain amount of mineralisation): *i.e.* some gneisses may be formed by crushing from granites, some schists out of other igneous rocks. It may obliterate an earlier foliation, or it may intensify it, or it may produce an independent and more fissile foliation. In this sense gneiss may be said to pass into granite, because a rock which is now, both macroscopically and microscopically, a gneiss may prove to be a granite which has in some parts yielded to pressure more than in others. (9) As we pass outwards from the great central granitoid masses we come to gneisses and schists where the evidence of some kind of stratification becomes more marked; bands of crystalline limestone, quartzite, and granulite being associated with mica schist of many kinds—simple, garnetiferous, staurolitic, actinolitic, and the like—the bands of different mineral character and composition varying from mere streaks to layers up to many yards in thickness. In fact the above-named rocks are associated exactly as limestones, sandstones, and clays are associated in the ordinary sedimentaries. (10) Although the crushing of a crystalline rock *in situ*, or the squeezing and shearing of a breccia or conglomerate of crystalline fragments, occasionally gives rise to local difficulties, these are on a small scale, and sedimentary beds belonging to the Palæozoic or later periods of deposition are generally readily distinguishable from the whole of the crystalline series. Though folded and faulted in the most extraordinary manner, the members of the two series can generally be separated and in the Alps there is no evidence of a mingling of the one with the other in the process of rolling out or squeezing together; so that, after patient study and microscopical examination, we can generally decide without hesitation whether a particular set of rocks has originated from the crystalline or the sedimentary series. I do not say that we can always decide whether a schist or a gneiss has originated from an igneous rock or from an older schist or gneiss, but I think that in the Alps we can say that it has originated from one of these. Fortunately, intrusive rocks are very rare in the Palæozoic and later deposits in this part of the Alps. (11) Thus, although the Tertiary metamorphism of the Alpine rocks is very important, it is more pretentious than real, and its effects seem to have been the greatest where it has found a rock already crystalline to act upon. Hence I believe that every true gneiss and schist in the Alps is much older than the Carboniferous, and is probably older than any member of the Palæozoic period.

The Direction of Glaciation as ascertained by the Form of the Striæ, by Prof. H. Carvill Lewis.—As there seemed to be a disagreement between certain Scotch geologists and the Irish geologists regarding the inferences as to direction of glaciation to be deduced from the form of glacial striæ, the author was led to bring forward some observations of his own, made in America and in Great Britain, which threw light upon the disputed point. Well-preserved striæ are frequently blunt at one end and tapering at the other, the shorter ones sometimes resembling the characters used in the cuneiform inscriptions. This form may be seen in striæ of all sizes—from those several yards in length, when the blunt end may be an inch or more in breadth, to the finest scratches, where a microscope is necessary to detect any difference between the two ends. As shown in the Reports of the Boulder Committee of the Royal Society of Edinburgh (Fifth Report, pp. 18–20, 29, 58; Seventh Report, p. 18) and elsewhere, certain Scotch geologists regard the blunt end as the point of impact of the striating agent, and as therefore facing the direction from which the motion came. On the other hand the Irish geologists ("Memoirs of the Geological Survey of Ireland," Explanation to sheets 86, 87, 88, p. 55; Explanation to sheet 193, p. 18, &c.) interpret the shape of the striæ as indicating motion in the opposite direction, believing the tapering end to point to the direction from which glaciation proceeded. The point at issue is of importance, especially in outlying islands and elsewhere, where other indications of the direction of glaciation fail. In Pennsylvania, which is crossed from east to west by the terminal moraine of the great ice-sheet, and where the glaciation is uniformly in a southward direction, the author had observed that the blunt ends of the striæ, where flat surfaces were studied, were always to the south ("On the Terminal Moraine in Pennsylvania and Western New York." Report Z, Second Geological Survey of Pennsylvania, pp. 33, 85, 86, 107, 275). In certain instances the mode of formation of the striæ was also indicated by their shapes, which showed that a stone pushed along under the glacier had ground in deeper and deeper until in some cases it stopped or hopped out, in other cases was ground down to another cutting edge, and in others *turned over*, and began its work of engraving by a fresh and sharp corner. The peculiar gorges at the farther end of certain striæ showed a sort of slow rocking motion in some stones before they finally turned over. The author's observations in Ireland, both at localities where there could be no doubt as to the direction of glacial movement, and at localities where such direction was not previously known, led to conclusions entirely in harmony with those already reached in Pennsylvania and with those held by the Irish geologists. One of the best examples falling under the former category was among the local glaciers in the mountains of the Dingle promontory, a region not invaded by the great confluent ice-sheet of central Ireland. The striated beds of these small glaciers, beginning in a "corey" and bounded below by a semicircular terminal moraine, are beautifully defined and afford good opportunities for striæ study. It was found that *on upward slopes or in flat surfaces the striæ as a rule are blunt at the end towards which the motion was directed, but that in downward slopes the reverse is generally the case.* While this rule does not hold good for every individual scratch at a given locality, it has been found most useful when applied to striated surfaces in general. At Glengariff, where some finely striated surfaces occur, a number of tracings were taken directly from the rock, which clearly show the broader ends of most of the striæ to be to the south, the direction towards which the glacial stream advanced. Similar observations were made at several localities south of the Shannon. Finally, as an instance where the direction of glaciation was previously unknown, certain striæ were described which the author had observed on the top of the cliffs facing the Atlantic at Kilkee. These point N. 58° W. and S. 58° E., and the question to be determined was whether the glaciation proceeded from the Atlantic towards the land or whether it went north-westward and out to sea. The form of the striæ alone decided it. Their broad blunt ends were as a rule toward the north-west, the surface being horizontal, a fact which, taken in connection with other observations made about the mouth of the Shannon, showed that a great ice stream had flowed westward along the valley of the Shannon, and had opened out fan-shaped as it plunged into the sea.

The Geology of Durness and Eriboll, with special Reference to the Highland Controversy, by B. N. Peach, F.R.S.E., and J. Horne, F.R.S.E., Geological Survey of Scotland.—With the permission of the Director-General of the Geological Survey, the authors gave an outline of the geological structure of the Durness-Eriboll region, illustrated by a series of horizontal sections. They showed that the Silurian strata of Durness are arranged in the form of a basin, bounded on the east side by powerful faults disconnecting them from the same series in Eriboll. The order of succession in the two areas is identical, from the basal quartzites to the horizon of the limestone group. On the west side of Loch Eriboll the basal quartzites rest unconformably on the Archæan gneiss, but on the eastern shore there is conclusive evidence of the repetition of various members of the Silurian series by a remarkable system of reversed faults, culminating in a great dislocation which has thrust the Archæan gneiss over the truncated edges of the quartzites, fucoid beds, serpulite grit, and basal limestone. Reference was made to the effects of these mechanical movements on the Silurian rocks, and to the developments of new planes of schistosity in the gneiss above the thrust-plane. At intervals small patches of the basal quartzites are met with throughout this mass of Archæan gneiss, which are abruptly truncated by great reversed faults; but in the district between Eriboll and Assynt the whole Silurian succession from the basal breccia to the lowest limestone occurs repeatedly above the first great thrust-plane, separated by wedges of highly-sheared gneiss. It was shown that the alteration produced by each successive displacement gradually becomes more pronounced as the observer passed eastwards across the area. The old north-west strike of the Archæan gneiss gave place to a new foliation running more or less parallel with the strike of the thrust-planes; the felspathic basal quartzites and the "pipe-rock" pass into quartz schists and mica schists, and the Silurian limestone is felted with the crushed Archæan gneiss. Reference was next made to the outcrop of the great thrust-plane extending from the Whitten Head coast far to the south, which ushers in a highly schistose series with a north-north-east and south-south-west strike. After describing the lithological characters and order of succession of the eastern schists, the authors stated that the new planes of foliation had been superinduced by the mechanical movements that took place between Lower Silurian and Old Red Sandstone time, and that along these new planes a re-arrangement and recrystallisation of mineral constituents took place, resulting in the production of crystalline schists. Applying the knowledge thus obtained from the study of the eastern schists to the undisturbed Archæan masses, they had found conclusive evidence of similar mechanical movements. Each plane of schistosity exhibits the parallel lineation like slickensides trending in the same direction over a vast area, while the minerals were oriented along these lines. From a consideration of these phenomena the authors inferred that regional metamorphism need not necessarily be confined to any particular period, and further that the planes of foliation or schistosity in those areas which had been subjected to regional metamorphism were evidently due to enormous mechanical movements which had induced molecular changes in crystalline and clastic rocks.

The Highland Controversy in British Geology: its Causes, Course, and Consequences, by Chas. Lapworth, LL.D., F.G.S., Professor of Geology and Physiography, Mason College, Birmingham.—The author gave a *résumé* of the views of the earlier geologists respecting the geological age and possible mode of formation of the Highland metamorphic rocks; and sketched, in brief, the rise and progress of the controversy between Sir Rod. Murchison and his followers on the one hand, and Prof. Nicol, of Aberdeen, on the other, till its temporary close in 1861, by the publication of the Highland Memoir of Murchison and Geikie. He then reviewed the reopening of the controversy by Dr. Hicks in 1878, and the work of the Archæan geologists, up to the date of publication of Dr. C. Callaway's paper in 1883, in which Nicol's view of the great physical break between the Palæozoic rocks and the Eastern or Upper Gneissic series was shown to be correct, but the so-called Eastern gneiss was provisionally erected into a new Archæan system, the Caledonian, having the Arnaboll gneiss as its lower member. The author next gave a summary of his own views as deduced from his personal study of the Durness Eriboll district in 1882 and 1883, and published in 1884, illustrating these by coloured maps and sections. He held that (exception being made of the local Torridon Sandstone) the only rock-formations in the Durness-Eriboll area are, as Nicol originally contended: (1) The Archæan or Hebridean gneiss; and (2) The Palæozoic quartzites, fucoid beds, and limestones. But the so-called upper gneiss or eastern metamorphic gneiss appears to be composed of elements derived from one or other of the foregoing. There is no conformable ascending succession from the Palæozoic rocks into this Eastern Metamorphic series. The line of contact is, generally speaking, a plane of dislocation, and where this is wanting the Palæozoic rocks rest unconformably upon one of the members of the eastern gneiss. The present physical relations of the eastern metamorphic series are the effect of lateral crust creep, by which the eastern metamorphic rocks have been forced over the Palæozoic rocks in grand overfaults to the west, often for many miles. This Eastern Metamorphic series is composed of two petrological members, the *Arnaboll gneiss* to the west, and the *Sutherland schists* and gneisses to the east, having between them a series of *variegated schists* possessing characters common to both. The Arnaboll gneiss is simply the easterly extension of the Hebridean of the west The remaining gneisses and schists of the eastern metamorphic series are mainly composed of re-metamorphosed Hebridean, with included patches of igneous and Palæozoic material. The planes of schistosity which divide the layers of the Upper Gneissic series are not planes of bedding, but planes of dislocation. The dip and strike of these planes have been given to them since Silurian times by the agency of the great earth-movements. In some instances the original structures of the rocks are still recognisable; usually, however, they are wholly obliterated: the old minerals have disappeared as such, and new minerals have been developed. The Eastern Gneissic series has thus no pretension whatever to the title of a sedimentary rock-system. It is a petrological rock-massif, a metamorphic compound, composed of local elements of very different geological ages. In all their essentials these views appear to agree with the far more contended and minute results worked out independently, and published by Messrs. Peach and Horne in November 1884.

In the second part of his paper the author gave a summary of the work accomplished among the metamorphic rocks of the Alps and Eastern Germany by Heim and Lehmann; and described the several types of rock-metamorphism found in the Eriboll district, as worked out by himself. The Arnaboll (Hebridean gneiss) can be traced stage by stage from spots where it retains its original strike and petrological characters, to others where it acquires the normal strike and mineralogical features of the ordinary Sutherland schists. The old planes of schistosity become obliterated, and new ones are developed; the original crystals are crushed and spread out, and new secondary minerals, mica and quartz, are developed. The most intense mechanical metamorphism occurs along the grand dislocation (thrust) planes, where the gneisses and pegmatites resting on those planes are crushed, dragged, and ground out into a finely-laminated schist (*Mylonite*, Gr. *mylon*, a mill) composed of shattered fragments of the original crystals of the rock set in a cement of secondary quartz, the lamination being defined by minute inosculating lines (fluxion lines) of kaolin or chloritic material and secondary crystals of mica. Whatever rock rests immediately upon the thrust-plane, whether Archæan, igneous, or Palæozoic, &c., is similarly treated, the resulting mylonite varying in colour and composition according to the material from which it is formed. The variegated schists which form the transitional zones between the Arnaboll gneiss and Sutherland mica-schists are all essentially mylonites in origin and structure, and appear to have been formed along many dislocation planes, some of which still show between them patches of recognisable Archæan and Palæozoic rocks. These variegated schists (Phyllites or Mylonites) differ locally in composition according to the material from which they have been derived, and in petrological character according to the special physical accidents to which they have been subjected since their date of origin—forming frilled schists, veined schists, glazed schists, &c., &c. The more highly crystalline flaggy mica-schists, &c., which lie generally to the east of the zones of the variegated schists, appear to have been made out of similar materials to those of the variegated schists, but to have been formed under somewhat different conditions. They show the fluxion-structure of the mylonites; but the differential motion of the component particles seems to have been less, while the chemical change was much greater. In some of these crystalline schists (the augen-schists) the larger crystals of the original rock from which the schist was formed, are still individually recognisable, while the new matrix containing them is a secondary crystalline matrix of quartz and mica arranged in the fluxion-planes. While the *mylonites* may be described as microscopic pressure-breccias with fluxion-structure, in which the interstitial dusty, siliceous, and kaolinitic paste has only crystallised in part; the *augen-schists* are pressure-breccias, with fluxion-structure, in which the whole of the interstitial paste has crystallised out. The *mylonites* were formed along the thrust-planes, where the two superposed rock-systems moved over each other as solid masses; the *augen-schists* were probably formed in the more central parts of the moving system, where the all-surrounding weight and pressure forced the rock to yield somewhat like a plastic body. Between these augen-schists there appears to be every gradation, on the one hand to the mylonites, and on the other to the typical mica-schists composed of quartz and mica. Like the mylonites, the crystalline augenites and micalites present us with local differences in chemical composition (calcareous, hornblendic, quartzose, &c.), suggestive of Archæan, igneous, or Palæozoic origin. They also show similar structural varieties due to secondary physical changes (frilled, veined, glazed, &c.), as well as others due to the presence of special minerals (garnet, actinolite, &c., &c.).

On certain Diatomaceous Deposits (*Diatomite*) *from the Peat of Aberdeenshire*, by W. Ivison Macadam, F.C.S., F.S.C., &c., Lecturer on Chemistry, School of Medicine, Edinburgh.—The material was found below the peat in certain districts of Aberdeenshire, but principally in the basin in which lie Lochs Kinnord and Dawin. After removal of the surface peat-fuel, the lower and more highly mineral portion was cut in blocks and air-dried. The substance then consisted of almost pure Diatomacea bound together by the remains of Spragnum, Equisetacea, &c. Besides being found underlying peat the substance was also obtained on the shores of Loch Kinnord, and the more pure Diatoms were thickly distributed over the bottom of the deeper portions of the lake; these latter, however, from the want of the binding obtained from the marsh plants above mentioned could not be rendered readily available for market. An interesting point regarding these deposits was that whilst in Loch Kinnord an abundant supply of the Diatoms could be obtained, in the neighbouring Loch Dawin scarcely a single Diatom (recent or fossil) was found. This was probably due to the fact that whilst the feeding waters of Loch Kinnord flowed from hills consisting of a coarse and much disintegrated granite, and consequently contained a considerable portion of soluble silica, the Loch Dawin waters were obtained from hornblendic mountains, and held much less soluble silica in solution. The material was principally used for the manufacture of dynamite, and a considerable quantity had been forwarded to the works for this purpose. Unfortunately, however, dynamite had fallen to a great extent out of use, being replaced by the more powerful blasting gelatine, and thus what had at one time appeared as if it would prove an important local industry had entirely fallen away. Other uses, however, could be found for the material, such as the manufacture of ultramarine, for which, from the very small proportion of iron present, the diatomite has more especially to be recommended. As an absorbent it was of fully double the value of the ordinary German varieties of "kieselguhr."

On Some Recent Earthquakes on the Downham Coast, and their Probable Causes, by Prof. G. A. Lebour, M.A., F.G.S.—For the last two years frequent slight shocks, resembling those of earthquakes, and accompanied by rumbling noises, have been felt at Sunderland. Much discussion has arisen as to the cause of these, but that they are due to natural causes is now quite certain. Sunderland stands upon magnesium limestone, from 300 to 400 feet thick beneath the town; the rock is riddled with cavities of every size, some so small as to give a vesicular character to the stone, some large and forming true caverns. These cavities are partly due to the washing out of marly matter, partly to solution of the limestone. Every thousand gallons of Sunderland water contains one pound of stone; in this manner about forty cubic yards of magnesian limestone are yearly pumped up by the Water Company, and of course a much larger quantity is removed by natural channels. This action enlarges the cavities; the sides and roof fall in, thus accounting for the shock. The same explanation applies to the "breccia gashes" which are exposed along the shore. These are fissures filled with breccia. Quite recently similar shocks to those here referred to have been observed at Middlesborough. Pumping the brine from the salt deposits, 1000 to 1200 feet below the surface, may produce cavities into which the rock falls.

Some Examples of Pressure-Fluxion in Pennsylvania, by Prof. H. Carvill Lewis.—The three localities in Pennsylvania described in this paper lie in an area which had been especially studied by the author for some years back and had led him to conclusions similar to some of those recently announced as the result of studies in North-Western Scotland, which have justly attracted widespread attention. (1) a zone of ancient crystalline rocks extends across South-Eastern Pennsylvania, near Philadelphia, which is generally believed to underlie the lowest Cambrian strata and to be of Archæan age. This zone is about a mile wide where it crosses the Schuylkill River, south of Conshohocken, and it is from this point to Westchester, some twenty miles westward, that the present remarks especially apply. Although in many portions exhibiting a distinct gneissic lamination, the rocks of this zone are held by the author to be of purely eruptive origin, consisting of syenites, acid gabbros, trap granulites, and other igneous rocks, often highly metamorphosed. It is the outer peripheral portion of this zone to which attention is here directed. While the rocks are massive in the centre, this outer portion has been enormously compressed, folded, and faulted, with the result of producing a tough-banded, porphyritic *fluxion gneiss* identical with the "milonite" of Lapworth or the "sheared gneiss" of Peach and Horne. So perfect is the fluxion structure that the rock resembles a rhyolite. As in the "banded granulite" of Lehmann, elongated feldspar "eyes" lie in flowing streams of biolite grains and broken quartz, the streams often parting and again meeting around the porphyritic "eyes." Occasional crystalline eyes of hornblende remain, but most of it has been converted into biotite. A point of especial interest is that the feldspar of the eyes is quite colourless and free from inclusions, like the sanidine of recent lavas, while, on the other hand, the feldspars of the inner and massive portions of the zone, out of which this outer portion has been reformed by pressure fluxion, are full of inclusions and have the "dusty" appearance so common in ancient feldspars. The fresh-looking feldspar eyes are therefore believed to have been subsequently formed as a result of a *recrystallisation* of the old material under the influence of *pressure fluxion*. In similar manner the biotite has been made out of the old hornblende, garnets have been developed, and the quartz has been granulated and optically distorted by pressure. The influence of pressure is also seen in certain Cambrian strata in the immediate vicinity, where a sandstone containing cylindrical casts of *scolithus linearis*, apparently identical with the "pipe-rock" of North-Western Scotland, has, like it, been compressed to such a degree that the vertical casts are flattened out and elongated in the direction of lamination to several times their original length. In the same sandstone quartz pebbles have been pulled out and flattened, while sericite has been largely developed along the cleavage planes. The pressure can be shown to have been directed mainly from the south-east. (2) The second locality is in the midst of the Laurentian area of Buck's County, and is known as Van Artsdalen's Quarry. A mass of crystalline limestone is here mingled with an eruptive diorite in such manner as to show that it had actually flowed like an igneous rock, and had caught up inclusions. The results of extreme metamorphism are exhibited in the development in the limestone of graphite, wollastonite, and other minerals. The chemical changes and interchange of elements which might result from a loosening of molecular combinations under extreme pressure and their subsequent "regulation" into new compounds were discussed as among the phenomena of mechanical metamorphism. (3) As an American instance of the conversion of an intrusive diabase dyke into amphibolite schist, analogous to the case recently described by Teall, a long narrow belt of sphene-bearing amphibolite schist in the City of Philadelphia was adduced. This belt with distinctive mineralogical characters cuts across the metamorphic mica schists of the region unconformably, and is believed by the author to be a highly metamorphosed intrusive dyke of Lower Silurian age. The original augite or diallage has been completely converted into fibrous hornblende, and the influence of pressure is shown in the perfectly laminated character of the schist in the close foldings produced, and in the minute structure of the rock. Some interesting details of the latter having been photographed, diagrams constructed from these were exhibited. These showed that the rock was traversed by a parallel series of slips and crushings, and that about such lines of faulting and crushing there was a peculiar arrangement of the lines of hornblende crystals, not very unlike the arrangement of iron filings about the poles of a magnet, such as could not be satisfactorily explained by any theory of aqueous deposition, but pointed to a lamination by pressure.

SECTION D—BIOLOGY

On the Cause of the extreme Dissimilarity between the Faunas of the Red Sea and Mediterranean notwithstanding their recent connection, by Prof. Edward Hull, LL.D., F.R.S.—The faunas of the Mediterranean and of the Red Sea are so unlike that if the beds of the two seas were upraised, and their contents examined, naturalists would probably refer them to distinct geological periods. The dissimilarity is greater than was formerly supposed. In Woodward's "Manual of the Mollusca" it is stated that seventy-four species of mollusks are common to the two seas, but Prof. Issel, of Genoa, places the number at eighteen, or about 2 per cent. Equal differences exist if we compare other great groups of life; in fact, as Prof. Haeckel well observes, the fauna of the Red Sea is related to that of the Indian Ocean, the fauna of the Mediterranean to that of the Atlantic. This extreme dissimilarity would not surprise us if it were not for the proofs of recent connection between the two seas. Evidence of old sea margins, up to about 220 feet above the present sea-level, are frequently found along the Nile and in the valleys and plains of Philistria. As many of the marine forms found in these deposits still exist, the date of the submergence may be safely referred to that of the Pliocene; but it continued to a later period, and (in the author's opinion) it to some extent remained to the time of the Pharaohs. The existing fauna probably dates back to Eocene times, when the ocean spread widely over the area in question. In the Miocene period the main outlines of land and sea as we now find them were marked out, the deposits of this age being here small and local. Under the extremely different conditions existing in the two areas, the fauna during and after the Miocene period became differentiated. The connection re-established during and after the Pliocene period was insufficient to destroy these differences, although it allowed a mingling of forms to some extent. The maximum submergence was about 220 feet; but as the summit level between the two seas is about 50 feet, the depth of water would only be about 170 feet at the maximum. Only littoral and shallow-water forms would cross in the adult state; but many forms inhabiting deeper water in the adult state might have crossed when in the free-swimming larval state. When the land again rose, and the marine straits were finally effaced, the different physical conditions of the two seas would again come into effect. The difference of temperature is now very considerable, and probably was much greater during the Glacial period, especially if, as appears probable, the eastern or Levant basin of the Mediterranean were separated from the others; for into this would flow the cold waters of the Black Sea and of Central Europe, whilst the Red Sea would receive warm water, and be itself exposed to the rays of a tropical sun. It would be an interesting subject of inquiry—Which of these faunas most closely resembles that of the original stock?

On the Tay Whale (Megaptera longimani) and other Whales recently obtained in the District, by Prof. Struthers.—Prof. Struthers gave a description of the various parts of the anatomy of the whale. In addition to the Tay whale members of three other whales recently obtained in the district were exhibited for the purpose of comparison, and the analogy of its structure to that of other animals was specially referred to in order to show its identity with the mammal. Prof. Flower joined in the discussion which followed, and remarked that they now had an idea at least as to the origin of the whale: it carried its pedigree in every part of its body. It had been thought that the mammals that live upon land had been derived from progenitors that formerly lived in the sea, and that the mammals may have passed through an aquatic or marine stage before they took to land, but the observations of anatomy showed that this cannot have been the case. There was no doubt that the whale had been derived from a four-footed land mammal. All observations, for example, had shown that at some period of their life whales have a hairy covering, generally in the region of the mouth, that hairy covering being functionless and very often lost even before birth. In the same way whales at an early stage of their existence are furnished with a complete set of teeth, the rudiments of the teeth of the land mammal. The organ of smell, although in a rudimentary state and in some species almost entirely gone, also points to the origin of the whale.

Some Points in the Anatomy of Sowerby's Whale, by Prof. Turner.—Prof. Turner remarked that *Mesoplodon bidens*, or Sowerby's whale, of which he had dissected two specimens, was now for the first time dissected so that the viscera of this whale were seen by any anatomist, or that its tail and paddle, or fin, had been figured. The tail presents a very material difference from the customary tail in the cetacea in having the posterior border smooth instead of notched. Dr. Turner called attention in detail to the intestinal and limb structure of this species of whale, showing the affinity or resemblance of the cetacea to the reptilious and the amphibious, particularly in reference to the corpus. Prof. Flower said he was glad to find that Prof. Turner had found some intention for the muscles of the corpus. For all that they were very rudimentary as compared with the same muscles in other animals, and he thought that he might have to modify his views on this point as he had had to do in regard to many other things throughout life. Prof. Marsh, of Yale College, said the intermediary bone pointed out by Prof. Turner interested him much.

On the Cervical Vertebræ of the Greenland Right Whale, by Prof. Struthers.—The reduced condition of the upper and lower transverse processes was commented on, and the meaning of their different parts explained; also the completely fused condition of the bodies of the seven vertebræ. A nearly similar condition of the neck of the Pilot Whale (*Globicephalus melas*) was demonstrated, showing in the young condition the two body epiphyses on the rudimentary vertebræ. Other specimens illustrated the fibrous condition of the transverse processes in the Narwhal and Beluga.

On the Development of the Vertebræ of the Elephant, by Prof. Struthers.—The point was that in the anterior vertebræ the neural arches meet behind the body, covering it deeply, and shutting it entirely out from forming any part of the wall of the spinal canal.

On the Development of the Foot of the Horse, by Prof. Struthers.—Dr. Struthers called attention to the fact that the epiphysis of the rudimentary metacarpal and metatarsal bones is not at the upper or functional end, but at the reduced end or "button," from which only a slender ligament proceeded. This he considered a most interesting fact, one which completed the chain of evidence of the descent of the horse. There was a reason why the epiphyses should be there in the hipparion and previous forms from which the horse of the present day was descended. The development of the corresponding bones in man, the cetacea, and various other mammals, was given in illustration.

A specimen was shown of a two-toed horse. The valuable researches of Prof. Marsh on the descent of the horse were specially alluded to. Dr. Struthers demonstrated another fact connected with the development of the foot of the horse—that the first phalanx, or pastern bone, has an epiphysis at both ends.

On the Viscera of Gymnotus electricus, by Prof. Cleland.—Independent of its electric organs, this fish has a number of remarkable internal peculiarities. The curious spongy protuberances of the mucous membrane of the buccal cavity are well known to zoologists. The two swimming-bladders are remarkable for their relation to the kidneys; the anterior swimming-bladder being a small structure between their anterior extremities, and the larger posterior swimming-bladder being situated altogether behind their under hinder ends, while the duct of the latter ascends by the left side of the renal outlet, to be joined by the duct of the other bladder before entering the gullet. The pylorus also is remarkably contracted. But the most striking and altogether curious arrangements are seen on the ventral wall of the abdomen. The intestine passes forward the whole length of the abdominal cavity to the vent, and on its under side is a long renal duct as wide as itself, and opening immediately behind the vent; while, opening into this duct close to its outlet, are the ducts of the two ovaries, which lie one on each side, their morphologically anterior extremities placed posteriorly, as if in process of development these organs had been pulled around from their proper sub-vertebral position until completely inverted.

The Spiracle of Fishes in its relation to the Head, as developed in the Higher Vertebrates, by Prof. Cleland.—A very extraordinary mistake can be shown to be prevalent among embryologists, to the effect that the spiracle corresponds with the tympanum and external auditory meatus in the higher vertebrates. This is not the case. The spiracle is pre-oral; the tympanum is post-oral. The apparent sequence of the spiracle with the branchial clefts occurs, as Balfour described it, in the embryo of the dog-fish; but for all that, and although it has rudimentary external gills attached to its margins in the embryo, it is in front of the mandibular arch and above the maxillary lobe. Between the middle and lateral frontal processes is the nostril; between the lateral frontal process and the mandible is the space into the upper part of which the eyeball projects, and from which the lachrymal duct is developed; while between the first and second visceral lobes is the external ear; and it is highly probable that the upper part of the first branchial cleft is homologous with the clefts in front of and behind the lateral frontal process. Thus a certain amount of homology would exist between the spiracle of fishes and the lachrymal duct.

Is the Commissural Theory of the Corpus Callosum Correct? by D. J. Hamilton, M.B., Professor of Pathological Anatomy, Aberdeen University.—The results recorded by the author were obtained by certain special methods of preparation. They went to prove that the corpus callosum is not an inter-hemispherical commissure, as is generally supposed, but that it is in reality the decussation of a particular system of fibres on their way downwards to join the inner and outer capsules. These fibres are not to be confounded with the motor and other direct fibres derived from the cerebral cortex, and which decussate at some point lower down.

The Evidence of Comparative Anatomy with regard to Localisation of Function in the Cortex of the Brain, by Alex. Hill, M.A., M.B. Cambridge.—The object of the paper was to show that the theory of the localisation of function in the cortex of the brain must be submitted eventually to comparative anatomy for proof. The key to the arrangement of the lower parts of the central nervous system is to be found, as the author had elsewhere shown, in its segmental disposition: the grey matter is disposed in clumps the cells of which bear a definite numerical relation to the fibres of body nerves. The problem discussed in the present paper was the relation of the grey matter of the cortex to this lower grey matter, and therefore to the body nerves. Is each region of the cortex equally in relation with all the segments of the "central grey tube"? or is the cortex also divided up into areas, the superficies of each of which varies as the amount of grey matter in the clump of the lower system with which it is related, and therefore as the number of fibres in its associated nerve. For this investigation guides to the delimitation of the cortex are necessary, and no others are available for the purpose if the fissures fail. The homological value of the fissures is, however, established by the study of adult and fœtal brains. They are remarkably constant in their arrangement throughout animals of the same type, and in animals of different type they are very constant with regard to the order of their appearance, their progressive extension and permanent depth. The author of the paper expressed himself content, on account of the precision with which the fissures respond to the ordinary tests of homology, to place himself unconditionally in their hands, and the boundaries of the various regions of the cortex being thus marked out, it remains to devise a system of mensuration by which the superficial area of each region of the cortex may be determined for comparison with the cross-sections of the several nerves. As yet no satisfactory method of measurement has been devised, but even in the absence of exact data important results can be obtained by the observation of the brains of such animals as are conspicuous for excess or deficiency in the development of the muscular system or of one or more of the senses. As examples of such results Mr. Hill exhibited diagrams of the brains of the sheep, cat, pig, dog, and otter, enlarged from tracings of the pictures in Leuret and Gratiolet's Atlas. It was shown that, although it is impossible, as yet, to map out the brain into areas associated with the several nerves, it is quite possible to predict from the appearance of the brain the principal sensory and motor endowments of the animal to which it belonged. In the main Mr. Hill's results confirm those already obtained by Ferrier and other experimental physiologists; they seem, however, to show that they are open to correction in certain important points with regard to the areas allocated to the senses of smell, hearing, and facial sensation.

The Action of Cold on Microphytes.—Prof. M'Kendrick, Glasgow, gave an interesting account of the methods of trying to destroy small organisms like bacteria, not as is commonly done by heat, but by cold. It is known that by means of Coleman's cooling machine meat may be kept from putrefying for a considerable time, but in attempting to sterilise a putrescible solution by means of cold, it was found that, though in some cases putrescence was delayed, in no case were the organisms completely destroyed. Organic fluids were exposed to temperatures more than 120° below 0° F., but on thawing they were found to contain living organisms still. Thus the hope of preserving putrescible matter by means of cold—an important economical result—is, so far as investigation yet goes, destroyed. The organisms under cold seem to be in a nearly solid state, though we cannot call it a crystalline state. In a paste solution the water is crystallised under cold, the paste remaining spongy. Possibly cold may separate from these minute organisms the water they contain, and this water is again absorbed on thawing. Meat under cold becomes very friable, while yet minute fragments of it show the same microscopic constitution of muscle. It is well known that frogs have been found in blocks of ice and been revived. Frogs have been frozen at 20° F. in about half an hour. On thawing slowly the animal, in two instances, completely recovered. When it was frozen for longer than half an hour it did not recover; but, though reflex action was gone, there remained some irritability both in nerves and muscles. It was found also that certain vital functions may be arrested by cold, and thus conceivably higher organisms may be kept vitally inert for an indefinite time. Experiments were also tried on warm-blooded animals. A rabbit subjected to a temperature 100° below 0° F. recovered. No temperature lower than 73° below 0° F. has been obtained in free atmosphere. Prof. M'Kendrick gave a short sketch of the literature of the subject.

The Action of Ozonised Air upon Micro-Organisms and Albumen in Solution, by J. J Coleman, F.I.C., F.C.S.—This paper described a number of experiments conducted by the author in conjunction with Prof. McKendrick, F.R.S., being supplementary to their joint investigation upon the influence of cold on microphyles. Air artificially impregnated with ozone by means of a Ruhmkorff coil, so as to contain a much larger percentage of ozone than any natural atmospheric air, was passed continuously through a 1 per cent. solution of white of egg placed in a glass flask, the inlet and outlet tubes of which were carefully plugged with cotton wool previously to commencing the experiment. It was found that a stream of air containing an amount of ozone equal in weight to the albumen in solution passed through 100 c.c. of the liquid for thirty hours, failed in producing the slightest trace of oxidation, and that the ozonised air passed through the liquid quite unaltered. During the course of the experiment and for six days following the development of micro-organisms ceased, but at the end of that time, and notwithstanding the cotton wool plugs, the liquid became slightly turbid from the presence of organisms. As dilute hydrogen peroxide is without action upon albumen, the conclusion seems inevitable that albumen is practically indestructible by any atmospheric agency without previous splitting up by micro-organisms, and further, that whilst micro-organisms cannot develop, and are probably killed in an ozonised atmosphere, these spores are not easily destroyed by its agency. These results confirm the surmise of the late Dr. Angus Smith that putrefaction is a necessary preliminary to oxidation in all cases of *natural* river purification. Prof. Burdon Sanderson, Dr. W. B. Carpenter and Capt. Douglass Galton all commented upon the practical value and interest of this paper, Capt. Douglas Galton observing that the sooner organic matter of sewage is got on to land the better.

The Use of Graphic Representations of Life-Histories in the Teaching of Botany, by Prof. Bower.—This was a paper referring to a series of diagrams prepared by the author to bring in review the chief facts in the life-history of the moss, fern, equisetum, *Selaginella*, a conifer, and an angiosperm. Prof. Bower pointed out that these diagrams could be extended to include lower forms, and that they are only intended for use *after* the student has mastered the facts in detail in the laboratory. Having described the diagrams and referred to some interesting processes of vegetative reproduction in the mosses and ferns, the author then proposed for discussion a series of questions as to the advisability of employing such diagrams, or of extending their use. The discussion which followed was taken part in by Sir J. Lubbock, Profs. Bailey Balfour (Oxford), M'Nab (Dublin), Trail (Aberdeen), Mr. Marshall Ward (Owens College), and others, and several suggestions were proposed for rendering Prof. Bower's graphic representations still more graphic.

A New Theory of the Sense of Taste, by Prof. J. Berry Haycraft.—The author showed that "quality" in this sense depends upon the nature of the atoms found in the sapid molecule. A study of the periodic law demonstrates that similar tastes are produced by combinations which contain elements such as lithium, sodium, potassium, which show a periodic recurrence of ordinary physical properties. Among the carbon compounds those which produce similar tastes are found to contain a common "group" of elements. Thus organic acids contain the group CO.OH, the sweet substances CH_2.OH. There is no relation between quality of sensation and gross molecular weight, except that substances of either very small or very great molecular weight are not tasted at all.

On the Hybridisation of Salmonidæ at Howietoun, by Francis Day.—During the last eleven years Sir J. R. Gibson-Maitland, at Howietoun, near Stirling, has devoted much attention to this subject, and gone to great expense in order to efficiently carry out the many experiments he has instituted, while he has likewise afforded the author facilities for personally watching many of them, and furnished him with data as well as with specimens. When we consider that the ova of teleostean or bony fishes have, as a rule, to be fertilised by the milk of the males diffused in the surroundiag water, it is not difficult to believe that this fluid from the male of one genus might come into contact with the eggs from fish of another species, genus, or even family, and a hybrid offspring be thus occasioned. But the size of the micropyle of the ovum and that of the spermatozooid of the milt must be of conforming capacities, or fertilisation would be a physical impossibility. It would appear from the experiments made that the following conclusions may, with more or less probability, be drawn:—(1) Salmon and trout, trout and char, and different species of char, may interbreed and give rise to fertile hybrids. (2) Hybrids raised from Lochleven trout eggs fertilised by salmon milt breed in their fourth year, similar to young female salmon kept under the same conditions. (3) The anodromous instinct is not lost in these trout and salmon hybrids. (4) Judging from the period of breeding in the foregoing hybrids, the male element is prepotent. (5) In hybrids raised from Lochleven trout eggs fertilised by the milt of the American char, the male element would appear to be prepotent, if we judge simply by the colour of the offspring. (6) In hybrids raised from American char eggs fertilised by the milt of the Lochleven trout, the female element would appear to be prepotent, if we judge simply by the colour of the offspring. (7) In hybrids raised from American char eggs fertilised by the milt of the British char, the male element would appear to be prepotent, if we may judge simply by the colour of the offspring. (8) In all instances of hybridisation between different species, as between salmon and trout, or trout and char, numerous instances of malformation and great mortality occur among the offspring, but much less when two forms of char are intercrossed. (9) In intercrossing hybrids both the eggs and milt were found to be fertile, but the malformations and mortality very great. The parents, however, at Howietoun are not yet of sufficient age to admit any safe deductions on this head. (10) The age of the parent exercises great influence on the vitality of the offspring, for, when very young, we may expect a large percentage of malformations, as well as dropsy and other diseases of the offspring.

Chinese Insect White Wax, by A. Hosie.—The author began with a reference to the European and Chinese writers who mention Chinese insect white wax, and then proceeded to say that, although the province of Ssu-chuan, in Western China, where he has been stationed for the last three years, is the chief wax-insect and wax-producing country in the Empire, insects and wax are found in other provinces. Mr. Hosie was called upon by the Foreign Office to collect for Sir Joseph Hooker specimens connected with, and all possible information on, the subject of this industry, and he states that the present paper is a revision, with additions, of a Report already published in a Parliamentary paper in February last. He describes the insect-producing country, the tree on which the insects are propagated, the insects themselves, and their transit from the valley of Chien-chang, their breeding-ground, in the west of Ssu-chuan, across the mountains to Chia-ting Fu, the habitat of the wax tree. This tree is then described, and details are given of the treatment of the insects, their suspension on the trees, the depositing of the wax, and of a parasite on the insects. The method of removing the wax from the branches of the tree and of preparing it for market is then explained. The author then detailed the result of an examination of the insects after the wax has been fully deposited, finally passing to the annual quantity of insect white wax produced, its value, and uses.

On the Size of the Brain in Extinct Animals, by Prof. O. C. Marsh.—Prof. Marsh, of Yale College, said that for fifteen years he had directed his attention to the subject of the size of the brain in extinct animals. In every instance he found that the mammals from the lower Tertiary had very small brains. He carried out his investigation into the upper Tertiary, and found that the brain was much larger in the pliocene than in the miocene. All the tertiary mammals had small brains; there was a gradual increase in the size of the brain during this period; and this increase in the size was generally in the cerebral hemisphere or higher portions of the brain. In some groups the convolution of the brain had gradually become more complex. In some the cerebellum and the olfactory lobes had even diminished in size. There was now evidence that the same general law of brain growth holds good for birds and reptiles from the Jurassic period to the present time. The brain of an animal belonging to a vigorous race fitted for a long survival was larger than the average brain of that period in the same group, and the brain of a mammal of a declining race was smaller than the average brain of its contemporaries of the same group. The small animals now existing had proportionally larger brains than the larger animals, and young animals had proportionally larger brains than adult animals. They found some interesting examples which threw light on this question. For instance in the Eocene they had an animal, the oldest known ancestor of the rhinoceros, and it had an exceptionally large brain. Taking all the facts together it seemed as though this brain growth was an important element in the survival of animals. If the animal became large and unwieldly with a small brain, it would be liable to suffer from any change of climate. In other words, in early times the big brain conquered as it is the big brain that conquers in civilisation to-day. Prof. Flower said it was satisfactory to find a case where the facts worked out coincided with previously-formed theories, because that was not always the case, and sometimes the facts or the theories had to go to the wall. In this case they had no such difficulty; and they had to thank the American Government for the way in which it had taken up Prof. Marsh's work and were disseminating it.

On the Systematic Position of the Chamæleon and its Affinities with the Dinosauria, by D'Arcy W. Thompson, B.A. —The author believes that the great anatomical differences which separate the Chamæleon from all other Lacertilia are connected with marked resemblances to the Dinosauria, especially the group Sauropoda. The shoulder-girdle is quite identical with that of (*e.g.*) Brontosaurus, but differs wholly from that of the Lacertilia in the simple form of the scapula and coracoid, the absence of coraco-scapula fenestrations, of clavicle and interclavicle. Equally marked affinities with the Dinosauria may be traced in the carpus and tarsus, sternum, pelvis, and skull. While similarly the comparatively large size of the cerebellum, the absence of a urinary bladder, and the presence of pulmonary diverticula or rudimentary air-sacs, are all foreshadowings of ornithic structure.

The Origin of the Fishes of the Sea of Galilee, by Prof. Hull.—Of the abundant fishes of the Sea of Tiberias nearly one-half of the species are peculiar to the lake and its tributaries, while of the rest only one, *Blennius lupulus*, belongs to the ordinary Mediterranean fauna; two others are found in the Nile; seven other species occur in the rivers of South-Western Asia; and ten more are found in other parts of Syria. Tristram considered that this assemblage pointed to a close affinity of the fauna of the Jordanic basin with that of the rivers of tropical Africa; but what most struck the observer was perhaps the speciality of the species to Jordanic waters, sixteen out of a total of thirty-six species being peculiar. Assuming that the forms which are common to Jordanic and other waters had been distributed in a manner similar to that by which they had to account for the distribution of lacustrine forms in other parts of the world, they had yet to account for the presence of the forms which were special and peculiar. After referring to the formation of the Jordanic basin, Prof. Hull argued that by the subsidence of the floor of the sea along the line of the Jordan valley an inland lake was formed whose waters were first derived from those of the ocean itself, in which were enclosed the fishes, mollusks, and other forms which inhabited these waters themselves. The law of "descent with modification" would come into operation, and they might suppose that throughout the Miocene and Pliocene periods the process of modification in form, colour, and habit gradually proceeded. The fittest forms would survive, and differentiation between those of the outer and inner seas would result in an almost entire specific change. Prof. Hall also read a paper on the cause of the extreme dissimilarity between the faunas of the Red Sea and Mediterranean, notwithstanding their recent connection.

The St. Andrews Marine Laboratory.—Prof. M'Intosh stated briefly the structure and arrangement of the marine laboratory at St. Andrews, and made some general remarks on the work done during the last nine months there. A great many of our food fishes, he said, were carefully examined in regard to the development of the eggs and the growth of the young fishes. About twenty species were examined in this way. They experienced some difficulty with some of the forms, on account of their voracity, particularly with the cod. They found that a cod of five inches long would swallow a cod of three inches, and if it could not get it all down at once, it would keep it in its throat till the head part was digested, and then draw in the tail. Mollusca were studied chiefly in connection with the development of the mussel, but he might say that very hazy notions were held in regard to it. Some larger forms were also examined, including porpoises and sharks. One porpoise was extremely interesting. He had noticed it for some time in the bay, and that its motions were very peculiar. He could not make out what it was doing there so constantly in shallow water. But some days afterwards a large female was caught in the salmon nets, and they found that it was a female giving milk. Its milk was of a most interesting kind, and formed the subject of examination and analysis by Prof. Purdy. It was as dense as cream, and of a deep yellow colour.

On a Chemical Difference between Living and Dead Protoplasm, by Dr. Oscar Loew, of Munich.—Protoplasm, it was found, contains certain aldehyd groups, which account for the extreme mobility and readiness of change in living protoplasm. These aldehyd groups can be reduced by very dilute alkaline solutions of silver salts. *Spirogyra*, one of the lower *algæ*, acts on this solution in a peculiar way. Living protoplasm reduces the salt, while dead protoplasm does not. The specific gravity of the protoplasm of *Spirogyra* was increased, and was found to contain silver deposited in its interior. Argyria, or the effect of nitrate of silver on the human subject in certain diseases, was found in these *algæ*. Thus was shown a specific chemical difference between living and dead protoplasm. Ordinary poisons, such as prussic acid and strychnine, have no such striking effect on lower organisms, but a poison to all protoplasm is hydroxylamyl. Prof. Burdon-Sanderson said that this investigation had more importance than might at first appear, for it had arisen out of the epoch-making paper of Pflüger. Pflüger concluded that there must be a chemical change in the transition from living to dead protoplasm, and Dr. Loew took up the question as to what exactly this change was. His investigations are an important step in deciding this most important question. Prof. Stirling said this gave us a new test for living protoplasm. The chief thing to settle was what exactly causes reduction of the silver.

Digestion of Proteids in Plants, by Sidney Martin, M.D. (Lond.), B.Sc., M.R.C.P.—Of proteolytic ferments occurring in plants two kinds have been described—one acting like animal pepsin, and occurring in carnivorous plants, in the seeds of vetches, hemp, flax, barley, and malt, and the fruit of the fig, *Ficus cerica*; the other acting like animal trypsin (pancreatin) and occurring in the juice of the green fruit of *Carica papaya* (the papaw tree). The use of these ferments in the plant economy has only been surmised by testing their action on animal proteid, from which they form peptones. It is a question whether they form peptones from the proteid occurring in the individual, and from two considerations. It is doubtful whether a true peptone exists in plants—by which I mean a proteid soluble in water, and not precipitated by boiling, nitric acid, or acetic acid and potassic ferrocyanide. Vines (*Journal of Physiology*, vol. iii.) concludes that the body called vegetable peptone is hemialbumose (Meissner's α-peptone). It is also evident that the action of these ferments on the proteids will be slow in comparison to the action of animal proteolytic ferments; thus there might appear the proteids intermediate between albumen and peptone, which Kühne and Chittenden call *albumoses* (*Zeitschrift f. Biologie*, Bd. xx.). These questions I attempted to settle in the case of the papaw juice. I first of all extracted the proteids, which consisted of a ***globulin***, corresponding to animal paraglobulin; two albumoses, which I propose to call ***α- and β-phytalbumose***. The β form is precipitated; the α form is not thrown down by boiling; a vegetable ***albumen*** corresponding to egg-albumen. The effect of pure papain (the proteolytic ferment of the papaw juice) was tested on each of these bodies, but from none of them was a true peptone formed; only a body corresponding to Meissner's b-peptone. The very slow proteolysis explains the limitation of the formation of the final products of proteid change. Leucin and tyroin were formed. Full details of methods and results will be found in the forthcoming *Journal of Physiology*, September 14, 1885.

On the Application of the Anatomical Method to the Determination of the Materials of the Linnean and old Herbaria, by Prof. L. Radlkofer.—Prof. Radlkofer spoke generally of the anatomical method of botanical study, and dwelt on the results that had already been accomplished by it. With the aid of the anatomical system he advocated an extensive review of the herbaria of the country with reference to the writings of their former possessors. These herbaria should henceforth not merely be preserved; there should be the diffusion of new light on their contents so as to become useful to every one in a scientific sense, even to those who are unable to look through them. At some length he demonstrated the value of anatomical characters in systematic botany, and concluded with an appeal to all English botanists to direct their attention and their influence to the accomplishment of the work. In the accomplishment of this the British Association might, perhaps, give substantial assistance.

Notes on Experiments as to the Formation of Starch in Plants under the Influence of the Electric Light, by Mr. M. Ward, of the Owens College, Manchester.—The experiments, Mr. Ward said, were made not so much to determine a point already determined generally—that plants can be grown under the influence of the electric light—as to discover how far the electric light can be used for teaching purposes and investigations in the laboratory so to speak as an artificial sunlight. It would obviously be of enormous advantage to the vegetable physiologist if experiments could be easily performed under the influence of electric light. He explained the experiments he had made in the laboratories at the Owens College, Manchester, and at the residence of Mr. W. Crossley, of Bowden (who kindly placed a powerful arc lamp at his disposal), on this interesting subject, and described the means that had been employed in devising and conducting the experiments. Under a powerful arc light the results had been fruitful; but small clusters of Swan lamps had yielded no satisfactory results, at any rate at low temperatures. The subject requires still further examination, however, and Mr. Marshall Ward intimated that he intended to carry on the experiments, so that at a future date he might be able to convey more detailed information than could be given in a paper of a preliminary character. The plants employed were hyacinth potato, Algæ, *Faba*, *Phaseolus*, *Dicentra*, and the vine, and some interesting remarks on methods, &c., were made in the discussion which followed.

On the Coloration of the Anterior Segments of the Maldanidæ, by Allen Harker, F.L.S., Professor of Natural History, Royal Agricultural College, Cirencester.—The author, while studying the circulation and respiration of annelids at the zoological station at Naples, had been specially interested in the Maldanidæ, from their partially tubiculous habit and the brilliant coloration of their anterior segments. The bands of colour usually ornament the anterior segments, beginning with the second or third, and continuing to the ninth; but the distribution of the coloured bands differs widely in the different species. The colour in living or freshly-killed specimens is of a rich rose madder colour, shading off in each segment to a brighter rose-pink hue. Quatrefages attributed a physiological value to these coloured bands, describing them as being connected with the respiratory function. In connection with the whole subject of cutaneous respiration in annelids, it appeared important to settle this question, and the author made sections of the anterior segments in the Maldanidæ, and finds the colour to be due to a special pigment, whose behaviour under various reagents he described. On the other hand the author has studied the blood-vessels and their distribution in the living chætopod, and is satisfied that it extends equally in those portions of the cuticle which are uncoloured as in those which are. The coloured bands do not appear, therefore, to be in any way connected with the function of respiration.

SECTION E—GEOGRAPHY

The Indian Forest School, by Major F. Bailey, F.R.G.S., Royal Engineers, Director of the School.—It is only within the last twenty-five years that a special State department has administered the Indian forests. The staff was at first composed of men who had received no professional education, but they were able to do all that was then needed, and they accomplished work of great value. But as a result of their work the State became possessed of large forest areas, from which a permanent supply of produce had to be secured, and which had therefore to be managed systematically. At this time nothing was known of systematic forestry in England or in India, and an arrangement was made in 1866 under which candidates for the Indian Forest Service were trained on the Continent. The arrangement with the French Government is still in force, but it has now been decided to undertake the instruction in England. Great progress has been made in Indian forestry, which is mainly due to the professionally-trained men with whom the Forest Department has been recruited, but up to 1869 nothing bad been done towards the education of the subordinate ranks. As work requiring professional skill became necessary over large areas, it was found that the "divisions" must be broken up into a number of smaller executive charges under natives of the country, and that they must receive a professional education. In 1869 Mr. Brandis made proposals to organise the subordinate grades and to train men at the Civil Engineering Colleges, and several other attempts were made in the same direction, but without marked success. In 1878 Mr. Brandis proposed to establish a Central Forest School, and his proposals were accepted by Government. The chief object of the School was then to prepare natives of India for the executive charge of forest ranges, and to qualify them for promotion to the superior staff, but it was hoped that the school might ultimately be used to train candidates for the controlling branch. The chief forest officers of provinces were to select candidates and send them to be trained at the School. None but natives of India were to be admitted. A number of forests near Dehre Dun were grouped together as a training ground and placed under a separate conservator, who was also appointed director of the school. A board of inspection was appointed. The first theoretical course was held in 1881, and they have been held every year since then. The present system is that the candidates, who must be in robust health, are selected by conservators of the forest or by the director of the school. They must serve in the forests for at least twelve months before entering the School. Candidates for the ranger's certificate must have passed the entrance examination of an Indian University on the English side; candidates for the forester's certificate pass a lower examination. The course of training for these two classes extends over eighteen and twelve months respectively. Men who gain the certificates return to their provinces, and are employed there. The course of instruction for the ranger's class embraces vegetable physiology, the elements of physics and chemistry, mathematics, road making and building, surveying, sylviculture, working plans, forest utilisation, forest botany, the elements of mineralogy and geology, forest law, and the elements of forest etiology. The course for foresters is much more simple. The preparation of manuals is in progress, and a library, museum, chemical laboratory, observatory, and forest garden have been established. The period of probation in the forest before entry into the School has a twofold object: firstly, to enable the theoretical course to be understood; secondly, to eliminate men who are unsuited to a forest life before time and money have been spent on their training. As a rule, the students are *employés* of the Forest Department, and they draw their salaries and maintain themselves while at the School. No instruction fees are charged. It would not at present be possible to get condidates whose maintenance and education are entirely paid for by their friends. Nine men who have left the School have appointments of from 125*l.* to 200*l.* a year, and this ought to draw eligible candidates. Conservators of forests say that the men trained at the School are markedly superior to their untrained comrades. The area of reserved forests has largely increased of late, and the prospects of the students are very good. During the session of 1884 there were forty-six students of all classes at the School, of whom eight were from Madras, and seven from native States, the chiefs of which have been induced by the establishment of the school to take measures for the protection of their forests. The School has now been made an imperial institution, and this is a great advantage in every way. The expenses of the School in 1884 are said to have been 1911*l.*

On Journeyings in South-Western China, by A. Hosie.—In the autumn of 1881 Mr. Hosie was appointed Her Majesty's Agent in Western China, and reached Ch'ung-ch'ing, in the province of Ssŭ-ch'uan, in January, 1882. From this point he made three journeys in South-Western China. In the spring of 1882 he proceeded through Southern Ssŭ-ch'uan and Northern Kuei-chou, the Chinese "Switzerland," to Kuei-yang Fu, the capital of the latter province, whence he journeyed westward in the footsteps of Margary to the capital of Yünnan. From Yünnan Fu he struck north-east through Northern Yünnan, following for days here and there the routes of Garnier and the Grosvenor Mission. At last he descended the Nan-kuang River and reached the right bank of the Great River, the local name of the Upper Zangtsze, at a point below Hsü-chou Fu, an important city at the junction of the Min River and the Chin-sha Chiang, or River of Golden Sand. Here he took boat and descended the Great River to Ch'ung-ch'ing, his starting-point. In February, 1883, Mr. Hosie again left Ch'ung-ch'ing, and proceeded north-west to Ch'êng-tu, the capital of the province of Ssŭ-ch'uan, by way of the brine and petroleum wells of Tzŭ-liu-ching. From Ch'êng-tu he journeyed west and southwest through the country of the Lolos, skirting the western boundary of Independent Lolodom. From Ning-yüan, locally called Chien-ch'ang, and lying in a valley famous, among other things, as the habitat of the white-wax insect, he passed southwest through the mountainous Cain-du of Marco Polo, inhabited in great part by Mantzŭ tribes, and struck the left bank of the Chin-sha Chiang two months after leaving Ch'ung-ch'ing. From this point Ta-li Fu, in Western Yünnan, was easily reached. From Ta-li Fu Mr. Hosie jurneyed eastward to Yünnan Fu, which he had visited the year before, and then struck north-east through Western Kuei-chou to the Yung-ning River, which he descended to the Great River. Lu Chou, an important city at the junction of this river with the T'o River, was soon reached, and the Great River was again descended to Ch'ung-ch'ing. This journey occupied four months. In June, 1884, Mr. Hosie again left Ch'ung-ch'ing, and from Ho Chou, a three days' journey to the north of that city, he struck westward through a beautifully cultivated and fertile country to Chia-ting Fu, on the right bank of the Min at its junction with the T'ung River. Chia-ting is famous as the great centre of sericulture in Ssŭ-ch'uan, and as the chief insect wax-producing country in the Empire. A day's journey west of Chia-ting is the famous Mount O-mei, rising 11,100 feet above the level of the sea. This mountain, which is sacred to the worship of Buddha, Mr. Hosie ascended in company with crowds of pilgrims. He then proceeded south, skirting the eastern boundary of Independent Lolodom, to the River of Golden Sand, the left bank of which was struck at the town of Man-i-ssŭ, between forty and fifty miles above P'ing-shan Hsien—the highest point reached by the Upper Yangtsze Expedition in 1861. From Man-i-ssŭ Mr. Hosie descended the Chin-sha Chiang and the Great River to Ch'ung-ch'ing.

Antarctic Discovery, by Admiral Sir Erasmus Ommanney, C.B., F.R.S.—The object of this paper is to draw attention to the neglect of the Antarctic region as a field for exploration. The author gives a summary of the work which has already been done by Cork, Bellingshausen, Weddell, Biscoe, Balleny, Wilkes, Dumont d'Urville, James Ross, and Nares (in the *Challenger*). The author refers to a paper by Dr. Neumayer on the subject, the substance of which was reproduced in NATURE (vol. vii. p. 21). The author concludes as follows:—I have thus laid before you but a very imperfect description of these voyages; to give the details of the scientific results would occupy a separate paper. But I have endeavoured to demonstrate how large a field remains open for discovery. I think, from all we now know, we may infer that the South Pole is capped by an eternal glacier; and, from the nature of the soundings obtained by Ross, it would appear that the great ice-wall along which the ships navigated was the termination of the glacier—the source from which the inexhaustible supply of icebergs and ice-islands are launched into the Southern Ocean, many of which drift to the low latitude of 42°. The fact of finding the volcanoes of equal proportions to Etna or Mont Blanc creates a zest for further research regarding that awful region on which neither man nor quadruped ever existed. No man has ever wintered in the Antarctic zone. The great desideratum now before us requires that an expedition should pass a winter there, in order to compare the conditions and phenomena with our Arctic knowledge. The observations and data to be collected there throughout one year could not fail to produce matter of the deepest importance to all branches of science. I believe that such an achievement can be accomplished in these days with ships properly designed and fitted with the means of steam propulsion; nor is it chimerical to conceive a sledge party travelling over the glacier of Victoria Land towards the South Pole, after the example of Nordenskjöld in Greenland. Another interesting matter requires investigation, from the fact that all the thermometers supplied for deep-sea temperatures to Ross were faulty in construction, as they were then not adapted to register accurately beneath the weighty oceanic pressure. Moreover, another magnetic survey is most desirable in order to determine what secular change has been made in the elements of terrestrial magnetism after an interval of forty years and more, when taken by Ross. In fact, there exists a wide field open for investigation in the unknown South Polar Sea. This paper will, I trust, be the prelude for others to follow in arousing geographers and this powerful Association in promoting further research by despatching another South Polar expedition, having for its object to secure a wintering station. No other nation is so capable of providing and carrying it out. Even in the Australian colonies there exists the spirit and the means for such a noble enterprise.

Projected Restoration of the Reian Mœris, and the Province, Lake, and Canals ascribed to the Patriarch Joseph, by Cope Whitehouse, M.A., F.A.G.S.—The Berlin Geographical Society has published, in its *Zeitschrift* for May, 1885 (No. 116), the latest map of Egypt, from the Fayoum to Behnesa, and from the Nile to the Little Oasis. The text by Dr. Ascherson gives credit for a considerable area to the topographical observations presented to this society at Montreal. So much of the Reian basin as lies between the Quasr Qerūn and the Quasr Reian has not been visited by any European except the author of this paper (1882, 1883). It is now an accepted fact that there is a depression south of the Fayoum, not less than 150 feet below the level of the Mediterranean, with a superficial area at the level of high Nile of several hundred square miles. It is irregular in shape, curving like a horn from a point near Behnesa to the ridge which separates it from the Fayoum. In the southern part are two, and perhaps three, patches of vegetation, wild palm-trees, and ruins of Roman and early Christian date. This part was visited by Belzoni, May 22, 1819; Caillaud, November 24, 1819; Pacho and Müller, 1823-24; Sir G. Wilkinson, 1825; Mason Bey, 1870; and Ascherson, March 27, 1876. Dr. Ascherson determined by aneroid observations that his camp was 29 metres below the sea. Caillaud found ruins about +38m., or about the level of high Nile in the valley on the same latitude. The aneroid, theodolite, and other observations of March 6 and April 4, 1882, and April, 1883, by the author of this paper, established a depth of −175 to −180 English feet. The greatest depth is probably under the western cliffs south of the Haram Medhūret el-Berl. No previous explorer had conceived it possible that this might have been a lake within historic times. The level of the ruins, as determined by Caillaud, shows that the ancient station of Ptolemais might have been, as represented in the text and maps of Claudius Ptolemy, on a horn-shaped lake about 35 miles long and 15 wide, with a maximum depth of 300 feet, fed by a canal, partly subterranean, from Behnesa, as well as by a branch of the present Bahr Jūsuf communicating with it through the Fayoum. The lower plain of the Fayoum had been, at that time, fully redeemed, and the present Lake of the Horn reduced to such insignificant dimensions as to be unnoticed. The restoration of the Reian basin of Lake Mœris and the drainage by evaporation of the Birket el-Querūn would be a repetition in modern times of the best results reached in the Greco-Roman period, perhaps 3000 years after the first effort to utilise these two unique basins for storage and drainage.

On Batho-hypsographical Maps, with Special Reference to a Combination of the Ordnance and Admiralty Surveys, by E. G. Ravenstein.—The batho-hypsographical map, which exhibits the vertical configuration of the solid surface of the earth, above as well as below the ocean levels, is a product of modern times. It was Gerard Mercator who first inserted soundings upon a chart in 1585, but nearly two centuries passed away before Cruquins, in 1728, introduced the fathom-lines with which we are all familiar. Buache, and after him Ducarla, first suggested the introduction of contours upon maps, and their idea was realised in 1791 by Dupain-Triel on a map of France. The combination of these two descriptions of contoured maps we owe to modern German geographers, and more especially to Berghans, Von Sydow, and Ziegler. Cartographers, in effecting this combination, had hitherto quite lost sight of the fact that the heights on maps are referred to high or mean water, whilst the depths on charts represent soundings reduced to low water. This rough method gave satisfactory results when dealing with maps on a small scale, but a more rigid method would have to be applied when it was desired to combine accurate surveys like those made by the Ordnance and Admiralty Departments. The so-called mean level of the sea was not a suitable datum level, and it would be necessary to carry on tidal and other scientific observations on a far more comprehensive plan than had been done hitherto if a really satisfactory batho-hypsographical map of the British Islands were to become attainable. These various supplementary surveys, tidal observations, &c., it was to be hoped, would expand into a comprehensive scientific survey of the British seas.

What has been done for the Geography of Scotland, and what remains to be done, by H. A. Webster.—After remarking on the unsatisfactory state of the Ordnance Maps, Mr. Webster said that in regard to the depth of our lakes and rivers—and the submerged portion of a valley is geographically as interesting as the sub-aërial portion—absolutely no data are supplied by the Ordnance Survey. Nor, with a few individual exceptions, do they exist in an accurate and trustworthy form anywhere else. It was an open secret that, when this omission was pointed out to the Government by the Royal Societies of London and Edinburgh, the Lords of the Treasury refused, and again refused, to authorise a bathymetric lake and river survey being carried out, either by the officers of the Ordnance Survey or by those of the Hydrographic Department. Such a refusal could not be permanently accepted. It was to be hoped that when the Government was next urged to move in the matter they would be asked for more, and not for less. We required not only a hydrographic survey done once and for all (though that was worth the doing); we required a systematic registration of hydrographic facts throughout the country, in order that the true *régime* both of lakes and rivers may be known in detail and with scientific precision. The ignorant niggardliness of the British Government was in striking contrast to the conduct of those of some foreign countries. In Switzerland, for instance, there was a regular system of inland hydrographic observations, by which the *régime* of all the principal rivers was annually recorded and rendered easily intelligible by a series of graphic bulletins. In regard to a Swiss river we could tell the volume at any period of the year at several important points, and could compare the facts of 1884, for instance, with those of any year in the last two decades. Every one knew what a vast body of interesting data had for generations been accumulating about such rivers as the Po and the Rhone, and many had no doubt heard of the system of hydrographic stations recently established by the Italian Government in the basin of the Tiber. Why should we not endeavour to learn something definite and precise about the character of our own rivers? The investigation was only the natural complement, on the one hand, of the physical structure of the country, and, on the other hand, of its meteorology. Our Scottish Meteorological Society had now succeeded in establishing meteorological stations throughout the country; let hydrographic stations bear them company along our principal rivers. Rainfall and river discharge were mutually illustrative.

On Overland Expeditions to the Arctic Coast of America, by John Rae, M.D., F.R.S.—The following table shows the approximate amount of geographical work done by the expeditions under—

			G. M.		G. M.	G. M.
1821.	Franklin & Richardson ...	on foot ...	35	in canoes	415	450
[1] 1826.	" " ...	" ...	90	in boats	955	1045
				Total ...	...	1495
1834.	Back	in boat / on river ...	120	in boat / on coast	105	225
[2] 1837 1838. 1839.	Dease & Simpson (H. B. Co.)	on foot ...	95	in boats	722	817
[3] 1847. 1851. 1853-4.	Rae (H. B. Co.)	sledging / on foot ...	1123	in boats	369	1492
				Grand total	...	4029

A Word or Two on the Best and Safest Route by which to attain a High Northern Latitude, by John Rae, M.D., LL.D., F.R.S., F.R.G.S., &c.—The plan proposed is that the route by the west shore of Spitzbergen should be taken by one, or perhaps two, steamers similar to the fine vessels used in sealing and whaling at the present time. That after forcing the ice "pack" at the north-west end of Spitzbergen, a north-east course towards Franz-Josef Land should be followed. That a depôt of coals should be placed at a convenient harbour in North Spitzbergen. Extracts are given from Parry's "Narrative," 1827, pp. 101 and 148, showing how open and small the ice was in latitude 82° 45′ N. The southern drift of the ice that so obstructed the advance of Parry's boats will be no great impediment to a powerful steamer, whilst if she gets helplessly fixed in the pack she will drift homewards with it. No well-equipped and powerful steamer has tried this route.

JAPANESE TATTOOING

THE last number (Heft 32, May, 1885) of the *Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens* is almost wholly occupied by a paper of a most exhaustive character by Dr. Baelz, a physician in the service of the Japanese Government, on the physical qualities of the Japanese. A previous paper by the same writer gave the results of his investigations into Japanese skeletons. For the purposes of the present paper he obtained numerous anthropometrical measurements—about 2500—based on a scheme which included seventy-nine measurements in the case of each individual. It is noticeable that Broca confined himself to little more than a third of this number, Virchow's scheme contemplated thirteen, and at the most thirty-eight, Weissbach sixty-seven, and Quetelet, in his anthropometry, gives eighty-two measurements. The skeleton plan of the paper is as follows: 1. Skin and hair: the colour of the skin and its cause, artificial colouring, including tattooing, the characteristics and nature of the hair; 2. The *physique* in general, including the carriage and gait of both sexes, weight, size, and growth; 3. Measurements of the body and limbs. In the discussion of the results set forth in this section the author expresses the opinion, based on his own investigations, that in general the value of these anthropometrical measurements is much exaggerated by anthropologists and ethnographers.

The tattooing of the skin by Japanese, generally those of the lower classes, has attracted much observation from Europeans, due partly to the extraordinary elaboration and artistic skill displayed, partly to the fact that the occupations and customs of the class in which tattooing is most practised are such as to render it necessary frequently to wear none but the most indispensable garments. This subject has never, so far as we are aware, been examined with so much thoroughness and care as by Dr. Baelz. He says that among the various peoples which have, in the course of centuries, reached a high standard of culture the Japanese are probably the only race which have retained generally the practice of tattooing and have brought it to a state of highly artistic development. Up to a few years ago the practice was so widespread that in Tokio alone there are estimated to have been, possibly still are, 30,000 men who were tattooed. This decoration is not confined, as in Western countries, to a small part of the body, but it covers the whole back and a considerable part of the limbs. The head, neck, hands, and feet are never tattooed, a circumstance of importance in explaining the practice. It was confined to the lower classes; amongst the better classes it was considered unworthy to disfigure the body in this way. It was widely spread amongst the workmen in great towns and coolies, and even to-day it is exceptional to find an old man of either of these occupations who is not tattooed. The objects illustrated were various: amongst the most common were large dragons, lions, battle scenes, beautiful women, historical occurrences, flowers, &c. Dr. Baelz states that he never saw obscene pictures tattooed. The colours employed are black, which appear blue, and various shades of red. The first is obtained from Indian ink, the usual Japanese writing material, the red from cinnabar. When a man wishes to undergo the process he looks out in a popular picture-book some illustration which takes his fancy, or he evolves something from his own imagination, and goes with it to the artist. The latter makes his arrangements, and sketches the picture on the skin. If he is skillful at his calling he sketches the merest outline, and straightway introduces all the details; but if he is not so confident in himself he first draws the whole picture on the skin. There is no special ceremony attending the work as in some of the South Sea Islands, nor is there any religious signification whatever in the process. The artist uses for the purpose exceedingly fine, sharp sewing needles, fixed firmly, four, eight, twelve, twenty, or forty together, in a piece of wood. They are arranged in several rows; when there are forty they stand in four rows of ten each. The points are quite even, except when it is desired to produce a light or dark shading, when the needles are arranged in corresponding lengths. This combination is said to be especially painful. The skin, at the place where the puncturing is going on, is stretched between the thumb and first finger of the operator, who holds between the third and fourth fingers of the same hand a writing brush with ink or cinnabar, as may be required, on it. He holds the wood containing the needles in his right hand, and, having put the colour on them, he rests the hand on the thumb of his left hand, and then proceeds with extraordinary rapidity to puncture the skin, stopping every now and again to put on the fluid anew. Dr. Baelz counted on one occasion ten punctures per second, and as there were ten needles the person being tattooed received one hundred punctures per second. The wonder is that with such speed excellent pictures, with various degrees of shading, can be produced, but such is the fact. A skillful operator can in this way puncture the back or breast and stomach of a grown man in a day. A few hundred thousand punctures are necessary for this purpose. The patient, if he may be so styled, does not suffer so much pain as might be expected. The punctures are not very painful, they tickle rather than hurt. No blood is drawn; a circumstance which shows that the needles do not reach the cuticle, and which also explains the slight pain of the operation, and the possibility of enduring it. This, however, is not the case always, for in many parts of the body where the skin is tender, or where a deeper shade is required, some clammy blood comes slowly to the surface, and the operation becomes painful. This occurs most frequently at the knees and elbows. To be well tattooed, therefore, is taken as a sign of manly vigour and endurance. As soon as the sitting is over the punctured parts are bathed with warm water, which produces a slight pain. The colour then comes out more clearly than before, and the patient can do as he likes. No special diet is ordered. A few hours after the operation he often has a slight feverish feeling, but this soon leaves him. After about three days the skin scales off like bran, but the tattooed parts are never irritable or sensitive, and the man goes about his work as usual. There are cases in which women have been tattooed, but these are very rare. The women are mostly dissolute who allow this to be done; but it is said that the colours come out with great clearness and beauty on the comparatively fair skins of women. Recently tattooing has been prohibited by law under the impression

[1] Actually two expeditions—one east, the other west.

[2] Dease and Simpson had to pass over about 500 miles of previously traced coast before getting to new ground, but Franklin and Richardson were on new ground at once on reaching the coast.

[3] Of the coast, &c., traced by Rae, 1123 miles were done by sledging, believed to be the most laborious of Arctic work.

that it is a barbarous custom unworthy of a civilised people. But Japanese tattooing is so superior to that of all other nations that European sailors are said to look forward to it as the principal advantage in a visit to the land of the Rising Sun.

This being the method in which the practice is carried out, Dr. Baelz comes to discuss its origin and meaning. The oldest reference we have to tattooing in Eastern Asia states that a Chinese prince, about three thousand years ago, who was nominated heir to the throne against his will, had himself tattooed in order to render his succession impossible. But at the present day the practice in China and Korea has fallen into desuetude, while in Burmah it still appears to be in vogue. In 1872, a man was exhibited in Europe who had been a prisoner amongst the Burmese, and who was tattooed from the crown of the head to the sole of the foot. The practice is still prevalent amongst the South Sea Islanders and the American Indians. In his work on the origin of writing, Wuttke seeks to show that tattooing is a kind of writing; but however correct this theory may be in the case of the tattooed peoples known to him, it certainly does not hold good in the case of the Japanese. The signification of the practice, says Dr. Baelz, amongst the latter is quite distinct from that which it has amongst other peoples. In the first place, amongst the South Sea Islanders and the Indians, tattooing has a religious, a symbolical meaning; it is a ceremonial, frequently a sacred process. There is nothing of this in Japan—neither ceremony, nor other peculiar meaning; it is done for cosmetic purposes and for no other. Again, amongst other peoples tattooing was a species of distinction; it marked the heroes, leaders, chiefs, of the tribe. In Japan it marks a man of the lower classes. Elsewhere, also, the uncovered parts of the body, such as the face, neck, hands, &c., are the favourite spots for tattooing; in Japan it is only the portions usually clothed which are tattooed. It is noticeable that amongst the Ainos the tattooing takes place on the exposed parts of the body, and that it is largely practised by women, two circumstances which distinguish it from the practice amongst the Japanese, and in which the Ainos resemble other northern peoples such as the Esquimaux, the Ostiaks, and others. In answer to the question, What meaning has the practice amongst the Japanese, as distinct from other races? the author replies that in Japan tattooing is a garment, a decoration. Various proofs of this statement are advanced, amongst them being the following: only those parts of the body are tattooed which are usually covered; all workmen do not tattoo themselves, but exclusively those whose work causes excessive perspiration, and who can, therefore, work best in a semi-nude state, such as runners, grooms, bearers, &c., and amongst these the practice prevails only with those who have connection with large towns, where nudity would be objectionable. Their garments are tattooed on their bodies, and they appear clothed without clothes before the public. The peasants are never tattooed. Again, the colours of the tattooing corresponds with that of the dress; it is the same dirty, dark blue. This theory never suggested itself to the Japanese: they thought that it must have come from China, and that it was a species of punishment. It was, it is true, at one time the custom to tattoo marks into criminals, but this was confined to a ring on the elbow. It would not explain the spread of the practice amongst certain classes in certain directions. Dr. Baelz's theory that it is merely a substitute for dress, and as the wearing of clothes is now compulsory, tattooing has lost its meaning. As for its origin, the peoples around the Japanese, the Ainos and the Loochooans, have practised it; and the Japanese navigators who travelled far and wide in the Eastern seas in the sixteenth century might well have seen it elsewhere. The Japanese discovered, says Dr. Baelz, that man can paint a figure on his skin which the rain cannot wash away, the sun wither, or even all-devouring Time destroy, and with their instinctive artistic skill they gradually developed and perfected the original rude figures in idea and execution. At first few only wore this blue skin-dress, but these few appeared to their companions decorated and clothed (a tattooed person does not appear actually naked), and as such a garment was cheap and lasting, and every man could have it according to his own fancy, tattooing became the fashion.

It may be added here that among the Igorrotos of the mountanious districts in the north of Luzon tattooing is also exceedingly elaborate, although it consists rather of a series of lines, curves, &c., than of one large, elaborate picture. Dr. Meier, in a paper read not long since before the Anthropological Society of Berlin, described the Igorrotos as tattooing the hands, arms, breast, and also part of the legs. The back is untouched except by one tribe. A picture of the sun, as a number of concentric circles on the back of the hand, is the commonest object represented. The process takes place at puberty, and is a long one, as the punctures (which are made with a three-pointed instrument which is clumsy in comparison with the Japanese needles) become inflamed and take a long time to heal. The tattooing of the Buriks, a tribe of Igorrotos, takes three or four months to complete.

It may not be out of place here to refer to Dr. Baelz's aocount of the Japanese use of moxa, which, like tattooing, comes into his section dealing with the skin. On the bodies of almost every Japanese, and sometimes on every part of the body, one sees round white spots. These are the moxa spots, produced by burning the flesh with a species of plant, with the object of curing some affection. This is a universal popular specific in Japan, which is its home, although moxa is to be found used elsewhere. It was introduced from Japan to Europe by the Portuguese and Spaniards, and the name is Japanese. In May the leaves of the *Artemisia Chinensis* are powdered and dried, and the mass cut into small blocks or pieces. One of these is laid on the body and set on fire, burning slowly away. At first it naturally produces a sore, more or less deep, according to the intensity of the heat; soon this heals, leaving the scar for ever. The belief in the efficacy of this process is universal, and, Dr. Baelz thinks, not altogether misplaced, for the moxa acts much as our blisters do. Moreover, from the accounts of those who have gone through the cure, it is by no means so painful as one would anticipate from the heroic nature of the remedy.

SCIENTIFIC SERIALS

American Journal of Science, August.—Origin of coral reefs and islands, by James D. Dana. The arguments recently raised by Dr. A. Geikie against Darwin's theory of subsidence as an explanation of the formation of *atolls*, or barrier reefs inclosing a lagoon, are discussed and shown to be largely based on misunderstandings of the facts. It is pointed out that local elevations within the sinking area are not evidence against a general subsidence, such local disturbances and faults being almost necessary concomitants of subsidence. The conclusions as to changes of level in the large Pacific groups south of the equator agree mainly with Darwin's views, and the subsidence indicated, according to him, by *atolls*, is shown to be real, not an apparent sinking due to change of water-level.—On the meteorite of Tomatlán, Jalisco, Mexico, by Charles Upham Shepard. The striking peculiarity of this stone, which fell in August 1879, is the prevalence everywhere of octahedral crystals of nickeliferous iron. The specific gravity of the two fragments examined was 3·47—4.43.—On the widespread occurrence of allanite as an accessory constituent of many rocks, by Joseph P. Iddings and Whitman Cross. From its mode of occurrence and association the authors conclude that allanite must now be added to the group of primary, accessory rock constituents, similar to zircon, sphene, and apatite, though much rarer than any of these. In some regions it appears to be quite uniformly distributed through certain types of rock, such as the porphyrites and allied porphyries of the Ten Mile District, Colorado.—Crystals of analcite from the Phœnix Mine, Lake Superior Copper Region, by Samuel L. Penfield. These crystals, which occur thickly grouped together on calcite and native copper associated with tabular crystals of apophyllite, are of all sizes from minute particles up to one centimetre in diameter. The small ones are simply tetragonal trisoctahedrons of the form (211), 2 - 2; the larger ones are of the same form, but with the planes differently arranged.—On a differential resistance-thermometer, by T. C. Mendenhall. This instrument has been devised and constructed for the study of certain problems connected with meteorology, especially the observation of soil and earth temperature, and the use of which would not demand greater skill than that of the ordinary meteorological observer. It consists essentially of a mercurial thermometer, not unlike ordinary forms, except that the bulb is greatly enlarged, so that the stem may have a diameter of about a millimetre, still leaving the scale tolerably open. By its means observations may be taken in less than a minute, no time being consumed in the preparation of liquids of known temperature at the observing station, as in the use of the thermo-junction on the resistance coil.—Impact friction and faulting, by George F. Becker. The author discusses the phenomenon of "step faults," as described in Mr. Geikie's "Text-Book of Geology," p. 532, which he concludes to be not merely local, but of general occurrence.—A standard of light, by John Trowbridge. Objections are raised to the standard adopted at the Paris Conference of 1881–4—that is, the light emitted by a surface of platinum at the point of solidification. A more satisfactory standard might be an incandescent strip of platinum radiating a definite amount of energy, this energy being measured at a fixed distance, which will best agree numerically with the absolute system of measures now universally adopted in heat and electricity.—On hanksite, a new anhydrous sulphato-carbonate of sodium from San Bernardino county, California, by W. Earl Hidden. This new Californian mineral has a density of 2·562, hardness 3·—3·5, and is readily soluble in water, yielding an abundant precipitate of barium sulphate when barium chloride is added to the solution. The author names it "hanksite," after Prof. Henry G. Hanks, whose name is so intimately associated with the mineralogy of the Pacific coast.—Mineralogical notes, by Edward S. Dana and Samuel L. Penfield. The chief subjects of this paper are the analysis of a large crystal of hanksite from California and an artificial crystallised lead silicate from the Desloge Lead Company, St. François County, Missouri.—On the amount of moisture which sulphuric acid leaves in a gas, by Edward W. Morley.—Local deflections of the Drift Scratches in Maine, by G. H. Stone. Traces of these indications of secondary glaciation have been observed, especially in the Sebasticook Valley, the Belfast and St. George River districts.—Successional relations of the species in the French Old Tertiary, by Otto Meyer. In these, as well as in the corresponding American formations, many animal and vegetable species can be traced along through the succeeding strata, the latter being apparently connected by descent with the earlier forms. The paper is accompanied by a comparative table of Lower, Middle, and Upper Eocene and Oligocene forms illustrating this principle.

The American Naturalist for August contains notices of some human remains found near the City of Mexico, by Mariano de la Barcena.—Evolution in the vegetable kingdom, by L. F. Ward.—The relations of mind and matter, by Charles Morris.—Affinities of Annelids to Vertebrates, by E. A. Andrews.—The use of copper by the Delaware Indians, by J. C. Abbott.—Notes of recent literature, &c.

Bulletin de l'Académie Royale de Belgique, June.—Note on some derivatives of tetrabromuretted hydrocamphene, by M. De la Royère.—On certain developments of algebraic series; the general formulas of these developments and their application to special cases, by M. J. Deruyts.—Researches on the action of a beam fixed at both ends and subjected to a movable overcharge, by M. G. Leman.—Questions of indeterminate analysis, by M. E. Catalan.—Note on the motions of the human brain, by M. Léon Frédéricq.—A new process of vivisection for the physiological study of the thoracic organs, by the same author.—On the optical properties of Ludwigite ($R_4FeB_2O_{10}$), by M. A. F. Renard.—Determination of the coefficient of compressibility for some fluids and of the variations of this quantity under different temperatures, by M. P. De Heen.

Rendiconti del Reale Istituto Lombardo, July 23.—On the causes and treatment of certain ophthalmic affections (preliminary note), by Dr. R. Rampoldi.—An exposition of the third paragraph of Riemann's memoir on the theory of the Abelian functions, by Prof. Giulio Ascoli.—Further researches on the neutralising agents of the tubercular virus, by Prof. G. Sormani and Dr. E. Brugnatelli.—Toxico-chemical affinities and differences of gelseminina and strychnine, by Dr. C. Raimondi.—On the phenomenon of etherification by double decomposition, by Prof. G. Bertoni.—The mental infirmities and last days of Torquato Tasso, by Prof. A. Corradi.—Note on an artistic palimpsest of the fourteenth century, by Prof. G. Mongeri.—Meteorological observations made in the Brera Observatory, Milan, for the month of July.

Rivista Scientifico-Industriale, July.—On the solar spots, their origin, nature, and harmless character, by Prof. Annibale Ricco.—Application of the telephone to the study of vibrating columns of gas, by Prof. Fossati.—A contribution to the study of etherification by double decomposition, by Prof. Giacomo Bertoni.—Geological constitution of Mount Vincigliata in the Fiesoli range, by C. del Lungo and R. Cocchi.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 28.—M. Bouley, President, in the chair.—Equilibrium of the moon, by M. F. Tisserand. In this paper calculations are submitted in support of M. Ch. Simon's theory, supplemented by M. Poisson, that, neglecting the excentricity of the lunar orbit, the axis of rotation is displaced in the interior of the moon in such a way as constantly to oscillate in the plane perpendicular to the main axis directed towards the earth.—Note on earthquakes, by M. A. d'Abbadie. The author gives an account of the seismic movements observed by him last winter in Egypt, where the seismograph was exceptionally active. He urges a systematic study of these phenomena in France, such as has already been commenced by M. E. de Rossi in Italy, and by Mr. Milne in Japan.—Researches on the nitric cellulose substances (gun cotton, &c.), by M. Ch. Er. Guignet. The constituents and properties are described of the four distinct nitric cellulose bodies hitherto determined, all of which may be regarded as derivatives of the cellulose $C_{48}H_{40}O_{40}$, where 4eq., 6eq., 8eq., or 10eq. of water are replaced by the same number of equivalents of hydrated nitric acid.—Memoir on the treatment of phylloxera by means of the organic sulphurs and the polysulphides of ammonium obtained by dissolving powdered sulphur in the night-soil of cesspools, by M. J. Jullien. This treatment is described as inexpensive, thoroughly efficient, and applicable to every description of soil.—Note on an unpublished document by Sergio Venturi, dated February 26, 1610, on the invention and the theory of the telescope, recently edited by M. G. Govi. This letter, addressed by the writer to the Marquis John Baptist Manso at Naples, is specially interesting as being anterior to the earliest publications of Galileo on the telescope which had just been invented by Lippersheim in Holland.—Note on the separation of liquefied atmospheric air into two distinct fluids, by M. S. Wroblewski.—Description of two new types of condensing hygrometers, by M. Georges Sire. The essential character of these hygrometers is that the moisture is precipitated on a bright metallic surface without solution of continuity. Perfect equality of temperature is secured in both instruments by the agitation of the volatile fluid and the thinness of the walls of the cylindric tube.—Genesis of the crystals of sulphur in square tables (five illustrations), by M. Ch. Brame. The author's experiments on the genesis of the square tables of sulphur show the direct passage from the curve to the straight line in the development of these crystals.—Morphology of the mandibule of the hymenoptera, by M. Joannès Chatin. This organ of the hymenopteræ is shown to be perfectly analogous in all its parts to that of the grinding insects.—Note on the application of thermo-chemistry to the explanation of geological phenomena, continued; iron ores, by M. Dieulafait.

CONTENTS

THURSDAY, OCTOBER 15, 1885

COMPARATIVE ANATOMY AND PHYSIOLOGY

Comparative Anatomy and Physiology. By F. Jeffrey Bell, M.A., Professor of Comparative Anatomy at King's College, London. (London: Cassell and Co., Limited, 1885.)

THIS work is one of a series of "Manuals for Students of Medicine," each of which is to be "compact and authoritative"—"embodying the most recent discoveries," and also to "contain all the information required for the medical examinations of the various colleges, halls, and universities in the United Kingdom and the Colonies."

On behalf of those of our readers who may be unfamiliar with the demands of certain of the examining bodies referred to above, it may be well to state that nothing but a *résumé* of all that is known in the subject could meet the requirements of the case. That which the publishers demand, and which the public therefore has a right to expect under the conditions laid down, is an ultra-condensed digest of all authoritative work in zoology and physiology. Incredible though this may appear to any one acquainted with the bibliography of the subject, Prof. Bell's manual is so far satisfactory that we cannot but congratulate the publishers upon their choice of an author, whose work in connection with the *Journal of the Royal Microscopical Society* and the *Zoological Record* render him *par excellence* the man for this *opus mirabilis*. When it is stated that there are but 548 pp. to the book it will be clear that it must be a vast collection of facts, little being left as to style or originality for that criticism which the author invites. The method of treatment, however, is somewhat novel, and in our opinion open to comment.

The author divides his work into fourteen chapters. Of these the first is introductory; the second is devoted to the Amœba as a physiological study; the third to "the general structure of animals," that is, to a consideration of the "broader characteristics of the groups into which the animal kingdom has been divided." Those which remain are devoted, each to one of the great systems of organs and to development.

In estimating the value of this volume, it must be clearly borne in mind that it is a book intended for beginners. Chapter II. is written for biological babes, and it will be clear to any one who reads the volume that the author would have the student familiarise himself with the facts in the order in which they are presented to him. This being so, it is a pity that Chap. I. should have been so largely devoted to the subtle details of cell-structure; the beginner is lost in descriptions of the "cytod" and the "cell," for each of which broad differences are dogmatically formulated, such as would tend to bias the mind of the average student. Draw hard lines by all means for the beginner, but not in such delicate matters as these. Only by working from the known to the unknown, can the student of science ever hope for success; the order of his elementary studies must be a recapitulation of that in which the science itself has advanced—he must here begin with gross anatomy, and we believe that to treat first of the subtle details of cell structure is to do violence to the cause of inductive science. A somewhat similar comment may be offered upon the manner in which the great phyla are dealt with in Chap. III. Having devoted nearly half the chapter to defining these, the author proceeds (pp. 58, 59) to deal with types of each. He prefers to commence with the Echinodermata, dealing thus "first of all" with the "most aberrant" phylum. If the Echinoderms are dismissed as a stumbling block, why not the Brachiopods, the Polyzoa, and certain other creatures well known to zoologists? These are all wisely relegated to the end of the chapter, as "groups of animals which in the present state of our knowledge cannot be satisfactorily placed with any of the great phyla" (p. 100). Just so, but why not put the Echinoderms there also If the student is to be allowed the exercise of any judgment in the matter, he cannot be expected to deal with the aberrant before he is familiar with the normal, and more stereotyped grades of organisation.

Although the work is professedly a text-book of comparative anatomy and physiology, the latter branch has suffered much in the process of condensing, necessary we presume in order to keep the book within the prescribed limits. At the commencement of each chapter a concise definition of that system of organs to be dealt with comparatively is given, together with a brief description of their functional activity; but the field of comparative histology is sorely neglected. The author neither furnishes the required information on this subject, nor does he take for granted that his readers have worked through even the broad principles of it. The student is occasionally referred (*Ex.* pp. 368 and 372) to Klein's "Manual of Histology"—a fellow volume to the one now before us; but as that work deals with the subject altogether from a special human-anatomist's point of view, the reader is at a loss to make much of the subtle differences in the comparative anatomy of, say, shells and teeth, until he knows more precisely than he is here informed what is involved in an exoskeleton and a tooth. Similarly, the statements made (p. 258) concerning the vertebrate excretory system are altogether too brief and dogmatic. The student is merely informed that *Meso* and *Metanephros* exist; of their adult structure he learns little or nothing, and in the face of such descriptions of the essential structure of an excretory organ as are given, he would be at a loss to make much of that of the vertebrate at any rate for himself.

Chapters V. and VI. are also at a disadvantage from this curtailing of the histological portion of the subject. The definition of the blood given (p. 181) would not convey to the beginner's mind a notion of its real complex nature; he would rather infer that it is merely "the result of the process of digestion," in function "respiratory as well as nutrient." Least successful of all the definitions given of great systems is that (pp. 393-94) of the nervous system, and it is exceedingly unfortunate that (p. 411) the nerves should be described as bringing or carrying "messages." A fascinating conception of the nervous activity this may be, but it is a commonplace one, well known to every teacher of physiology; the mischief attendant upon its use is patent, and it is highly desirable that special efforts should be made to secure its abolition. Its adoption in this work is therefore greatly to be regretted.

Prof. Bell's book is fully up to the date of writing, and the subject-matter is for the most part judiciously selected and arranged; but in a volume where so much of fundamental importance to the student is recorded, we could wish to see more discretion used in the transcription of certain hypotheses. We frequently find the most elementary facts set down side by side with the most daring generalisations. Nowhere is this more conspicuous than on p. 85, where Hubrecht's well-known Nemertean-Vertebrate hypothesis is referred to. The author mentions this with a caution it is true, but its introduction in the manner adopted, and with the illustrations given, is out of place. Again, a teacher is not justified in telling a novice as a *procès verbal* in an elementary text-book that "the Echinodermata, the Arthropoda, and the Mollusca form (p. 84) three very distinct branches or phyla, the common ancestor of which is to be sought for only in a simple worm." Neither is he justified in asserting (p. 403) without further qualification than is here given, that "with the exception, then, that in Peripatus and Proneomenia, the anterior end of the nerve-cords is enlarged into a cerebral mass, we should appear to be able to see no essential difference between them and a Craspedote Medusa, save in fact that the Medusa has a complete nerve ring." Statements such as the above may prove in the long run to be expressive of the truth, but if introduced into a text-book, efforts should be made to convey to the mind of the student some notion of what they involve. The beginner is too ready to rely upon his teacher and his text-book at all times, and the admixture of elementary facts with startling hypotheses is—in a work of this order—directly opposed to the true scientific principle. The natural tendency to generalise prematurely needs to be checked rather than otherwise, and if countenanced by a teacher, it must lead to fallacies greater and more mischievous, than were those of the catastrophic school.

There is a dangerous sketchiness about certain portions of this work. For example, on pp. 185 to 193 there is instituted a brief comparison of the great blood-vessels in the leading groups of animals. The descriptions given would lead one to infer that the antennary, hepatic, and sternal arteries of the Crustacean, and the auricles of Mollusca, are serial homologues of the circular commissures of a worm (here called "transverse"); this is in fact stated (pp. 186, 189) to be the case. The argument used above applies equally well here, and we are at a loss to imagine the state of him who, with the aid of this book, shall try to ascertain the actual condition of these vessels in the admittedly all-important worm.

When we reflect upon the advisability of placing this work in the hands of the average medical student, it must be admitted that it is not calculated to be of much service to him during his ordinary student life, except as a cram-book for the examination-room. The author has, by the terms of his agreement, pledged himself to produce a *précis* of all that is of first importance on the subject. The work will be very valuable as a remembrancer and book of reference to those who already know something definite of the broad principles of the science, and we conceive of it as calculated to be of especial service to geologists and others, whose work among the "dry bones" occasionally needs the light from within. So far as the medical student is concerned, it must be admitted that he is overtaught, and it is monstrous to reflect that there exist systems of medical education, such as have necessitated the production of this book as a "Manual for Students of Medicine." The days for "signing up" attendances on long courses of lectures upon zoology and botany are—or ought to be—numbered; and if, as is most desirable, the biological leaven is to be introduced into the medical curriculum, it can only be done to good purpose along lines such as have been successfully laid down, mainly by Prof. Huxley.

There is undoubtedly a need of a sound elementary book, which shall be up to date, on "the general structure of animals," and Chap. III. of this volume supplies the want in a measure. The paucity of certain parts of this, however, is a serious obstacle to its adoption, for diagnoses such as are given for the Scaphopoda (p. 82), for the Copepoda (p. 68), and for the Siphonophora, are of little avail.

Taking the book as a whole, the success with which the author has performed his task will be obvious to any one cognisant of the immensity of the field. Small errors cannot well be excluded from a work of this kind, but the volume contains some which ought to be rectified as soon as possible. For instance, there is no good ground for stating (p. 359) that the sesamoids are "no doubt to be explained by a reference to the primitively multiradiate condition of the vertebrate limb," and there is something akin to a contradiction in the assertion (p. 140) that the teeth are "developed from cells of epiblastic origin," and that there is "a community of origin between what have been well called dermal denticles and what we call teeth." One remarkable instance of the manner in which errors of observation may be spread and distorted in the process of abstracting, is to be found on pp. 301 and 377, where we read that the telson "sometimes, though very rarely (Scyllarus), *bears minute appendages.*" We mention this as the author lays stress upon it, and unless we are mistaken in the identity of the paper from which the above idea has been culled,[1] an attempt was merely made to show —and that unconclusively—that "the telson is a true body segment with lateral appendages, which are modified by cohesion and adhesion." He who abstracts cannot be expected to verify the accuracy of every statement he reproduces—life is too short for that—but a matter such as the above should not have been allowed to pass. In defining the Arachnida (p. 72) it is stated that "the mouth is never placed so far back that any of the appendages become antennary organs." This is but one view of a complicated and deeply involved question, and, even should it chance to be true in the end, it is but a deduction at the most, and its use here as a definition is unwarrantable. This same deduction underlies the statements made on p. 303 under a similar head, and also the insertion of the foot-note uncalled for to p. 224. The first mention of the "transverse processes" of the vertebra (p. 314) as "given off" from the centrum is to be regretted, as it leads up to a complete misunderstanding of the nature of the component parts of the adult vertebra; and, passing (pp. 324-25) from a somewhat jerky description of the vertebral column, it is doubtful how far it is wise to usher in so complex a subject as that of the skull, by a direct appeal to embryology. The statement (p. 325) that the trabeculæ "never form more than an

[1] Garrod, *Journal of Anatomy and Physiology*, May 1871.

imperfect roof" in the region of the fore-brain, hardly accords either with fact or with the characters delineated in Fig. 138. In dealing with another complex matter—the origin of the fœtal membranes—the student's attention is abruptly transferred (p. 509) from the vitelline membrane to the amnion, and that in such a manner that he would scarcely follow what is really meant. Closely allied is the description of the germinal layers, and we doubt if the bare statement (p. 34) that "the outer and inner layers undertake the functions which their position entails on them" is justifiable.

The work is got up in good style. The technical terms are printed in large type, but the choice of these is not always happy; on p. 5, for instance, in describing the movements of living protoplasm, we find the words "stream" and "gliding" set up in large letters; while, on p. 12, where the time-honoured terms "ontogeny" and "phylogeny" cannot well be dispensed with, neither they nor equivalents are employed—in fact, but for the aphorisms quoted on p. 13, the arguments used under the head of "development" would hardly carry conviction. Considering the nature of the book there are very few typographical errors. The more important are: p. 49, the description of Aspidogaster as "*ecto*parasitic;" p. 138, the "*anterior posterior* of the digestive tract;" and, p. 501, "the *cephalous* Mollusca, such as the mussel," &c. The illustrations are, for the most part, fairly good. Fig. 11, representing, as it does, only one-half of an anemone, is not easily intelligible to the reader, and the student should be informed what the right half of Fig. 22 is intended to illustrate. Fig. 66 illustrates but feebly part of an important subject—Mammalian odontology—which is poorly dealt with. Figs. 36, 42, 81, 82, 101, 170, and 192, are all out of place in a work of this kind. They convey little or no impression to the mind of the student, and are bare schemes such as an observer might construct for use in his own private notebook *side by side with actual drawings of the facts observed.* Diagrams such as Fig. 101 should never be shaded up, as if indicative of actual appearances.

To sum up. The author has successfully produced, at immense labour, a volume, of service to those who already possess a practical knowledge of the broad principles of the subject. A "Manual for Students of Medicine" it emphatically is not, except under that atrocious and misdirected *régime* of parrot-work not yet extinct. For this the system, and not the author, is to blame; he has performed a good service, the return for which will but ill repay him. G. B. H.

BRITISH DAIRY FARMING

British Dairy Farming. By James Long. (London: Chapman and Hall, 1885.)

THIS very readable volume is from the pen of one who evidently understands the highly technical subject to which he has devoted himself. Writing upon agriculture has too often been attempted by mere theorists, and as an inevitable consequence practical men have been contented to cursorily scan and forthwith consign both book and author to oblivion. In this department more than in many others those who know are not book-writers and those who are book-writers do not know. Mr. Long is happily able to exercise the discernment which comes of knowledge in the marshalling of his facts and the quality of his suggestions. In his introductory chapter he gives solid statistical reasons why we should as a community endeavour to "produce more and import less," and the subsequent chapters are devoted to a review and comparison of our dairy system and those of our Continental neighbours, much to the advantage of the latter. The genius of the English farmer does not appear to have as yet shone into his dairy. His fields, his machines, his cattle stalls, his animals, have each and all been the admiration and the model of Europe and America. But he pauses on the threshold of his dairy and, we may add, his hen-house. These are, he thinks, the proper domain of the dairy-maid or the housewife, and the farmer is done with the milk when he has set it down at his dairy door.

It is a case parallel with that of our *cuisine.* We produce the finest beef and mutton, but we are only too constantly reminded of the forcible old proverb that while God sends meat the Devil sends cooks. There is some ground for hope that we shall, if only by force of competition, be compelled to further elaborate our products. English cheese is excellent, but it is lamentably wanting in variety, and certainly is much too apt to be regarded as one of the necessaries rather than as one of the amenities of our daily fare. Butter-making offers fewer facilities for innovation, but much requires to be done before we can successfully compete with the butter-makers of Denmark, Normandy, and Brittany. It is to cheese-making that Mr. Long devotes the largest share of his space. In England the principal cheeses may be almost told off upon the digits of one hand: they are "Stilton, Cheshire, Cheddar, Gloucester, Derby, and Leicester." The two last are, however, a little less definite than the first four, and we do not quite see their right to continue a list so well begun. Derby and Leicester are, no doubt, very good cheeses, but if they are to be admitted to stand in the same relation to English dairying as Stilton and Cheddar, we think Mr. Long might well have increased his list by adding Cutherston, Dorset-blue, North Wilts, and other cheeses well known to thousands of admirers. The principal English cheeses are, however, undoubtedly the first four mentioned in Mr. Long's list, and, with the exception of the Stilton, none of them can compare, in the estimation of an epicure, *connoisseur*, or *gourmand*, with the soft, rich, palatable cheeses imported to this country under a puzzling variety of appellations.

The chief interest of Mr. Long's book consists in his minute workable descriptions of the manufacture of a large number of cheeses, which indeed appear to be as numerous and various as are different sorts of wines. The book is well illustrated, and the "plant" required for carrying on the manufacture of some of the cheeses is complicated and expensive. Still, there appears to be no reason why similar cheeses should not be successfully made in England, and it is not improbable that the processes would be further improved in English hands were the matter once taken up.

Take, for example, Camembert:—

"The rennet is added to the milk at a temperature similar to that at which it is drawn from the cow: it is heated in a tub, and a portion of the morning's milk is added to the milk of the previous evening. . . . When the rennet is added the milk is gently stirred with a long spoon for two or three minutes; a wooden cover is then placed on each pan, and it is left for five or six hours. . . . The curd is then taken out by spoonfuls and put into cylindrical white metal moulds which cost about 4*s.* 6*d.* a dozen, and which are open at both ends. These are previously placed upon rush mats upon slightly inclined tables, and which have on the lower extremity a small gutter which carries off the whey into a receptacle beneath. . . . When the curd has remained two days in moulds the cheese possesses consistency enough to enable it to be moved with ease. Then the left hand is placed beneath it, and, assisted by the right hand, cheese and mould are turned, so that the top face is placed at the bottom, in contact with the mat. At the end of thirty-six to forty-eight hours from filling, the cheeses are taken out of the moulds and salted. . . . When salted, they are placed upon the wooden shelves above the draining tables, and here they are left for two or three days until they are ready to be sent to the *hâloir*."

We have quoted the foregoing passage in order to show that there is nothing more complicated in the making of a French Camembert cheese, nor yet so complicated, as in the making of an English Cheddar. Whether by following Mr. Long's directions an English dairyman could produce the correct type and flavour can only be demonstrated by trial, but probably a cheese would be produced suitable to English methods which would add to the variety of our dairy products and find a ready market. Mr. Long also describes the manufacture of various other cheeses, among which are Pont l'Evêque, Livarot, Mignot, Boudon, Brie, Géromé, Coulommiers, Mont d'Or, Void, Suisse, St. Remy, Gervais, St. Marcellin, Jour iac, Gex, and a large number of others, the mere mention of which would occupy more space than we can spare.

Mr. Long has certainly contributed a handy text-book which it is hoped will find its way among and be studied by dairy farmers.

JOHN WRIGHTSON

OUR BOOK SHELF

Chain Cables and Chains. By Thomas W. Traill, C.E., R.N., the Engineer-Surveyor to the Board of Trade. (London: Crosby Lockwood, and Co., 1885.)

IN the volume before us we find the business of chain cable-making in its several branches well explained and illustrated; nor does the aim of the author end here. There is information given which is most useful to surveyors and inspectors, and we recommend all who have to deal either with the manufacture, inspection, or testing of chain cables to study the work. The volume contains many well-executed plates, showing good, bad, and indifferently-formed links, &c., for various kinds of cables, also tables of the best dimensions of each part of each link and shackle used in cables from 7-16th to 2½ inches, the dimensions being given in decimals to two places, and also calculated to thirty-second parts of an inch. We find also exact copies of certificates given by the several public proving establishments, seven plates in all, more than one example being quite unnecessary, varying as they do only in colour and the name of the town in which the establishment happens to be.

After a few pages giving an outline of the general manufacture and the methods of welding the links, we have a long historical chapter of the early uses of metallic chains, in which we are told that their uses date back to the time of Pharaoh and King Solomon; but it was not until 1808 that chain cables were used on board ship; at this time a chain cable was used in a vessel called the *Ann and Isabella*, of 221 tons, built at Berwick, and owned by Joshua Donkin. This cable was made by Robert Flinn, in North Shields, perhaps the first artificer in chain cables. In the year 1833 the first machine for testing iron cables in a Government yard was put down at Woolwich, and in 1834, although chain cables were almost in general use, the rules of Lloyd's Registry only specified the length, and it was not until twelve years afterwards it was part of the surveyor's duty to see that they had been properly tested. The author gives a very interesting account of the progress of manufacture and general adoption of iron cables. We then find the various Acts of Parliament pertaining to their use given in full. All public proving establishments are now under the management of Lloyd's Committee.

The method of proving chain cables is as follows:—From every length of 15 fathoms of the cable to be proved a piece consisting of three links is taken and subjected to an appropriate breaking-strain. If the piece so selected fail to withstand such a breaking-strain, another piece of three links is taken from the same 15-fathom length and tested in a like manner. If the first or second of such pieces withstand the breaking-strain, the remaining portion of the 15 fathoms of cable is then subjected to the tensile strain. If it is found that after the application of the tensile strain the cable is without defects or flaws, it is then stamped as proved with the distinguishing marks of the proving establishment; on the other hand, should the cable fail to stand the appropriate tests, it is rejected. Mr. Traill condemns the overtesting of cables, considering that the material is injured by so doing, and we agree with him in saying:—"A moderate test is all that is not detrimental. Proving the iron from which the cable is made, and breaking a sufficient number of samples, is what can and should be done to prove the actual quality and reliability of a chain."

The volume does great credit to the publishers, being well printed on good paper. We can safely recommend this work to all in any way connected with the manufacture of chain cables and chains as a very good book.

United States Coast and Geodetic Survey. Determination of Gravity at Stations in Pennsylvania, 1879-1880. *Appendix No.* 19. *Report for* 1883.

THIS appendix is a portion of the Annual Report of the U.S. Survey, and contains the pendulum observations made in 1879-1880 by Mr. C. S. Peirce at three stations in Pennsylvania—namely, at the Alleghany Observatory, at Ebensburg, and at York. The observations form part of a series undertaken in connection with the Geodetic Survey of the United States. A Repsold reversible pendulum was used and oscillated *in vacuo*, using various kinds of supports. At York a series of experiments were made to determine the effect of the flexure of the support. It appears from a previous report (Appendix No. 14 of 1881) that Mr. C. S. Peirce maintained against MM. Plantamour and Hirsch in Switzerland, that the oscillations of the support have a marked effect on the time of oscillation of the pendulum, and he accordingly undertook an exhaustive series of experiments to prove his point, and to measure the allowance to be made. The experiments given in Appendix No. 19 are only a small portion, and are in fact re-published from Appendix No. 14, with some few corrections. The question was disposed of in Appendix No. 14, and it was clearly shown that the flexure of the support ought to be taken into account, and it is evident, therefore, that the stiffness of the support is of vital importance. Experiments were also made at York to determine the relative value of the method of transits and a method of eye and ear coincidences invented by Mr. Farquhar; the method is not described, but appears to be far less accurate than the method of transits. The effect of substituting steel cylinders for the usual knives was also tried, and every care taken to prevent the inclusion of dust, but the results were very unsatisfactory.

The results obtained are as follows:—

Length of second's pendulum reduced to sea-level at the equator.

	Metre.
Alleghany Observatory	0·9909384
Ebensburg	0·9910672
York	0·991015

At Alleghany, the effect of a valley was not taken into account, as there was no topographical survey available; the necessary correction will slightly increase the above value.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Presence of the Remains of Dicynodon in the Triassic Sandstone of Elgin

In my address to the Geological Section of the British Association I was fortunately able to announce a discovery which is of the very greatest interest both to geologists and biologists. As this discovery was made only a few days before the commencement of the meeting at Aberdeen, and after the draft of the address was in type, it does not appear in your columns; I will therefore ask you to insert this note upon the subject. Visiting the "Cutties Hillock" quarry near Elgin early in September, I found that the workmen had recently obtained a new specimen of a reptile, in which the head was preserved. On examining this I found that there were clear indications of two large canine teeth in the upper jaw with permanent pulp cavities. These characters and the general form of the skull left scarcely the smallest doubt in my mind that the remains must belong to a reptile closely allied to *Dicynodon*. From the examination of a photograph which I submitted to him, my friend Dr. Traquair was able to fully confirm this conclusion, and to lay a preliminary note on the specimen before the Geological Section at Aberdeen. I hope that ere long he will be able to give a complete description of it.

As Dicynodonts have hitherto been only found in South Africa, in India, and in the Ural Mountains, this discovery is an exceedingly important one. Seeing that doubts have been expressed concerning the Triassic age of the South African deposits, the occurrence of the very characteristic African form in the Trias of Western Europe is an important link in the chain of evidence by which these beds have been correlated. It is interesting, too, to be able to point out that the sandstones of Elgin, concerning the age of which such a great amount of controversy has taken place, have now yielded reptiles belonging to no less than *four* orders—namely, the Lacertilia, the Crocodilia, the Dinosauria, and the Dicynodontia. J. W. Judd

An Earthquake Invention

While on a visit to the Melbourne Observatory I saw Nature of July 2 containing two letters from Prof. Piazzi Smyth, intended to expose a piratical attempt on the part of a "B.A. man" to adopt an idea of Mr. David Stevenson with regard to the construction of houses to withstand earthquake motion. The publication of the first of these letters is at the request of Mr. D. A. Stevenson. The piracy referred to by Prof. Smyth is a brief note in a paper written by myself. My name is at the head of it (see *Report* to the B.A. 1814). Prof. Smyth complains that I have not taken notice of a paper written some twenty years ago by Mr. D. Stevenson. I regret to say that I am not acquainted with that paper, and how Prof. Smyth expects that I should be when living 10,000 miles away from collections of European books, I fail to see. I am, however, acquainted with very much relating to aseismic or aseismatic tables, and if I made reference to the work of Mr. David Stevenson, I must necessarily have referred to the work of others. As every report which I have hitherto written for the British Association has been in the form of notes which have subsequently been expanded in special papers, an historical account of aseismic tables would have been out of place. Prof. Smyth is apparently only acquainted with the work of Mr. D. Stevenson. Under the head of aseismic tables I include ball and plate seismographs, the lamp tables in certain Japanese lighthouses, two model houses which I constructed in Japan, together with the model lighthouse spoken of by Prof. Smyth, and my own dwelling house. *All of these involve the same principles, and they only differ in their dimensions.*

(1) *Ball and Plate Seismographs.*—Of these seismographs I have constructed *several* types. At the time of an earthquake, in consequence of acquiring a surging movement, they fail to give reliable records. They have been *independently* invented and described as original by many. Mr. Briggs, of Launceston, Tasmania; Dr. Verbeck, of Tokio, Japan; Mr. T. Gray, of Glasgow; Mr. D. A. Stevenson, of Edinburgh, &c., have all been authors of such instruments.

Mr. D. A. Stevenson recently figured and described his form of seismograph in the pages of Nature. If we overlook certain mechanical defects in this instrument, as, for instance, attaching a recording index to the edge of the "steady plate" rather than at its centre of inertia, the resemblance of Mr. Stevenson's contrivance is strikingly like a seismograph the photographs and descriptions of which existed in several societies and libraries in Britain prior to the appearance of Mr. Stevenson's invention. After reading Mr. Stevenson's description I did not ask for the publication of an "interesting" and "well-put" letter, accusing Mr. Stevenson of having appropriated the ideas of others, but I furnished him with copies and references to papers in the *Transactions* of the Seismological Society and other periodicals where mention was made of this type of instrument.

(2) *Lamp Tables.*—As I have been an officer in the Public Works Department of Japan for the last ten years, where I have every facility of knowing what the performance of the lamp tables at the lighthouses has been at the time of severe earthquakes, I trust that some credence may be given to what I may say on this subject. When I last made inquiries about these tables, I found that they were all regarded as failures and one and all had been clamped. If Mr. Stevenson would like to have details respecting these failures I shall, on my return to Japan, have great pleasure in making them public.

Mr. Mallet, in his "Palmieri's Vesuvius," very distinctly states that he was consulted by Mr. Stevenson respecting the Japanese structures, and that the principles indicated by him (Mallet) were followed out in their construction.

As Mr. Mallet is dead, perhaps Mr. Stevenson or Prof. Smyth will kindly enlighten us as to the meaning of this passage. Although I have made seismology a speciality for some years, I must confess that I am as yet in the dark as to who was the first inventor of the aseismic joint. To me it appears that there have been many inventors.

(3) *Models.*—My first model was about as large as a good-sized dog kennel. For a *short*-period oscillatory movement the house resting on its rollers remained at rest. Prof. Smyth speaks of Mr. Stevenson having imitated earthquake motion by the blows of a sledge-hammer. Although Prof. Smyth regards the blows of a sledge-hammer as an admirable illustration of earthquake motion, any one acquainted with the true nature of earthquake motion would decline to recognise Mr. Stevenson's test as any test whatever.

(4) *Building.*—The only *building* placed on free foundations with which I am acquainted is the one I have erected in Tokio. At first it rested on balls, and, like Mr. Stevenson's lamp tables, it was for certain reasons a failure. Now it rests on spherical grains of cast-iron sand. It is now astatic, and I regard it as a success. At the time of an earthquake the motion outside the house is usually about six times what it is inside. A description of it will be found in the *Reports* of the British Association for 1885.

From what I have now said it will be clear that I have no desire to claim the authorship of the aseismatic joint. Detailed reference to the obscure and manifold authorship of what has hitherto proved a failure would certainly have been out of place in the report to which Prof. Smyth has referred.

Had Messrs. Stevenson and Smyth been acquainted with the nature of earthquake motion, a few of the more important facts in the history of the ball and plate joint, and the details of the failure of the tables in the Japanese light-houses, I feel sure that much of the objectionable innuendo to which I have been subjected would never have been penned. JOHN MILNE

s.s. *Waihora*, Hobart, Tasmania

P.S.—The above has been written whilst at sea, and I have neither had opportunity to refer to books or papers. On my return to Japan I shall be glad to continue the history of the ball and plate joints, should it be required.

Tremble-terre du 26 Septembre, 1885

UNE seule secousse a été constatée le 26 Septembre à 0h. 58m. du matin ; elle a été composée de 2 à 3 oscillations, de direction variable suivant les localités. Le centre de la secousse a été dans le milieu du Valais, où son intensité a été appréciée comme très-forte, mais où il n'y a cependant pas eu de dégâts matériels ; il faut lui attribuer le No. VI. de l'échelle qui évalue en dix degrés l'intensité des tremblements de terre.

La secousse s'est étendue vers le nord jusqu'à Schwenden et Zweisimmen dans le Simmenthal, à Château d'Oex, Aigle et Yvorne ; dans les Alpes vaudoises elle a été fort bien sentie dans les vallées de l'Avençon, de la Gryonne, de la Grande-eau, et de la Savine. Dans tout le reste du canton de Vaud le tremble-terre semble avoir passé inaperçu, tandis qu'il nous est signalé de deux localités fort distantes, Genève et Nidau ; il est cependant probable que la secousse de Nidau a précédé de quelques minutes la grande secousse du Valais; d'après un observateur très précis la secousse de Nidau a eu lieu à 0h. 53m.

En même temps que le sol de la Suisse était ainsi ébranlé, les appareils très délicats de l'observatoire sismique de Rome, qu' avaient été en repos les jours précédents, ont signalé des vibrations du sol vers 1 heure du matin ; et dans le même nuit un violent tremblement de terre ravageait la ville de Nicolosi près de Catane en Sicile. F.-A. FOREL

Morges, 8 Octobre

Larvæ of Cerura vinula

LAST year I was rearing up some larvæ of *Cerura vinula*, the Puss Moth, from the egg, and I determined, while I had the chance, to write a life-history of them.

On examining the egg closely I found a small hole in the apex of each, and I thought at the time that this was probably caused by ichneumons, and therefore I laid the eggs by in a small box that I might capture the ichneumons when they made their appearance. Great was my surprise, then, when I found that the young larvæ came out as usual.

I therefore determined to get some more eggs and to find out whether this hole in the apex was caused by the mandibles of the larva inside, but I found that the larva did not emerge by this hole, but by a fresh one made in the side of the egg. And I find that all Puss Moth eggs have this hole in the apex.

I am now hoping to get some eggs of moths belonging to the same family (*e.g. Cerura furcula* and *bifida*) to see if they also are perforated in this way. I should be much obliged if any one who has got any of these eggs would kindly let me know whether this is the case.

This hole reaches through the shell of the egg, but is covered, on the inside (of the egg) with a thin tissue, like that which is found in birds' eggs.

I have carefully examined several scientific books, but have been unable to find this fact mentioned ; therefore I should be much obliged if any one could throw a light on this mysterious fact.

I unfortunately have none of these eggs to forward as examples ; but, as they are pretty common in May and June on poplar trees, I have no doubt that such of your readers as are interested in the subject will be able to examine them for themselves. CYRIL B. HOLMAN HUNT

Draycott Lodge, Fulham, October 9

Pulsation in the Veins

I AM quite satisfied that the pulsatory movement in the veins, to which my former communication referred, is not in any way *abnormal*, as suggested by Mr. Williams (p. 466). In all cases, without exception—and they have been a good many—in which I have had opportunity for the observation, the minute *visible* evidence of the pulsatory action has been present, and I have invariably been able to count the pulse of the individuals, as in the experiment detailed in my former letter.

The mirror experiment was tried on my own hand. And a medical friend who applied the sphygmograph in the usual way informed me that my pulse was free from any abnormality.

It is to be borne in mind that the pulsatory indications with which my paper is concerned are exceedingly minute and would escape the perception of nine persons out of ten—requiring an eye educated to appreciate very minute differences of shade and colour. I do not think that the bristles or sealing-wax thread which a correspondent (p. 437) kindly suggests, or even the orthodox sphygmograph would have a chance of effectually exhibiting them. I say shade *and colour*: for when a vein free from turgidity, and not sensibly altering the smooth surface of the skin, is seen only by its blue track, a modification of the *tint* is perceptible (to an educated eye) ; and the blue varies in intensity with the pulsatory action, sufficiently for the success of the pulse-counting experiment. J. HIPPISLEY

Stoneaston Park, October 4

Stonehenge

IN NATURE, vol. xxxii. p. 436, R. Edmonds associates Stonehenge with the metonic cycle, and quotes from Diodorus Siculus, whom he says flourished about 44 B.C. Would not the latter part of the first century A.D. be more accurate? He gives in his extract from Diodorus Siculus a quotation from Hecatæus, whom he confuses with Hecatæus of Miletus, when it was Hecatæus of Abdera to whom Diodorus referred. Hecatæus of Miletus flourished about 500 B.C., and Hecatæus of Abdera about 300. Mr. Charles Elton, M.P., in his "Origins of English History," gives the very same extract, and says that "We cannot admit that the work of Hecatæus is on the subject of Ancient Britain," and estimates its value in the following extract from the works of an eminent Polish scholar (Lélewel, Pythéas, 45): "Hécatée a publié un fameux ouvrage dont le titre décèle une vieille idée poétique rajeunie sous sa plume. Elle devait s'allier aux nouvelles découvertes et y prendre une place éminente au détriment de la science et du bon sens. Hécatée, énumerant tous les êtres mystérieux de la géographie septentrionale, enrichit leur nomenclature d'une rivière Scythique récemment trouvée en Orient par le conquérant, qu'il a appelée Parapamisos ; et plus encore des promontoires et des îles Celtiques, qu'il a probablement puisées dans les rélations véridiques de Pythéas pour les entrelacer dans les plages superboréennes."

The quotation from Diodorus is from his second book, but the whole of this second book is dedicated solely to a description of Asia ; and it is not until the fifth book is reached that he describes the British Isles, and with a very considerable degree of accuracy. (See Fergusson's "Rude Stone Monuments," p. 8).

I do not think, either, that "Nine Maidens" is simply an abbreviation of "Nineteen Maidens," for, like "Nine Ladies" of Stanton Moor, in Derbyshire, it is a memorial circle.

Stone Henge, moreover, is much more probably a memorial circle, as its original name implies—"Stan Hengis"; and commemorates the massacre of Vortigern's chiefs by Hengist in 462 A.D. The Rollright circle probably commemorates the victory of Rollo over Eadward, circ. 913, whilst Avebury and Hakpen (520), Kit's Coty House (455), Long Meg and her Daughters (508–520), Stanton Drew (508–520), Arthur's Table, Arbor Lowe, Cumrew, Salkeld and Mayborough commemorate some of the victories of Arthur. That this is reasonable may be mentioned the facts that coins of Claudius Gothicus (270 A.D.), Constantine the Great, Constantine junior, and Valentinian have been found at one or other.

Milverton, Leamington SAND. S. STANLEY

The Forecasting of Barometric Variations

IN a paper published in the *Journal* of the Royal Meteorological Society, vol. x., p. 219, 1884, I pointed out that during a series of years the barometric variations in Western India had presented certain features which, had they been known at the beginning of 1876, and, indeed, at the beginning of 1872, would have made it possible to have calculated with a considerable degree of precision and reliability the general course of the barometric variations from 1872 up to 1883, in some cases three months, and in some cases even twelve months beforehand. The facts brought forward in that paper were of such a nature that, as will be readily understood, I wished very much they could be found to occur generally. But it was undoubtedly better to restrict their application to the area and period dealt with in the paper. It having been shown, however, that at one period and over a certain area quantitative relations had existed between previous and subsequent barometric variations, it is natural to suppose that quantitative relations may be found to exist at other periods and over other areas also. The question arises, Can the facts brought forward in the above-mentioned paper serve as a guide to future investigation? I think to a certain extent they can.

The paper pointed out that there was a remarkable approach to an annual symmetry in the abnormal variations of the barometer in Western India during many of the years under observation. It supposed that this symmetry would have occurred every year during that period had it not been masked by larger variations of another character; and it was mainly by acting on this supposition and noting the departure from symmetry in any given year, and by considering that departure as being an index of the variation that was about to come, that the position of the barometer in the subsequent year was calculated. The paper attempted to explain the occurrence of this annual symmetry in two ways: (1) By supposing it to be a constant phenomenon connected with the annual double oscillation known to be present in the normal barometric curve; and (2) by supposing it to be a chance phenomenon, characterising a phase in the march of barometric variations, and persistent during the period dealt with, but not necessarily to be found in any other period. After further reflection I am inclined to believe that the latter is the correct explanation.

And here I think may be a guide to future investigation. It seems very likely that barometric variations may always be passing through phases which are persistent for several years. And, during the continuance of each phase the abnormal barometric curve will necessarily approach more or less to a certain annual type. In the cases dealt with in my paper that type chanced to be of a symmetrical form, sufficiently remarkable to strike the eye at once. The regularity of its form made it comparatively easy to be dealt with. An irregular type would of course be less easy to recognise and less easy to be dealt with. But it is obvious that if such types do exist and persist for several years in succession, then, by catching the type as the barometric phase comes in and by noting the departures from it each year, in a manner similar to that adopted with the symmetrical type I had to deal with, these departures may serve also in a similar manner as indices of the coming variations. Of course the methods of calculation would have to be purely arbitrary and specially devised for each barometric phase. If barometrical curves would yield to strictly mathematical methods, the problem of season-forecasting could be regarded as in a fair way of being solved. But it has never yet been found possible to resolve them entirely into regular periodical oscillations; and I believe they will always have to be arbitrarily dealt with.

Melbourne, July 21 A. N. PEARSON

Transmission of Sound

IN connection with the subject of mechanical telephones, which has been occupying public attention lately, there is a note by Mr. Miller in a recent number of NATURE, regarding certain experiments made in 1878 on the propagation of sound. With reference to this, Prof. Wernhold, of Chemnitz, writes to me, saying that as early as 1870 he had shown that human speech could be transmitted very distinctly through stretched wires or threads, and mentions that the results of his researches were published in an article on "The Transmission of Human Speech through an Iron Wire," in Carl's "Repertorium für Experimental Physik," Band vi., Serie 168. As your correspondent will probably like to refer to this, may I ask you to kindly publish this letter? W. E. AYRTON

Central Institution, Exhibition Road, London, October 12

Are there Rabbits in the Western Islands?

PROF. THOROLD ROGERS in his interesting book on "Work and Wages" mentions the relatively high value of rabbits in the thirteenth century, and suggests that they were then a recent introduction to England. It is well known that several islands on the west coast of Scotland have no rabbits upon them—for instance, Kerrera, which seems to point to the same conclusion. It would be interesting to know whether this is really the fact or not? HERBERT ELLIS

112, Regent Road, Leicester, October 4

THE HELL-GATE EXPLOSION

PROBABLY the largest chemical mechanical experiment ever thought of was successfully performed last week in New York Harbour by the removal of the obstruction known as Hell Gate, or Flood Rock, a considerable-sized island, as stated by the papers, about nine acres in extent, in Long Island Sound. The agent employed for this immense engineering work is a preparation or preparations of nitro-glycerine, and there is no doubt that this is the only explosive compound which could have been used for the purpose on account of the very enormous quantity required and the peculiar nature of the explosion of this substance. All the compounds or preparations of nitro-glycerine produce by explosion what are known as local effects only, as distinguished from gunpowder, the effects of which are much more gradually developed on ignition, but extend, owing to the slower and larger wave of disturbance, to a much greater distance. The legitimate use of nitro-glycerine is for purposes such as this, where a disruptive action is required.

The operations leading up to the final explosion have been some years in progress. They have consisted in forming a system of tunnels at a considerable depth under low-water level in the solid rock, and the charging of these tunnels with dynamite and mixtures known as rackarock, of nitro-glycerine with compressed gun-cotton. Twenty-four galleries were driven through this island, some of them 1200 feet long, and these were intersected by some forty-six others. These tunnels were about 10 feet high and 8 feet wide, and the roof of rock above them varied from 10 to 25 feet in thickness. The quantity of rock to be removed by the explosive was about 275,000 cubic yards, the quantity removed by tunnelling being about 80,000 cubic yards. A good deal of trouble has been occasioned during the course of the mining work by fissures, which have had to be stopped by wooden plugs in most instances. The explosive was charged into holes drilled into the roof and supporting walls and pillars at different angles, with a view to disrupt the strata of rock as much as possible.

The holes to be charged were about 9 feet in length and $2\frac{1}{2}$ inches in diameter. The holes were charged first with the blasting gelatine or rackarock and filled to the ends with a dynamite cartridge, to which the detonator and electric wire were attached. In all fourteen thousand cartridges of a total weight of fourteen tons were employed. Near observers describe the explosion as being accompanied by a dull roar, but with only the slightest shaking of the ground, even at a moderate distance. An immense quantity of water was bodily raised up to heights estimated variously at 150 to 200 feet.

The results, as far as can be ascertained, are very satisfactory, the rock having been very thoroughly broken up, so that it can easily be dredged away.

After the example of an experiment on this scale, carried out without the least accident, perhaps it may occur to those in authority that we have on our own coasts dangerous rocks, not of the extent of Flood Rock, which might with immense advantage be similarly "chemically" removed.

Had gunpowder been the only explosive available, at least five times the quantity by weight of the nitro-glycerine preparations used in this experiment, would have been necessary and the results would not have been by any means so local or perhaps so satisfactory.

After this the engineer may find it to his advantage to cultivate more the acquaintance of the chemist and his products than has been hitherto the case.

SUBMARINE DISTURBANCE

THE following is an extract from the Meteorological log kept by Capt. R. J. Balderston on board the ship *Belfast*:—

"On December 22, 1884, at about ten minutes to 3 a.m., local ship's time, or 21d. 19h. 6m. Greenwich mean time, the ship *Belfast*, of Liverpool, was shaken by an earthquake which lasted from about 75 to 90 seconds. The vessel at the time was in latitude 34° 34′ north and longitude 19° 19′ west, the island of Madeira bearing true S.E., distant 145 miles.

"The shaking of the ship was accompanied by a loud rumbling noise, which, as heard from the cabin, resembled the sound which would be made by the rolling of large, empty, iron tanks about the decks, but which, as heard from the upper deck and in the open air, was as that of not very distant thunder, and it appeared to fill the whole of the air.

"I did not hear the commencement of the thunderous sound, and cannot say on what compass-bearing of the visible sky it commenced, but it travelled rapidly through the air and towards the S.W.

"The vibration of the vessel and the noise were greatest during the first 50 or 60 seconds; the former then died gradually away and ended in the very faintest tremor, while the latter, as it travelled south-westward through the atmosphere, died out with a low roar as it appeared to sink beyond the horizon.

"The helmsman found the steering-wheel much shaken as he held it, and in the cabins and cook-house, tin ware, crockery ware, and other light articles were rattled about.

"This little earthquake occurred three days prior to the commencement of the earthquake which caused so much loss of life and property in Spain.

"Meteorological Office, October 9"

THE BOTANICAL GARDENS IN JAVA

DURING the last few years so many useful and important improvements have been made in the botanical gardens at Buitenzorg and Tsi-Bodas that it might not be amiss if the attention of the readers of NATURE were again drawn to these valuable seats of systematic and philosophical research.

On entering the gardens at Buitenzorg the stranger is at once struck with the wealth and luxuriance of the vegetation he sees, the great height of the trees whose trunks and branches are in many cases covered with heavy creepers, the dense copses of the different species of bamboo, the eccentric-looking screw-pines and the handsome palm trees; but the scientific observer is also struck with the care that has been taken to arrange all these many varieties of tropical plant life in, as far as possible, their systematic order, and that each specimen has its scientific, and in many cases its Malay name also, clearly and distinctly printed on a little board by its side.

It is not difficult for any one to find his way about the garden, and in a very short time he can discover the particular family or group of plants which he may desire to study. Many families have probably more representatives in these gardens than in any in the world. The Sapataceæ, for instance, so rarely seen in Europe, are here represented by a great variety of genera and species, and the Palmaceæ, the Rubiaceæ, the Burseraceæ, the Orchidaceæ, and other families have now a large number of rare and interesting representatives.

The herbarium which is attached to the garden contains a large collection of dried plants and seeds collected together from the many expeditions into the little or unknown parts of the archipelago and from other sources. Attached to the herbarium there is a comfortable and convenient little library which contains most of the mportant botanical books and journals.

The laboratory, which, thanks to the energy of Dr. Treub, the director, is now completed, is a large, lofty and, for these climes, particularly cool room, and is well fitted out with reagents and apparatus for carrying on botanical research. The generous invitation which Dr. Treub has issued to naturalists and to which the attention of the readers of NATURE has already been directed has attracted several scientific men of different nationalities, and some excellent research has already been made in this laboratory.

When I arrived in Buitenzorg Dr. Treub was at Tsi-Bodas; so, after spending a few days in study in the gardens, I made the journey across the mountains to pay him a visit. The road from Buitenzorg to Tsi-Bodas crosses the Poenchuk Pass and is full of interest and beauty. On the way the traveller passes quite close to the Talaga Werner, the crater of an extinct volcano which is now filled with water, and forms a most beautiful little lake hidden in the dense foliage of the mountain slopes. The path from the road to the lake is through a dense wood of fine forest trees, and amongst the undergrowth is found many fine shrubs and plants which are not found in the low-lying country beneath.

The gardens at Tsi-Bodas are situated on the slopes of the Gedeh Mountains, at an altitude of 5000 feet, and here I found Dr. Treub at work in the comfortable little house which is attached to the gardens.

From this spot a very wide range of vegetation may be studied, from the rich and varied vegetation of the plains to the interesting vegetation of the Gedeh and Pangeranso peaks, at an elevation of 10,000 feet. In the gardens themselves a very fine collection of Coniferæ from America, China, Australia, and other parts of the world has been got together, and spaces have been cleared for the growth of the various species of Eucalyptus, Cinchona, and other plants. Year by year the surrounding forest is being encroached upon by these gardens to make room for new importations. I was extremely sorry that I could not prolong my stay at Tsi Bodas, but I had to return to Batavia to catch the Molucca boat. I saw, however, enough to convince me of the great importance of these gardens for the advancement of our botanical knowledge and the great opportunities they afford for research into all branches of the science.

I need hardly say that the climate in this region is extremely pleasant and invigorating, and the neighbouring village of Sindanlaya is much resorted to by Europeans and others whose health has suffered on the coasts or low-lying districts of the Archipelago. At Buitenzorg the climate is by no means unpleasant or unhealthy, but as it lies a few thousand feet lower than Tsi-Bodas, it is naturally a good deal warmer; but I am assured that several Europeans have worked there for several years without feeling their health the least bit affected.

It is hardly necessary to add that every one who has come over to Java to work in these gardens has been amply repaid for the time spent in the long journey over the sea, for the insight which can be gained here into what tropical botany really is is one which can be gained nowhere else in the world so well, and leaves an impression which is not likely to be forgotten in a lifetime.

Batavia, July SYDNEY J. HICKSON

ON CERTAIN NEW TERMS OR TERMS USED IN A NEW OR UNUSUAL SENSE IN ELEMENTARY UNIVERSAL GEOMETRY.

Point, Line, Plane, Space, Extension

A LINE may as usual be understood to mean a right line unless the contrary is stated.

Representable extension will comprise the concepts corresponding to the first four terms above written. So understood, the term *a space* is susceptible of a more precise meaning than is usually attributed to it: its *intrinsic* equation is given by Cayley's theorem of squared distances. It is a homaloid or flat of the 3rd as a plane is such of the 2nd, a line of the 1st, and a point of the *zero*th order.

The phrase *space of the 4th order* ought accordingly to be superseded if we would avoid using the same word in two different senses—*i.e.* in a wider and narrower sense. *Extension of the 4th* order is the proper expression to take its place, and so in general we ought to speak of *extension* of any given order n, and drop the phrase *space* of n-dimensions.

Figure, Plasm, Enclosure

A figure may exist in extension of any order. When pervasively limited by homaloids, simple and closed, I had proposed to give to it the *provisional* name of *plasm*, but Dr. Ingleby has supplied me with the more appropriate, or at least more simple, term, *enclosure*.

On the number and nature of simple regular enclosures in extension of any order, consult a remarkable memoir by Prof. Stringham * of the University of California (formerly of the Johns Hopkins University), in the third volume of the *American Journal of Mathematics*.

Homaloid, Flat, Niveau, Absolute Measure of Distance

Homaloid, the term long ago introduced by the writer of this note, *flat*, suggested by the late lamented Clifford, are now well understood, and need no new explanation; but it is well to bear in mind the *intrinsic equation* which serves to define them *to wit*

A homaloid in *extension of the nth order* is definable by means of an equation of the second order (naturally expressible in the language of determinants), in which $(n+1)$ points are the standards of reference, and the squared distances from these of any other point in the homaloid are the coordinates.

Observe that the squared length is the absolute measure of distance *between* two points. The distances of each *from* the other are not equal but opposite quantities differing in algebraical sign.

A *niveau* is a very convenient term to signify the *homaloid* of the *lowest* order that can be drawn through a given point-group and is always *unique;* the order of the homaloid which is the *niveau* to a group of n points cannot exceed $n - 1$.

Curves, surfaces, &c., of the 1st, 2nd, and nth *kind.*

A plane (or simple) curve is of the first kind; "a twisted curve," "courbe gauche," or a curve in extension of the 3rd order, of the second kind, and in general a curve in extension of the nth order is a curve of the $(n-1)$th kind.

Similarly we may define a simple surface as one of the first kind, and a surface in extension of the nth order as one of the $(n-2)$th kind; and so in general a figure of *variety* i † (i being 1 for a curve, 2 for a surface), in extension of the order n, is one of the $(n-i)$th kind.‡

Curve, Locus, Assembly, Envelop, Environment

A *curve* is that which is common to a locus of points and an assemblage of tangents; the locus is the *envelop* of the assembly, and the assemblage the *environment* of the locus.

Lines and Points

A line may be used in the double sense of a locus or direction. In the latter signification an Euclidian or objective line is the union of two lines running in contrary directions and an analytical line is a half-line, a "semi-droite," meaning, of course, a half-Euclidian line.

So a point may mean either a position or an infinite assembly of lines (containing or) contained in it; used in the latter sense, it might temporarily be termed a *pencil-point.*

There are half or split points, as there are half or split lines. Thus the infinite extremities of the asymptotes to a hyperbola are half-points, the union of two of them being the correspondent to a single point in any ellipse of which the hyperbola is a perspective image.

Coordinates, *Homogeneous and Correlated*

Homogeneous systems of coordinates may be distinguished into *absolute* and *proportional.*

In the former the absolute magnitudes of each are material, in the latter their ratios only.

Also into *direct* and *inverse.*

Direct coordinates are measured by given multiples of the distances of a variable point from fixed homaloids; inverse by given multiples of the distances of a variable line, plane, &c., from fixed points.

Correlated systems of direct and inverse coordinates are those in which my "universal mixed concomitant" (Clebsch's *connex*) $\xi x + \eta y + \zeta z$ (for greater clearness I confine myself for the moment to a particular diagrammatic case) equalled to zero expresses a line whose inverse coordinates are ξ, η, ζ, when these are made constant and a point (pencil-point) whose direct coordinates (when it is regarded as denoting position) are x, y, z when these in their turn are made constant.

If the distances of a point from the sides of the triangle of reference are l, m, n, and of a line from the angles of the *same triangle* λ, μ, ν, and if the direct coordinates being cl, dm, en, and the inverse ones $\gamma\lambda, \delta\mu, \epsilon\nu$, and the distances of the angles from the sides p, q, r—

$$c\gamma p = d\delta q = e\epsilon r.$$

l, m, n; λ, μ, ν are *correlated* systems.

If $l'\ m'\ n'\ p'$; l, m, n, p the direct coordinates of two corresponding points in a homography are connected by the Matrix M and $\lambda'\ \mu'\ \nu'\ \pi'$; λ, μ, ν, π (the inverse coordinates of two corresponding planes of the same homography) by the Matrix M', then if the two systems of coordinates are correlated, M and M' will be *opposite* matrices.*

Of course the like will be true in extension of all orders: thus *ex. gr.* in the case of a plane if for a given homography

$$\begin{aligned} & l' : al + bm + cn \\ :: \ & m' : dl + em + fn \\ :: \ & n' : gl + hm + kn \end{aligned}$$

Then

$$\begin{aligned} & \lambda' : (ek - fh)\lambda + (fg - dk)\mu + (dh - eg)\nu \\ :: \ & \mu' : (ch - bk)\lambda + (ak - cg)\mu + (bg - ah)\nu \\ :: \ & \nu' : (bf - ce)\lambda + (ed - af)\mu + (ae - bd)\nu \end{aligned}$$

* Mr. Stringham, a native of "the bloody land" of Kansas, studied mathematics and fine art under Peirce and Norton, at Harvard, obtained a fellowship at the Johns Hopkins University, and completed his studies under Klein in Leipsic. In his memoir he has given perspective drawings of the bounding solids about a vertex of the regular figures in quaternary extension, such solids being supposed to be previously rotated round the vertex into the same *space*, which of course may be done just as the bounding planes about a vertex of a regular figure in ternary extension may be rotated round that point into the same *plane*.

† A curve may be called a one-dimensional, a surface a two-dimensional, a solid a three-dimensional *continuum* and, and so on. Thus a *solid* is to a space what a *surface* is to a plane and a *curve* to a right line.

‡ The ordinary systems of geometry, whether Euclidian or Non-Euclidian (Ultra-Euclidian would be the more correct term), contemplate figures as contained in homaloids of some order or another; but this limitation has an empirical origin, and is not an essential ingredient of the pure theory of form; for instance, a curve, *i.e.* a *unidimensional continuum*, may, and in general will, be such as cannot be contained in a homaloid of any number of dimensions whatever; it might be said that the order of its *niveau* in such case is infinite; but this would be a mere verbal quibble—the right view being that it is *sans niveau*. The radical distinction therefore is not between the common Euclidian geometry and its generalisation (the so-called Non-Euclidian) but between the Homaloidal and the Anhomaloidal geometries.

* In other words, for two point line, point-volume, &c., schemes homographically related, employing *correlated* systems of *proportional* coordinates, the matrix which serves to express the relation between the direct coordinates of the first scheme and those of the second may be taken the transverse of the matrix which does the same between the inverse coordinates of the second and those of the first. This is an important and as far as I am aware a new *theorem*.

provided that l, m, n; λ, μ, ν are *correlated* systems of coordinates.

Images: Reciprocals or Polar Reciprocals

It is very convenient to speak of any function which equated to zero expresses a figure as an *image** of such figure; thus *ex. gr.* $\xi x + \eta y + \zeta z$ may be spoken of as an image of the line ξ, η, ζ and of the point x, y, z.

A curve being the concept common to a locus and an assembly (the common ground, so to say, of the existence of each of them), will be capable of being imaged in terms of either direct or inverse coordinates. If the two coordinate systems are supposed to be correlated (as they ought always to be) then any two homogeneous functions which are reciprocal, or, let us say, conjugate to one another (each in common parlance the *polar reciprocal* of the other) will be images—the one of the curve under its aspect as a *locus*, the other of the very same curve under its aspect as an *assemblage*.

Reduced Perpendicular Distances

An extremely convenient system of homogeneous coordinates of a point is where each coordinate is the distance from one of the boundaries of the fundamental enclosure divided by the distance of that boundary from the opposite angle. Such coordinates may be termed coordinates of reduced distance or reduced coordinates; they are analytically defined by their sum being unity. If a, b be the two vertices which correspond to the coordinates of reduced distances, the squared distance of any two points, $x, y, z, \ldots$; $x', y', z', \ldots$ in extension of any order is capable of being expressed by the formula $\Sigma(ab)^2 (x - x')(y' - y)$, which, as far as I have been able to ascertain, is nowhere stated in the books, except for the case of trilinear coordinates.

Exchangeable Figures

Two figures indistinguishable from each other by any of their internal properties, but incapable of occupying the same place (such as the left- and right-hand glove or shoe) have received the very awkward and misleading name of *symmetrical* figures; I propose to call them exchangeable figures, inasmuch as in the nature of things, as they are in themselves (without regard to the limitation of the human faculties), they may be made to pass into each other's places by a semi-revolution about a suitable homaloidal axis.

The Point-Pair at Infinity, Lines and Planes of Null

It has been already shown in these columns that the "absolute" in a plane has full right to be called the *point-pair* at infinity, in analogy with the received expression of the *line* at infinity, and those who have considered what has been here stated under the head of *reciprocity* will see good grounds for admitting that the line at infinity ought to be regarded as a complete line, *i.e.* as made up of two analytical "semi-droites."

Every line through either half of the absolute besides the property of being infinitely distant from any point in the finite region may be termed a *line of null*, in the sense that the distance between any two points in such line is zero.

In like manner any plane *touching* the absolute in extension of the 3rd order, besides being infinitely distant from the finite region, is in the same sense a *plane of null*; in it, form is divorced from content, for a figure of any shape being described upon such plane, its content will be *nil*.

Pluri-duality: Containing and Contained

In extension of i dimensions each continuum of λ dimensions stands in a relation of reciprocity to one of $i - \lambda - 1$ dimensions, the total number of these "dualities" being $\frac{i+1}{2}$ when i is odd and $\frac{i}{2}$ when i is even (in the former case the continuum of $\frac{i-1}{2}$ dimensions being its own reciprocal). It is very convenient in connecting reciprocal geometrical statements to ignore the difference between (and to regard as exchangeable and equivalent) the terms *containing* and *contained in* as applied to heterogeneous continua; indeed the ordinary distinctive use of these words suggests an erroneous conception; as *ex. gr.* of a line being *made up* of points or a plane of lines. A point may be said to contain every line or plane which passes through it, and a line every point which lies on it, and every plane which passes through it: as an example of this extended locution the order, rank, and class of a surface may be defined as follows—viz. the order and class as the number of its point and plane elements respectively contained in any given line; the rank as the number of its line elements contained in common by any given point and plane which contain one another.

A plane-section of a surface is the totality of its point- or line-elements contained in a plane and similarly a point-section (an enveloping cone), the totality of its plane- or line-elements contained in a point: hence indifferently the class of any plane-section or the order of any point-section of a surface is its rank.*

J. J. SYLVESTER

* When an *image* is given, its *object* is absolutely determined, but not *vice versâ*, since an image may be magnified or diminished at will by the introduction of a constant factor.

* The word *spread*, to signify an unlimited expanse of discontinuous points and so used by Dr. Henrici, is, I am informed, originally due to the late Prof. Clifford. In ignorance of this fact, on hearing that Henrici had been attacked for his use of the word, I stated my belief that it must have been borrowed from my use of it to signify a limited portion of a tissue of equi-spaced points, such as that which is turned to so profitable account in my *constructive theory of partitions* in the *American Journal of Mathematics*.

I did not know at the time that Clifford had used the word, nor that Dr. Henrici's treatise preceded by several years the publication of my memoir above referred to. This erroneous oral statement seems to have found its way by some more or less circuitous channel to the columns of the *Saturday Review* in a notice of a criticism, by Mr. Dodgson, of Dr. Henrici's geometrical manual in the Scientific Series. Dr. Ferrers (the Master of Caius College, Cambridge) was the first to apply a spread to demonstrate intuitively a celebrated arithmetical theorem of reciprocity due to Euler. Mr. Durfee a quarter of a century later led the way to a further and more pregnant use of the same by showing how to trisect a symmetrical spread bounded by two right lines and a broken line into a regular square and two quasi-triangular appendages, to which I superadded the notion of multisecting it into a succession of angles. Another pupil of mine at the Johns Hopkins University (Mr. Ely) has laid the foundation of a new theory of partitions, by studying the various modes of decomposing a *solid* spread of discontinuous points; his memoir on the subject is to be found in a recent volume of the *American Mathematical Journal*.

By means of the trisection method I obtained *inter alia* a new expansion of $(1 - xz)(1 - x^2z) \ldots (1 - x^2z)$, which, on making z unity and n infinite leads immediately to Euler's celebrated pentagonal-power series, and other results of a totally novel kind by the multisection method: so that a *spread* may justly be regarded as a potent instrument or magical mirror for extending old and bringing to view new truths in the *wonderland* of partition and elliptic-function series.

NOTES

ALL the five French academies will celebrate by a banquet the ninetieth anniversary of the foundation of the Institut, which was established on October 25, 1795, by the Conseil Législatif and Directoire Executif of the French Republic. The actual organisation is not quite the same as the original, great alterations having been made in 1814, and only partially abolished on subsequent occasions.

THE death took place last month of General J. J. Baeyer, President of the Central Bureau for European Triangulation and of the Royal Prussian Geodetic Institute. General Baeyer had reached the age of ninety-one years. A biography of some length will be found in the *Astronomische Nachrichten*, No. 2687.

M. ROBIN, a member of the Paris Academy of Sciences and of the French Senate, died last week. He had devoted his exertions to microscopy, and was professor to the School of Medicine.

By invitation of the Lieutenant-Governor of the Isle of Man Prof. Boyd Dawkins recently visited that island in order to report on its antiquities and the best means of preserving them. The result is given in a short communication to the Lieutenant-Governor, in which Prof. Dawkins indicates the present condition of the various classes of remains. He points out what should be done for their preservation, and advises that the island Legislature should pass an Act similar to the "Ancient Monuments Act" of the "neighbouring islands" of Great Britain and Ireland. The advice given by Prof. Dawkins is sound, and it is creditable to the Lieutenant-Governor that he has shown so much intelligent zeal in the matter. We are glad to note that he intends to follow up his action by introducing a bill into the Council with a view to carrying out Prof. Dawkins's recommendations.

The last publication of the Japanese Meteorological Observatory which has reached us contains the monthly summaries and monthly means for 1884, and is accompanied by forty-one maps, showing the isobars, isotherms, and prevailing winds. These volumes must demand unusual care on the part of the compiler, for they are printed in Japanese as well as English, and contain a mass of meteorological data of all sorts. We observe that three new stations have been added during the year, one in the north of Yezo, and the other, which should prove a valuable station, is at Fusan, the port of Corea recently opened to Japanese trade. This constant annexation of new territory by the Tokio Meteorological Bureau is to be highly commended.

A recent issue of *Cosmos* contains an account of the Jesuit establishments at Zikawei near Shanghai, the meteorological publications of which have frequently been noticed in Nature. The central establishment of the Jesuits in China is at Funkadoo in Shanghai, but about six miles away at Zikawei (Siccawei) they have a large adjunct, containing their schools, an orphanage, and a college. In the course of its existence the place has been twice sacked, but it was again rebuilt. In 1870 the fathers began with the rudiments of a meteorological observatory, of which Father Dechevrens was the founder, and has been to the present moment the director. Gradually, by purchase and by presentations from various Governments, the observatory became tolerably well equipped, and it is now a magnetic and meteorological station of the first order, making with excellent instruments observations on atmospheric pressure, temperature, humidity, evaporation, rain, winds, solar radiation, terrestrial magnetism in its various manifestations, &c. It issues a monthly *Bulletin* containing the observations, and a *résumé* and discussion of the meteorological events of the month. Thanks of the numerous missionaries scattered over the neighbouring provinces, who correspond with the director, the peculiar atmospheric movements in the China seas are beginning to be understood. Quite recently (as mentioned at the time in Nature) he has taken advantage, with the assistance of Sir Robert Hart, of the Telegraphs, to establish a regular daily weather service, for the benefit of mariners. The observatory is situated in a vast plain, where the horizon alone stops the view, and where atmospheric movements are not complicated by ranges of hills. A tower 33 metres in height has been erected, and the Beckley anemometer, constructed in 1884 by Munro, of London, is placed on a platform 7 metres higher. The observatory has gone on developing year by year, and there is little doubt that it will soon include in its field astronomical observations. The *Bulletins* are printed at the mission printing-press, which is included in the establishments at Zikawei, the printers being young Chinese. The monthly *Bulletins* form a considerable volume at the end of the year, and that for 1884, which has lately been issued, is the tenth in the series.

With regard to the new star in Andromeda Dr. Sophus Tromholt relates the following curious story in a Norwegian journal:—"When the interesting discovery had been made in 1877 that Mars was accompanied by two moons, it was shortly afterwards pointed out that Swift, in 'Gulliver's Travels,' relates that the Liliputian astronomers had discovered the two satellites (Voltaire, too, in a work in which he describes the experiences of two terrestrial beings on Mars, says that they saw the two moons unknown to mundane astronomers, but he has probably borrowed the idea from Swift). A similar remarkable proof that poets may also be prophets in astronomy has just come to light with regard to the new star in Andromeda. In the Hungarian periodical *Losonczi Phönix* for 1851 is a story by Maurus Jókai, the celebrated author, in which he refers to this star. Jókai makes an old Malay (?) relate that the Evil Spirit, Asafiel, revealed to King Saul and his sons the star in the nebula, and predicted that those who could not see it should perish in the impending battle. The Malay also reveals the star to his listeners and describes its position so accurately that there cannot be any doubt of the Andromeda nebula being the one referred to, although it is not named. The story, according to Jókai, rests on a biblical or Jewish legend. On the writer of these lines asking one of the greatest living authorities on biblical research whether the bible contains any reference to the point, he is informed that there is absolutely no such reference in that book, and that it is hardly possible that the nebula is mentioned in any Jewish legend. It is first mentioned by a Persian astronomer of the tenth century, and was first discovered in Europe in 1612. It would be exceedingly interesting to ascertain whether any Jewish tradition has preserved the mention of a star in the Andromeda nebula, as from this might be concluded that the new star is a variable one with a long period. I intend to inquire of Jókai whether his story is founded on any tradition or only an outcome of the author's imagination, but even should the latter be the case the story is a very curious one."

Algology is becoming a favourite science with some Russian botanists. After the valuable researches of Dr. Gobi on the algæ of the Gulf of Finland, several memoirs have been published by MM. Reinhardt and Rishavi on those of the Black Sea, and we find now in the last issue of the *Memoirs* of the Novorossian Society of Naturalists (ix. 2) an elaborate paper, by M. Reinhardt, being contributions to the morphology and classification of the Black Sea algæ. The paper is the first of a series. Following Bornet and Thuret's example given in their "Notes Algologiques," the author publishes his observations on separate species, without awaiting the time when he will be enabled to publish a more complete work. In the morphological part of his paper, M. Reinhardt discusses the development of a few Chlorophylleæ, and enters into more details with regard to some of the Cyanophyceæ, and especially the Phæosporeæ (the conjugation of *Ectocarpus siliculosus* and the growth of *Sphacelaria*). As to the Rhodophyceæ, only short remarks, especially as to pores in their external covering, are given. The chief attention has been devoted, however, to the Bacillariaceæ, and the paper contains a good deal of new observations on the structure of gelatinous colonies, the structure of the cell and its protoplasmatic parts, and the auxospores. The systematical part will appear in a next issue. The paper is accompanied by eleven tables engraved in Germany.

The same volume contains a very interesting paper on the development of Rotifers, by the Director of the Sebastopol Zoological Station, Miss Pereyaslavtseff. This subject has been rather neglected until now, and M. Zaleski's paper on the history of the development of the *Brachionus urceolaris* could not be considered as a complete solution of the question. Miss

Pereyaslavtseff's method differs from most of those hitherto recorded: she does not select one or another phase of development as being the most important, but, placing several Rotifers and Lepadellæ under the object-glass of a microscope, she waited until one of them would lay an egg, and the development taking about three days from the beginning of the segmentation until the issue of the new animal from the egg, she observed it continually throughout the first thirty to thirty-five hours, with only short interruptions of two to three hours in the observation of subsequent phases. This method has of course its inconvenience by preventing sleep for two nights. It cannot be applied also to those Rotifers which live an errant life. These last do not survive confinement, and must be kept in watch-glasses until they lay their eggs, which last are then brought under microscopic investigation. Ten different species were studied in this way, and proved to undergo the same development, so that *Rotifer inflata* has been given as a type of the development of the egg. The stages are all figured in forty-eight drawings on a plate accompanying the memoir.

THE same volume contains, moreover, three papers on geology: one by M. Sintsoff, on Tertiary fossils from Novorossia, being a description of the following new species: *Anodonta unioides*, *Scrobicularia tellinoides*, *Ervilia minuta*, *Neritina pseudo-Grateloupana*, and several others formerly described; it also contains a list of the fauna of the intermediate Ponto-Sarmatian deposits of the region. Another, by M. Miklashevsky, gives some information on the Government of Tchernigoff; and a third, by M. Andrusoff, deals at length with the geology of the Kertch peninsula, and throws some new light on the confused geology of the Crimea. It appears from the author's researches that the Tertiary deposits of the Crimea may be subdivided into the following: (*a*) the true *Congeriæ* deposits (Pontri), consisting of iron-bearing clays, equivalent in West Europe to the deposits of Hidas and Arpad, and of limestones, sandstones, and marls equivalent to the *Dreissena triangularis* deposits of the Vienna basin, the *D. rostriformis* deposits of Ploeshti and the upper Siebenbürgen deposits; (*b*) the Ponto-Sarmatian intermediate group of the Kertch limestone, equivalent to the lower Siebenbürgen deposits; (*c*) the Sarmatian group, equivalent to the same of Roumania, Turkey, and Austria-Hungary; and (*d*) the Upper Mediterranean, equivalent to the *Leythakalk*, the *Badner Tegel*, &c. It would result from the above, and from what is known about South Russia and the Crimea, that during the older Miocene period both were a continent. Later on they were invaded by a sea penetrating from the west, and a narrow gulf limited in the south by the Yaiba hills, extended towards the East. During the Sarmatian epoch the subsidence continued, followed soon by an upheaval towards the end of that period, which upheaval led to the formation of narrow, less settled bays, like those we see now on the Kuban, at the place formerly occupied by the Sarmatian Gulf.

The Garner and Science Recorder's Journal is the title of a new scientific monthly, edited by Mr. A. Ramsay, and published by W. E. Bowers, Walworth.

A SOCIETY for the Advancement of Science has been formed in Bergen, numbering about a hundred members, the President being Dr. Danielsen.

MR. ARTHUR S. PENNINGTON'S Manual of British Zoophytes, to be published immediately by Messrs. L. Reeve and Co., will include not only the Hydroida but also the Actinozoa and Polyzoa found in Great Britain, Ireland, and the Channel Islands. The same publishers announce an illustrative volume of "Collections and Recollections of Natural History and Sport," by the Rev. G. C. Green.

WE have received the sixteenth annual Report of the Norfolk and Norwich Naturalists' Society, forming part 1, vol. iv. of the *Transactions*. Amongst the published papers is a presidential address by Mr. Francis Sutton, F.C.S., on the nitrification of soils by means of minute living organisms; and the same gentleman also contributes a most valuable paper on the varieties of sugar, natural and artificial; Mr. Horace B. Woodward, F.G.S., gives a paper on the earthquake of April, 1884, which made itself so severely felt in the counties of Norfolk and Suffolk; Mr. F. D. Power, who visited the Norfolk coast during the period of the autumnal migration, in his "Ornithological Notes from Cley and Blakeney," shows the wonderful influx of birds, some of which are generally supposed to be of the greatest rarity, which takes place on the eastern coast at that period; amongst Mr. Power's list of rarities occurs the blue-throated warbler, of which he says he must have seen from eighty to one hundred individuals, and the barred and ictarine warblers. Mr. J. H. Gurney, jun., also contributes some valuable facts bearing upon the vexed question of migration, for the observance of which the Norfolk coast is so favourably situated. Mr. Southwold furnishes his usual review of the herring fishery from the ports of Yarmouth and Lowestoft, from which it appears that the enormous number of 505,005,600 fish were taken by the fishermen using those two ports; the same gentleman also contributes a paper on the white-beaked dolphin, a Cetacean which has been procured on several occasions on the east coast. The "Ornithological Notes" of Mr. Hy. Stevenson, F.L.S., are in continuation of a series extending back for many years; and a most interesting memoir of John Scales is contributed by Prof. Newton, forming one of a series of memoirs of naturalists of whom the county of Norfolk has since the commencement of the present century produced so many notable examples.

AN experiment has recently been tried at the Inventions Exhibition Aquarium by Mr. W. August Carter with a view to discovering how far fish are prone to sleep. After close examination he found that amongst freshwater fishes the roach, dace, gudgeon, carp, tench, minnow, and catfish sleep periodically in common with terrestrial animals. The same instincts were found to actuate marine fish, of which the following were observed to be equally influenced by somnolence—viz. the wrasse, conger eel, dory, dogfish, wrasse bass, and all species of flat fish. Mr. Carter states that, so far as he can discover, the goldfish, pike, and angler fish never sleep, but rest periodically. Desire for sleep amongst fish varies according to meteorological conditions. Fish do not necessarily select night-time for repose.

THE specimens of fish collected for the International Ichthyological Museum, which is being formed by the National Fish Culture Association, now number about 500. They include many rare fish as well as those of extraordinary growth and formation. Many of the specimens are the finest to be seen in London, having been specially caught for the Association by qualified ichthyologists and agents. The work of setting the fish out in glass jars is now being commenced, and it is hoped to be able to exhibit them to the public shortly.

WE have received the third and concluding part of Dr. Hann's paper before the Berlin Academy of Sciences on the temperature of the Austrian Alps. The tables contain monthly and yearly averages of temperature for 382 stations in the Austrian Alps and the neighbourhood reduced to the true (24-hour) average, and to a thirty-year period (1851–80). Of the stations 277 were below 1000 metres, 88 lay between 1000 and 2000, while 17 were over 2000 metres in height. The data obtained at all these stations over a period of years are here worked up and arranged. The present part contains over 160 pages, so that the whole paper would make a considerable volume dealing with temperatures in the Alpine regions of Austria.

M. D'ABBADIE begs us to state that the earth-tremors observed in his apparatus (NATURE, vol. xxxii. p. 568) about two miles north of the Spanish frontier coincided with the many earthquakes in the south of Spain. There were no such phenomena in Egypt.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. L. C. Phillips; a Ring-tailed Coati (*Nasua rufa* ♂) from South America, presented by Lieut. W. F. Tunnard, R.N.; a Black Wallaby (*Halmaturus ualabatus* ♂) from South Australia, presented by Mr. R. E. Wootton Isaacson; a Javan Cat (*Felis javanensis*) from Java, presented by Capt. T. H. Franks; a Puma (*Felis concolor* ♂) from South America, presented by M. Rodolfo Aranz; two West Indian Rails (*Aramides cayennensis*) from Brazil, presented by Mr. J. C. Fraser; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, presented by Mr. H. D. Astley, F.Z.S.; a Silver Pheasant (*Euplocamus nycthemerus*) from China, presented by Mrs. James; three Robben Island Snakes (*Coronella phocarum*), a Hoary Snake (*Coronella cana*), a —— Elaps (*Elaps hygiæ*), a Reddish Pentonyx (*Pelomedusa subrufa*) from South Africa, seven Geometrical Tortoises (*Testudo geometrica*) from the Orange River, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, deposited; a Blue and Yellow Macaw (*Ara ararauna*) from Trinidad, received in exchange; eight Summer Ducks (*Œx sponsa*, 4 ♂ 4 ♀) from North America, purchased; a Bennett's Wallaby (*Halmaturus bennetti* ♀), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, OCTOBER 18-24

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 18

Sun rises, 6h. 31m.; souths, 11h. 45m. 9·9s.; sets, 16h. 59m.; decl. on meridian, 9° 47′ S.: Sidereal Time at Sunset, 18h. 48m.

Moon (two days after First Quarter) rises, 14h. 51m.; souths, 20h. 0m.; sets, 1h. 17m.*; decl. on meridian, 10° 27′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 37	11 51	17 5	9 43 S.
Venus	10 37	14 30	18 23	23 26 S.
Mars	0 6	7 38	15 10	16 38 N.
Jupiter	3 35	9 54	16 13	3 5 N.
Saturn	20 41*	4 49	12 57	22 17 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Phenomena of Jupiter's Satellites

Oct.	h. m.		Oct.	h. m.	
21	4 32	I. tr. ing.	22	4 10	I. occ. reap.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Oct.	h.	
20	0	Saturn at least distance from the Sun.
20	13	Saturn stationary.

GEOGRAPHICAL NOTES

THE work done by Lieut. Wissmann in his exploration of the Kassai River, the great southern tributary of the Congo, is second in importance only to the discovery of the Congo itself. It will seriously modify the conjectural geography of that part of Africa. He found the river to be of immense volume, and navigable from its junction with the Lulua. He found the Sankuru and the Lubilash to be one river, which, instead of flowing northwards to the Congo, turns westwards, and join the Kassai. As it approaches the Congo Kassai receives the great Koango, and enters the main river by the Kwamouth, after receiving the water of Lake Leopold. Thus the river which on Stanley's last map joins the Congo west of Stanley Falls cannot be the Lubilash, and, moreover, must be of no great length. This discovery of Lieut. Wissmann, along with that of the Mobangi by Mr. Grenfell, greatly increases the navigable waterway of the Congo system.

THE September number of *Petermann's Mittheilungen* has for its principal article the first part of an account of Paulitschke and Hardegger's journey to Harar, by Dr. Paulitschke. It is accompanied by a map of the districts traversed. The present instalment describes the circumstances under which the journey was undertaken, the preparations at Zeila, where the English consul was able to put the travellers in friendly communication with Abu Bakr, the Governor of Zeila, who gave them the most important help, and the details of the journey as far as Bussa, on the frontier of the Northern Gallas country. Dr. Schinz asks the question whether Namaqua-Land or Nama-Land is correct, and decides in favour of the latter. "Namaqua" is a Dutch corruption; the term "Nama" is applied to Hottentots in general, without any distinction of sex; "namaqua" is properly "namagu" or "namaga," the nominative and dative plural of "nama"; "qua" is therefore doubly wrong as a suffix, and Namaland is the proper term. M. Rabot writes on the Stor Börgefjeld in Nordland in Norway, and the usual literary and geographical news brings the number to a conclusion.

THE last number (Band xxviii. No. 29) of the *Mittheilungen* of the Geographical Society of Vienna contains a paper on the ethnic members of the western Somali and north-eastern Galla tribes, by Dr. Paulitschke, accompanied by a map; six letters from Dr. Lenz on his Congo expedition, and the first part of a paper by Herr Jülg on the erosive action of the sea on coasts; the bibliography of Africa for the last half year, and the usual notices of geographical works conclude the number.

M. BRAN DE SAINT POL-LIAS, who was sent on a scientific mission to Tonquin and Java, returned to France towards the close of September. He brought back with him numerous specimens of the flora and fauna of the districts through which he travelled.

THE chief geographical societies in Germany have resolved to erect a monument to the late Dr. Nachtigal on Cape Palmas, where he lies buried. It is intended to have it so large that it will serve as a landmark to seamen.

THE Godeffroy Museum at Hamburg, illustrative of the natural history of the South Sea Islands, has been sold to the Ethnographical Museum of Leipsic.

THE GREAT OCEAN BASINS[1]

I.

THE ancients, down to the time of Aristotle—and most of them for a long time afterwards—regarded the earth as a great plain surrounded on all sides by the mighty, deep, gently-flowing stream of the ocean.

In the geography of the Homeric age there was not supposed to be any communication between the Mediterranean and this all-encircling ocean river. When, in consequence of the excursions of the Phœnicians, the communication through the Pillars of Hercules became known, ideas respecting the outer sea gradually changed. At first, curiously enough, the Atlantic Ocean was regarded as muddy, shallow, and little agitated by the winds—a belief apparently associated with the supposed subsidence of the legendary island of Atlantis. The world, as known to the ancients down to about 300 years before Christ, is represented in this map of Hecatæus.

There seems to be no doubt that the spherical form of the earth was known to some philosophers even before the time of Aristotle—the proof that the earth is a sphere being indeed easy to minds that had received a mathematical training—but these have been few in all ages, and an idea so directly opposed to the apparent evidence of the senses could only be expected to win its way with difficulty. Indeed, at the present day the majority of even educated people are unable to give any reason for their belief that the earth is a sphere, other than that navigators are now in the habit of sailing around it.

[1] Lecture delivered at the Aberdeen meeting of the British Association by Mr. John Murray, Director of the *Challenger* Reports.

However, we find that Erathosthenes, Posidonius, and other learned Greeks, who flourished between one and two centuries before our era, were in possession of ideas concerning the figure and position of the terrestrial globe which do not differ materially from those of the modern geographer. They had considerable knowledge of the great wide sea, a clear perception of the diurnal recurrence of the tides, of their monthly cycles of variation, and correctly ascribed these changes to the influence of the moon. They speculated on the circumnavigation of the globe, and thus anticipated by many centuries the project of Columbus of sailing direct from Spain to the Indies.

During the century immediately preceding the Christian era, and during the dark and middle ages, there was a large acquisition of information with respect to the superficial extent of the ocean. But, when we look back on the history of knowledge concerning our planet, there is to be found no parallel to the impression produced in men's minds and conceptions by the discovery of America, and the circumnavigation of the world, a few years later, by Magellan and Drake. The influence of these events and the great ideas associated with them, can be traced throughout the literature of the Elizabethan period; Shakespeare appears to have had the mental picture of the great, solid, floating globe continually before him. His spirit seemed

> ". . . . blown with restless violence round about
> The pendant world."

To the great mass of people the circumnavigation of the globe was the practical demonstration that the earth was swung in space, supported alone by some unseen power; it was the conclusive proof of its globular form—a fact which must be regarded as the fundamental principle of all scientific geography.

The rage for geographical exploration which set in after the discovery of America brought the phenomena of the ocean into greater prominence, but the science of the sea can hardly be said to have commenced till the seventeenth century, when Hooke and Boyle undertook their experiments as to the depth of the sea and the composition of ocean water; and several naturalists gave descriptions of the animals and plants inhabiting the shallow waters surrounding the land. During the eighteenth century there was again a large acquisition of knowledge concerning the ocean, for the navigator was busy with the study of the winds, currents, and tides; while the two Rosses with other explorers and scientific men made most praiseworthy endeavours to investigate the greater depths of the sea during the first half of the present century.

The vast abysmal regions of the great ocean basins, however, lay all scientifically unexplored, when about twenty years ago their systematic examination was undertaken by expeditions sent forth by our own country and by the Governments of the United States, Germany, Italy, France, and Norway.

It is not easy to estimate the relative importance of the events of one's own time, yet in all probability the historians of the reign of Victoria will point to the recent discoveries in the great oceans as the most important events of the century with respect to the acquisition of natural knowledge, as among the most brilliant conquests of man in his struggle with nature, and doubtless they will be able to trace the effect of these discoveries on the literature and on the philosophic conceptions of our age. A mantle of mystery and ignorance has been cleared away from the eleven-sixteenths of the earth's surface covered by the ocean, and in its place we have much definite and accurate knowledge of the depths of the sea. The last of the great outlines showing the surface features of our globe have been boldly sketched; the foundations of a more complete and scientific physiography of the earth's surface have been firmly laid down.

This evening we will endeavour to pass in review some of the chief phenomena of the great ocean basins, and attempt to bring before you some of the more important results arrived at by the many distinguished men who have been engaged in oceanographical researches during recent years.

If it be remembered that the greatest depth of the ocean is only about five miles, and that the height of the highest mountain is likewise about five miles above the level of the sea, while the globe itself has a diameter of 8000 miles, the comparative insignificance of all the surface inequalities of the earth is at once forced on our attention. A circle 66 feet in diameter having on its surface a depression of one inch; or a globe one foot in diameter, with a groove on its surface one-sixtieth of an inch in depth, would represent on a true scale the greatest inequality, of mountain height and ocean deep, on the surface of the earth. Misconceptions often arise, and erroneous conclusions are frequently arrived at when these proportions are not rigidly borne in mind. But, unimportant as these surface features may appear when viewed with reference to the diameter of the earth, or to the superficial area of an ocean several thousand miles in extent, still to the geologist and physical geographer the elevations and depressions, foldings and dislocations, vertical and lateral, which form these inequalities are truly gigantic, immense, profound; and the more they are studied the more do they appear to be the result of changes taking place in a very definite and orderly manner in the course of the earth's developmental history.

Allow me to direct your attention to the maps representing hemispheres of the earth drawn in equal surface projection. The continental land of the world is coloured black, the abyssmal regions are coloured red, and between these two there is a border or transitional area which is uncoloured.

You will observe that the dark-coloured masses of continental land are, at some one point, more or less closely connected with similar masses; there is usually a place where adjacent masses are not separated by oceans of very great depth. A traveller might almost journey from any one point in these regions to any other without once losing sight of land. If an exception must be made to this statement it is in the case of New Zealand and the Antarctic Continent, for the *Challenger's* dredgings, which brought up masses of schist, gneiss, granite, sandstone, and compact limestone along the borders of the ice-barrier, show beyond all doubt that there is a mass of continental land at the south pole, but, since it is buried beneath perpetual snow, its exact extent is a matter of conjecture.

The surfaces of the continents are everywhere cut into cliff and gorge, mountain and valley, and are continually undergoing a process of disintegration. Water, frost, ice, sudden changes of temperature, are ever tearing the solid rocks to pieces, rivers are transporting the fragments down to the ocean, or carrying away the solid earth in solution; the bulk of this material is deposited in the areas bordering the continents—the uncoloured areas on the maps—there to form rocks which may once again become dry land. Sooner or later the whole of the continents would in this way be reduced below the level of the waves, were not other forces at work producing elevation. Such forces there are, and they are probably more potent than the disintegrating and transporting forces, since there are many reasons for believing that there is now more dry land than at any other period of the earth's history.

The continents have an average height of about 900 feet above the level of the sea; they may be regarded as elevated plateaus occupying five-sixteenths of the earth's surface.

The abysmal regions of the earth, represented by the red colour on the maps, occupy eight-sixteenths, or one-half of the earth's surface, and have an average depth of three miles beneath the surface of the waves. The greatest depths in the Pacific are to the south and east of Japan, where there are abysses of over five miles; and in the Atlantic the greatest depth is to the north of the Virgin Islands, where there is a depression of a little over four miles.

From all we yet know of these abysmal areas they have not a diversity of peak, gorge, mountain, and valley comparable to those which are met with on land; they are fundamentally areas of deposition. It is true that the close soundings of telegraph engineers appear to show that in some cases there may be steep cliffs in the shallower depths of the ocean in volcanic areas; yet the general aspect of the abysmal regions must be that of vast undulating plains, interrupted here and there by huge volcanic cones, with slopes at a very low angle. When these cones rise above the surface they form volcanic oceanic islands. When they rise nearly to the surface they are, in the tropics, often capped by coral atolls; but many of them are far beneath the waves and are covered by a white mantle of carbonate of lime—the dead shells and skeletons of pelagic and deep-sea organisms.

The land of the oceanic islands is of small extent and differs widely in the nature of the rocks, as well as in the character of the terrestrial and marine fauna and flora, from the continents and continental islands. There has not been found in the abysmal areas any land made up of gneisses, schists, sandstones, or compact limestones; nor have fragments of these sedimentary formations been found in the erupted rocks of the volcanic islands, though they are frequent in the volcanic eruptions on the continental areas.

We may, indeed, compare the oceanic islands to the fresh and salt water lakes scattered over the surface of the continents and cut off from direct communication with the ocean. These lakes differ as much from the waters of the ocean as do the oceanic islands from the land of the continents.

The surface of the earth may then be divided into three great regions—the abysmal area, occupying, so to speak, the bottom of the basins, covering one-half of the earth's surface; a border region occupying, so to speak, the sides of the basins, covering three-sixteenths of the earth's surface; and lastly, the continents which cover five-sixteenths of the earth's surface. The average height of the elevated plateaux of the continents above the submerged plains forming the abyssmal regions is fully three miles.

When we pass to a consideration of the water of the ocean, which fills these great hollows of the earth, it is essential to take account of the superincumbent atmospheric ocean, which everywhere rests on its surface, for the composition of the ocean water, the currents, the distribution of salinity, density, temperature, and even that of deep-sea deposits, are largely determined by the movements of the atmosphere.

One of the most important parts played by the ocean in the economy of the globe is to bring about a more equable distribution of temperature by the winds which blow from it over the land and by means of the oceanic currents that are originated and maintained by the winds.

From the smallness of the *daily* variation of the temperature of the surface of the sea, which are shown by the *Challenger* observations, as discussed by Mr. Buchan, not to exceed 1° F., as compared with the large daily variation on land, there result directly the land and sea breezes with all their beneficial consequences. Similarly from the small *yearly* variation of the temperature of the sea, as compared with the very large variation of the temperature of the land surfaces of the globe, result those great annual changes of the prevailing winds—the most important of which, with respect to widespread climatic effects, is the summer monsoon of the Europeo-Asiatic continent.

But the most important, as well as the most direct, effect of the unequal distribution of temperature over the surfaces of the oceans and continents, is an unequal distribution of atmospheric pressure varying more or less with season. On the one hand, in a particular season we see a portion of the earth's surface with atmospheric pressure much less than in surrounding regions, and as long as the low pressure is maintained the winds from the regions all around continue to blow inwards upon it, bearing with them the temperatures and humidities of the regions from which they have come. On the other hand there are other parts of the earth's surface with atmospheric pressure much higher than in adjoining regions, and, as this state of things continues with little variation throughout the year, the winds blow out in all directions towards surrounding regions. Of this two illustrations may be given.

During winter months atmospheric pressure is much less in the North Atlantic about Iceland than it is all round, and towards this area of low pressure the winds from the surrounding continents blow vorticosely, thus determining the winter climates of the more important countries of the world. Over Canada and the United States the winds are north and north-westerly, by which the rigours of winter are intensified; but in Western Europe the prevailing winds are south-westerly, and, as these winds bring with them the warmth and moisture of the Atlantic, the winter climates of Western Europe contrast strongly, latitude for latitude, with those of the eastern states of America.

Again, pressure is higher in the Atlantic between the north of Africa and America than it is all round, and out of this anticyclonic area of high pressure observations show that the winds blow in all directions towards surrounding regions where pressure is less. To the westward of North Africa the prevailing winds are northerly and north-westerly, but on the south side of this anticyclonic region the winds are easterly, and on the west the winds are southerly.

Owing to these very different winds, and the oceanic currents to which they give rise, the temperature of the sea is much higher off the coasts of Florida than it is off the coasts of Africa in the same latitudes. The effect of these differences is recognisable in the distribution of marine life and coral reefs, and, consequently, of the deposits at the bottom of the sea.

Since over this anticyclonic area, and similar ones in the South Atlantic, North Pacific, and in a less marked degree in the South Pacific, atmospheric pressure remains high throughout the year, notwithstanding the outflow of wind all around from them, it follows that aërial upper currents must flow towards these high pressure regions accompanied by a slow downward movement of the air through their central portions. Now, as observations show that in such circumstances the sky is clear, the air dry, the rainfall small, and the evaporation large, it follows that over these parts of the great oceans, where atmospheric pressure is higher than all around, the rainfall is very far from being sufficient in amount to make good the loss arising from evaporation—a consideration which has important bearings on the difficult question of oceanic circulation.

As in these anticyclonic regions in the great oceans there is opened up a direct communication between the upper regions of the atmosphere and the surface of the sea, by means of the descending aërial currents, it is interesting to ask whether this fact may not have some connection with the volcanic and cosmic dust found in the same regions in the deep-sea deposits; especially is this interesting in connection with recent speculations as to the presence of these substances in the higher regions of the atmosphere.

In thus indicating the positions of the high-pressure areas, and of the winds that blow out from and around them over the great oceans, we have at the same time traced the courses of the great oceanic currents and the positions of the Sargasso seas, for the winds everywhere determine and control the movements of the surface waters.

The moisture taken up from the sea surface by the winds—leaving the water salter than before—is borne to the land and condensed on the mountain-slopes. Eventually this water gathers off the land, passes by rivulet, stream, and river down again to the ocean, bearing along with it a burden of earthy matters in solution. In this manner the ocean has most probably become salt in the course of ages. The water of the ocean now contains, it is almost certain, a portion of every element in solution. Many of these are present in exceedingly minute traces. They are detected either in the sea water or the evaporated-down residue by spectrum analysis; in the copper of ships' bottoms, which have withdrawn them by chemical decomposition; or, again, in the ashes of sea-weeds and marine animals, which, during life, exert a selective influence upon the surrounding water.

(A diagram was exhibited showing the average composition of sea salt.) The individual salts present in sea water are, of course, constantly interchanging their metals and acid radicals, so that it is impossible to say authoritatively what is the precise amount of the respective chlorides and sulphates of sodium, potassium, calcium, and magnesium actually present. But it has been shown by hundreds of laborious and most delicate experiments that the actual ratio of acids and bases in sea salts—that is, the ratio of the constituents of sea salts—*is constant* in waters from all depths, with one very significant exception—that of lime—which is present in slightly greater proportion in deep water.

The total amount of dissolved salts in the ocean would, it is calculated, if extracted, form a pavement 170 feet thick over the entire sea-bed, and of this amount 1¼ inches would be composed of pure carbon, chiefly present as carbonic acid in the carbonates.

On account of the constancy in its composition the determination of any one of the constituents of sea salt—chlorine, for instance—gives the datum for calculating the salinity—that is, the proportion of total salts to the water in which they are dissolved; though determinations of this nature are more conveniently made by observations of density by means of the hydrometer. (A map was exhibited on which Mr. Buchanan has shown the results of his laborious investigations in this direction.) An examination of this shows that the surface water of the ocean is freshest—that is, contains the least salt—at the poles and in the equatorial belt of calms. In the east of the Indian Ocean a change of the monsoons brings about a great change in the salinity of the surface water. The centres of the great systems of oceanic currents produced by the trade winds are the areas of highest salinity in the open ocean; yet here the water is not so salt as in some enclosed seas situated in areas of great evaporation, as the Mediterranean, and especially the Red Sea and Persian Gulf, where the saltest water is found and where a regular circulation is kept up by the outward flow of the denser water. The salinity of the deeper waters is considerably below the average at the surface in the open ocean, especially in the Atlantic.

In the equatorial regions the surface water of the ocean has occasionally a temperature of 85° or 86° F., and the normal temperature in tropical and sub-tropical regions ranges from 60° to 80°. This warm water is, however, a relatively thin stratum on the surface, the great mass of the ocean consisting of cold water—water of 45°, 40°, and of even a much lower temperature. At a little over half a mile of depth in the tropics the water has a temperature of 40°, and at the bottom it is still colder—ice-cold indeed. The ooze which is dredged from the bottom beneath the burning sun of the equator is so cold that the hand cannot be held in it for any time without great discomfort.

In the open ocean the temperature usually decreases with the depth, the coldest water being found at the bottom; but sometimes there are limited areas where the temperature remains uniform for a mile or half a mile above the bottom. This has been shown to depend on the existence of barriers to free circulation, which exist on the floor of the ocean, and cause in a measure a resemblance to the conditions which are so marked in many partially enclosed seas, shut off by submarine barriers from general oceanic circulation, where the temperature is uniform, it may be, from a few fathoms below the surface to the bottom—for instance, in the Mediterranean and Seas of the Malayan Archipelago.

The low temperature of deep ocean water was acquired at the surface in high latitudes, chiefly in the high latitudes of the southern hemisphere. The salt warm water of the tropical regions, which is driven in relatively rapid currents along the eastern shores of South America, Africa, and Australia by the action of the prevailing winds, on reaching a southern latitude of 50° or 55° sinks on being cooled, and spreads over the floor of the ocean. A similar circulation takes place in the northern hemisphere, though modified in many ways by the peculiar configuration of the land: for instance, it is almost certain that the cold water at a temperature of 30° F., which occupies the deeper part of the Norwegian Sea beyond the Wyville-Thomson Ridge, is the dense surface water of the Atlantic, which becomes cold and sinks as it passes northward in the extension of the Gulf Stream. Again, the relatively low temperature found on the eastern coasts of Africa and America seems largely due to the cold deep water which is drawn up to supply the place of the warm surface water driven forward by the trade winds.

While surface currents, both warm and cold, have at times considerable velocities, there is no evidence that rapid currents exist anywhere in the great deeps, on the contrary, the movements must be extremely slow and massive in character; the only exception seems to be on the crests of some ridges at moderate depths between volcanic islands or other similarly situated places.

Through the constant circulation in the ocean the gases of the atmosphere, which are everywhere absorbed at the surface of the sea according to the known laws of gas absorption, are borne down and thus enable myriads of living organisms to carry on their existence at all depths. The nitrogen remains at all times and places nearly constant, but frequently the proportion of oxygen is much reduced in deep water, owing to the processes of oxidation and respiration which are there going on.

The absorbed carbonic acid plays a most important and intricate *rôle* in the economy of the ocean, owing to its tendency to reduce normal carbonate of lime and magnesia to solution in the form of bicarbonate; and to the rapid interchanges to which it is subject in consequence of vital processes. It probably receives large additions from the bottom of the ocean, as an after-product of volcanic eruptions, and through the respiration of animals.

It is often supposed that hydrochemical actions go on with much greater activity in the deep sea where there may be a pressure of four or five tons on the square inch, but, while it would be convenient to assume it, there is no sufficient evidence that such is the case. The disintegrations, decompositions, and depositions which take place in the deposits are all similar to those which take place in shallow water or on land, and any chemical peculiarities occurring in inorganic or organic substances in great depths are probably due chiefly to the low temperature, almost perfect stillness, and the absence of light: for, although it may be admitted that some rays descend to much greater depths in the sea than is usually supposed, yet we must at present believe that none of them reach the greatest depths. The absorbed gases are probably but little affected by the great pressure of the superincumbent water, for in this connection it should be remembered that water is but little compressible; any substance which will sink to the bottom of a tumbler of water will in time sink to the bottom of the deepest ocean; this is true at least for all substances which are more compressible than water itself. The compressibility of water cannot, however, be neglected in oceanographical questions. In very great depths the lower layers are considerably compressed; for instance, in an ocean five miles deep, were the action of gravity suddenly to cease, the water would rise about 500 feet above its present level from expansion, a height sufficient to submerge nearly all the habitable land of the globe.

It remains to mention the investigations, which have recently been made, as to the change of level of the ocean, owing to the attraction of the masses of continental or other land—such, for instance, as that of the Himalayas for the water of the ocean to the south, by which the level of the Southern Indian Ocean is lowered some hundred feet; the bearing of this on the apparent elevation or submergence of land along coast-lines is evident, for the level of the sea, to which we refer all heights and depths, cannot be regarded as much more stable than the solid land itself.

(*To be continued.*)

NEW PROCESS OF LIQUEFYING OXYGEN[1]

LIQUID ethylene, the preparation and use of which I have already explained, shows, at its boiling point under the pressure of the atmosphere, a temperature of at least −103° C., only some 10° from the critical temperature of oxygen (−113° C.). It is understood how in the expansion of compressed and cooled

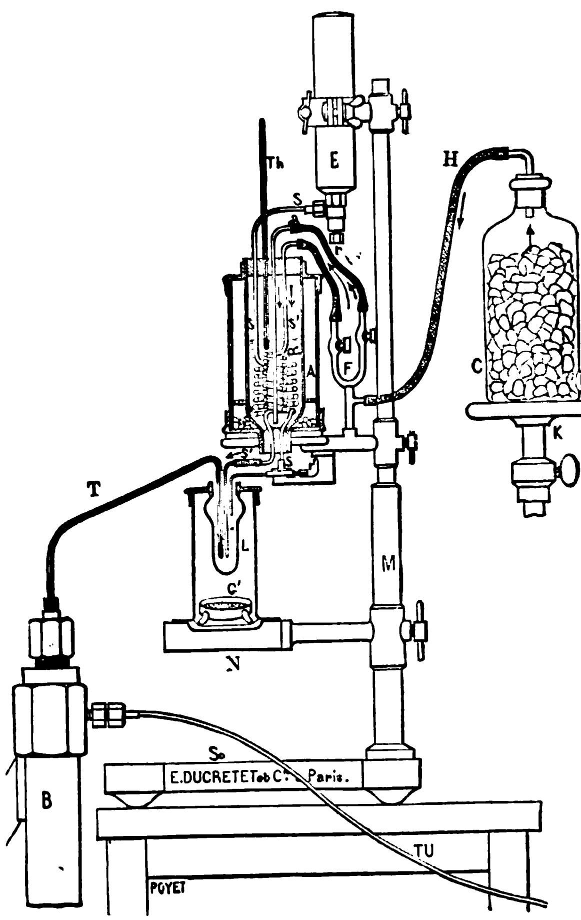


FIG. 1.

oxygen in the boiling ethylene the lowering of the temperature resulting from the expansion enabled me to establish "a tumultuous ebullition continuing an appreciable time." In

[1] From the *Journal de Physique*. By M. L. Cailletet. The illustrations have been kindly lent by MM. Ducretet et Cie, the manufacturers of M. Cailletet's apparatus.

regulating the expansion so as to maintain a certain pressure in the tube, the oxygen is seen for some time completely liquefied.

When by means of the air-pump the evaporation of liquid ethylene is accelerated, as was done by Faraday with protoxide of nitrogen and carbonic acid, its temperature is reduced much below the critical point of oxygen.

With a view to avoiding the inconveniences and complications involved in the necessity of working *in vacuo*, I indicated liquid *formène*, which with the greatest ease achieves the liquefaction of oxygen and nitrogen. Notwithstanding these advantages, in consequence of the perfection to which I have recently brought the preparation and management of ethylene, it has seemed to me that this substance should be preferred to formene, and so, by means of boiling ethylene in open vessels, I have succeeded in obtaining a temperature sufficiently low for the complete liquefaction of oxygen.

The preparation of ethylene by means of sulphuric acid and alcohol is frequently impeded by the frothing of the material, terminating the experiment before the gas has been completely liberated. The admixture of sand, recommended by Wöhler, does not always serve to counteract this frothing, but I have found the addition of a small quantity of vaseline efficacious in this respect.

The material I work with consists of 400 grammes of alcohol, 2000 grammes of sulphuric acid, and 15 to 20 grammes of vaseline. This is warmed in a glass globe, of 5 or 6 litres capacity, over a burner in the usual way. The gas is washed in two large flasks of caustic soda, and then collected in a water gasholder. By means of a mercury pump the ethylene is dried by passing through a flask of sulphuric acid and condensed in steel bottles having a screw tap.

Fig. 1 represents the apparatus I made use of to liquefy oxygen by the rapid evaporation of ethylene by means of a current of air or of refrigerated hydrogen. The liquid ethylene is inclosed in the bottle E, which is fixed to a vertical support, with its mouth directed downwards, and is in communication with a copper worm, S S, of 3 mm. to 4 mm. in diameter, closed at its lower extremity by a screw cock, *r'*. After the worm has been cooled to – 70° by means of chloride of methylene in the manner I shall explain further on, the ethylene there accumulating possesses at this temperature but a weak tension, and it may therefore be run without sensible loss into the test-tube, L, when the cock, *r'*, is opened. This new arrangement I have adopted for ethylene and formene allows the liquefied gas to be cooled as well as though the whole reservoir containing it were of the same temperature as the worm.

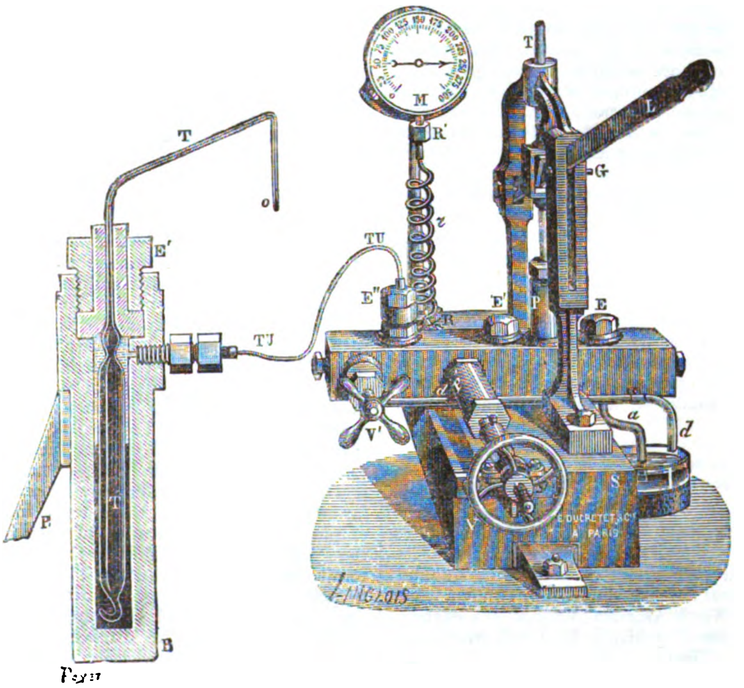


FIG. 2.

The glass test-tube L is arranged in a vessel containing, air dried by means of pumice and sulphuric G', and in this way hoar-frost is prevented from being deposited on the refrigerated sides.

When the ethylene has been received in the test-tube L, its evaporation is accelerated by passing through it a current of air, or, still better, of hydrogen dried by its passage in the vessel C, containing chloride of calcium, and cooled in the worm S'.

The two worms in which the air and the ethylene circulate are plunged into chloride of methylene which is rapidly evaporated by means of dry and cool air, and in this way a temperature of – 70° is obtained.

Fig. 2 shows the arrangement of the oxygen apparatus and the compression pump. When the tube T*o* is plunged into the ethylene, the evaporation of the latter is accelerated by gently opening the cock F, and blowing on to it the air or hydrogen cooled in the worm S'.

The pump is then brought into action, and the oxygen resolves into a colourless, transparent liquid, separated from the gas surmounting it by a perfectly sharp meniscus.

By means of a hydrogen thermometer, the construction of which I shall shortly explain, I have measured the temperature of the ethylene, which in one of my experiments was found to be – 123° C. By dint of certain modifications effected in the apparatus I am in hopes of achieving a still lower temperature.

Altogether, I have proved that by quickening the evaporation of the ethylene by means of a current of air or hydrogen cooled to a low degree, its temperature is lowered much under that of the critical point of oxygen, and that in such a medium the oxygen liquefies most easilyr[1]

This experiment is so easy of accomplishment, that the practice of it may be commenced at once in laboratories, and be repeated in public lectures.

The apparatus I have described has been constructed with great care by M. Ducretet, and I have to thank M. Jamin for kindly permitting me to perform the expeiiments in the Physical Laboratory of the Sorbonne.

[1] M. E. Sainte-Claire Deville, engineer to the Gas Company of Paris, and son of my illustrious master, has now for some time, by my advice, been studying the problem of lowering the temperature by means of the rapid evaporation of chloride of methylene, and has established that, by sufficiently cooling the injected air, temperatures varying from –23° C., to –72° C. may be maintained nearly constant for several hours.

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

V. *On an "Index-Collection" for small Zoological Museums in the Form of a Genealogical Tree of the Animal Kingdom*

EVEN in the smallest museums it is for many reasons difficult, and often impossible, to arrange the representatives of the various groups of animals in such a way as to bring out clearly their mutual relations. Hence arises the need of an "index-collection" in which each group is represented by one or more specimens so arranged as to indicate as accurately and clearly as possible the affinities of the groups they typify. The form which naturally suggests itself as the most suitable for a small type-collection of the kind indicated is that of a solid phylogenetic diagram or "genealogical tree."

An excellent form of "diagram in three dimensions" for lecture purposes has been devised by Haddon; the model I have recently had constructed appears to me to be more suitable for permanent use in a museum.[1]

It consists of a vertical wooden rod about 3 feet 6 inches in height, representing the main line of descent from Protozoa to Vertebrata; from this spring, at various levels, branches representing types which lie off the direct line; these have in most cases an upward direction, but are directed downwards from their point of origin in the case of degenerate groups. At appropriate points on this framework are placed either actual specimens or models of one or more examples of each group.

As the Vertebrata inevitably take up the largest share of space in a museum as well as of public attention, each of the classes of that group is represented on the model, while in the case of Invertebrata one or two examples only are given to each type or sub-kingdom.

For each group—type or class, as the case may be—a label is provided, giving (*a*) the name of the group, (*b*) the name of the specimen or model serving as an example of it, and (*c*) the place in the Museum where representatives of the group are to be found.

A more correct mode of construction for a model of this kind would be to make the branches of such a length as to bring the ends of all of them, and consequently the specimens they support, to one level; advance of organisation would thus be indicated, not by height above the ground, but by distance from a centre. But such a model would be far less convenient than the form I have adopted.

VI. *On the Size and the External Sexual Characters of the New Zealand Octopus* (*O. maorum*, Hutton)

In his work on the octopus,[2] as well as in his more recent pamphlet, "Sea-Monsters Unmasked,"[3] Mr. Henry Lee states that the largest British specimen he had examined had arms 2½ feet long; that examples with arms of about 4½ feet had been found in the Mediterranean; but that the largest specimens known were those found on the coast of North America (Vancouver's Island), one of which had been measured by Mr. J. K. Lord, who found the length of one arm to be 5 feet.

From this it would seem not to be generally known, even by naturalists, that a species of octopus is very common on some parts of the coast of New Zealand, and notably in Dunedin Harbour, the average size of which is fully equal to, while it occasionally exceeds, that of the specimen from Vancouver's Island just referred to.

I have recently had mounted for this Museum a female *Octopus maorum*, the longest arm of which is 4 feet 3¼ inches, but larger specimens have been frequently seen by my assistants and myself. The following are the dimensions of the largest individual—a male—which we have actually measured:—

		Feet	Inches
Length of body and head		1	1
Diameter of body		0	8
Length of arms—			
1st pair	Left	5	5
	Right	5	3
2nd ,,	Left	4	10
	Right	5	2
3rd pair	Left	4	7
	Right (hectocotylised)	2	11
4th ,,	Left	4	3
	Right	4	8
Diameter of largest suckers (on 1st or "dorsal" arms)		0	1¾

[1] The model referred to was exhibited and described in detail at a meeting of the Otago Institute on June 9.

[2] "The Octopus; or, the 'Devil-Fish' of Fiction and of Fact." (Chapman and Hall, 1875.)

[3] One of the "Handbooks" of the Fisheries Exhibition, 1883.

Besides the hectocotylisation of the third right arm, there is a striking difference between the two series which I have not seen mentioned. In the male the suckers simply undergo a gradual diminution in size in passing from the prominal to the distal end of the arm; they retain their characteristic form, and are easily counted up to about half an inch of the tip. In the female, on the other hand, the suckers become quite indistinct for several inches, and in some cases for fully a foot, from the extremity of the arm, taking on the form of small tubercle-like elevations. As an instance of this difference I may mention that in a male specimen with the first left arm 4 feet 2½ inches in length, from 292 to 319 suckers could be readily counted on each arm; while in a female with the corresponding arm of the same length, only 90 to 115 could be counted on each arm, the distal portions bearing tubercles so crowded as to make it practically impossible to count them.

T. JEFFERY PARKER

Dunedin, N.Z., June 19

THE BRITISH ASSOCIATION

SECTION H—ANTHROPOLOGY

Prof. W. Turner read a paper on *The Index of the Pelvic Brim as a Basis of Classification.*—That the inlet to the human pelvis presented variations in outline and in the proportions of its conjugate and transverse diameters has been recognised since the publication by Vrolik in 1826, and by M. T. Weber in 1830, of their important memoirs on the pelvis in certain races of men. In 1866 Zaaijer, of Leyden, in his study of the pelvis in women of Java, recognised differences in form in women of the same race, and he expressed these differences numerically, taking the transverse diameter as = 100, and then multiplying the conjugate diameter by 100, and dividing by the transverse; the numeral so obtained is the index of the pelvic brim, or "pelvic index." By applying this method to the pelvis in different races of man, a classification of races based on the index of the brim may be framed. In carrying out this method the male pelvis should especially be studied, as in women the pelvis, for sexual reasons, does not present such wide divergences in the form of its inlet as in men. To give precision to the classification, it will be advisable to employ special terms, and in order as far as possible to bring these terms into accordance with those employed in the classification of crania based on differences in the relations of the length to the breadth of the skull, Greek terms will be employed. Thus dolichopellic will signify a pelvis the conjugate diameter of which is longer than the transverse, or closely approaching to it; platypellic, a pelvis in which the transverse diameter greatly exceeds the conjugate; and mesatipellic, a pelvis in which the transverse diameter is not so greatly in excess of the conjugate. Owing to the comparatively limited number of pelves in the different races of men which have been measured, either it may not be possible to fix definitely at present the numerical limits of each of these groups; but the following were adopted provisionally by the author:—dolichopellic, a pelvis with brim index above 95; platypellic, one with brim index below 90; and mesatipellic, a pelvis with a brim index between 90 and 95, both inclusive. The number of pelvic measurements from which the author drew his conclusions were comparatively few, but from these it would seem that the dolichopellic division contains Australians, Bushmen, Hottentots, Kaffirs, and Andamanese; whilst Negroes, Tasmanians, and New Caledonians are mesatipellic, and Europeans, Chinese, and probably American Indians belong to the platypellic group. When a pelvis has dolichopellic characters it approximates in the relations of its transverse and conjugate diameters to the form of the pelvic brim met with in mammals lower than man; and in the dolichopellic Australians, Bushmen, Kaffirs, and Andamanese, the length of the sacrum is on the average greater than the breadth, and this also is an animal character.

Mr. W. F. Stanley exhibited a portable scale of proportions of the human body. The instrument is a small thin scale or rule of ivory, about three inches in length, and divided on each edge of the two faces by lines which represent the proportions of the human body, the male on the one side, and the female on the other. The opposite edge to that on which the proportions are shown is divided into 100 parts in the same space as the height of the body. The object aimed at by the use of this scale is to compare any person, or statue, or photograph with the model of perfect human form given by John Marshall, or to determine the parts of the body in proportional decimals of the whole, to facilitate description.

Mr. J. Theodore Bent read a paper on *Insular Greek Customs* as seen in the islands of the Ægean Sea. He proceeded to notice the modern Greek customs concerning birth and childhood, comparing them with ancient ones, among the customs described being that of fate-telling, and the notions regarding the deleterious influence of Nereids on children. The customs connected with death and burials were next described, and shown to be the same as those of the Greeks 2000 years ago. Some instances were given of the poetry of death-wails, and it was shown that the belief in Charon and Hades existed still in the islands of the Ægean Sea. Among the other customs described in the paper were feasts for the dead, which could be traced to a remote antiquity, and the ancient belief in vampires still survived. Instances were also given from agricultural life of the identity between ancient and modern customs, including the ceremony gone through before sowing of seed, the use of skins for grain, the granaries in the ground, in the kind of agricultural implements used, and also in the names used for animals.

Gen. Pitt-Rivers explained the provisions of the Act of Parliament relating to the preservation of ancient monuments. The Act scheduled the most important and best-known ancient monuments in the country, and provided that these should be registered. and after their registration, although they remained the property of the owner of the land on which they were situated, and might be sold along with the land, could not be destroyed by the owners. There were also a vast number of minor monuments of great interest and value well worthy of being preserved. It was not proposed that the Government should meddle with these minor monuments. What he (Gen. Pitt-Rivers) had done with regard to these minor monuments was to endeavour to see all the principal gentlemen most interested in local archæology, and ask them to let him know when any injury was done to monuments in their district. In the Island of Lewis the agent of Lady Matheson had promised to assist him in every way he possibly could; and Dr. Aitken, Inverness, had promised to him to do the same thing; and he had received promises of a like kind from a number of other gentlemen. In his wanderings throughout the country in connection with the working of this Act of Parliament, he had found no owner of the monuments scheduled in the Act unwilling to put his monument under the Act because he wished to destroy it. The feeling of those who were unwilling to put their monuments under the Act had rather been that they considered they were quite as able and willing as the Government to preserve the monuments. What the State desired was to preserve the monuments in the hands of any owners into whose hands they might fall. In these days there was no knowing to whom land might belong now that the gospel of plunder was proclaimed, and it was desirable that there should be some sort of security that the monuments might be preserved hereafter. As the result of his wanderings in order to work this Act in England and Wales, about half of the owners of the scheduled monuments had voluntarily placed them under the protection of the Act. In certain cases the monuments were leased, and the proprietors refused to place them under the Act without compensation, which the Government could not give.

Miss A. W. Buckland read a paper on *American Shell-Work and its Affinities*. In this paper the attention of anthropologists was called to some remarkable works in shell recently discovered in mounds in various States of North America, as described by Mr. W. H. Holmes in a valuable contribution to the *Proceedings* of the Bureau of Ethnology, Washington. These shell-works consist not only of beads of various shapes and sizes, but also of celts, fish-hooks, chips, and other implements of war and the chase, bracelets, pins, crosses of various forms, and more particularly of masks and elaborately engraved gorgets, the ornamentation upon which seems to bear some religious or astronomical signification. From the fact that implements and ornaments of the same form are found in the islands of the Pacific, and that some of the peculiar symbols engraved upon the ancient American gorgets reappear slightly altered on shell gorgets in the Solomon and Admiralty Islands, and also on the great Japanese drum exhibited this year at the Inventions Exhibition, the author inferred that a commerce existed between the islands of the Pacific and the American continent prior to the Spanish conquest.

Mr. E. F. im Thurn read a paper giving an account of the red men about Roraima, in British Guiana. In the paper an interesting account was given of the journey to Roraima, the scenery being described, as well as the manners and customs of the natives. In some of the villages visited the natives had never previously seen white men, and the utmost excitement was caused by the arrival of Mr. im Thurn. The natives of the villages visited were repulsively ugly, and it was almost impossible to distinguish men from women by their dress. The native tribes lived in remarkable isolation from each other, and even the different families in the same village lived in remarkable isolation from each other. There were traces of the Stone Age to be found of high interest. Stones were shaped into adzes and wedges, and they were often made into forms of animals, or of whistles, and models of bottles, which the natives had seen. There was among these tribes a revival of the ancient art of making stone implements, though these implements were simply regarded as ornaments. The natives also made drawings of rocks, which were used as ornaments, and which were evidently imitations of the drawings seen on the actual rocks. Mr. im Thurn closed his paper with an account of a number of some very remarkable games played by the tribes for the amusement of the visitors, in which the movements of animals were imitated in dances.

Mr. J. W. Crombie read a paper entitled *A Game with a History*, which was really an exposition of the antiquity, universality, and signification of the well-known game of "Hop-Scotch," a term which is probably a corruption of "hop-score." The author commenced by pointing out that as children in their play generally imitate something they have observed to be done by their elders, and a game once introduced is handed down from generation to generation of children long after its original has ceased to exist, many innocent-looking children's games conceal strange records of past ages and pagan times; hence the importance of the study of this apparently frivolous subject is now fully recognised by anthropologists. The game of "Hop-Scotch" is one of great antiquity, having been known in England for more than two centuries, and it is played all over Europe under different names. Signor Pitré's solar explanation of its origin appears improbable, for, not only is the evidence in its favour extremely weak, but it would require the original number of divisions in the figure to have been twelve instead of seven, which is the number indicated by a considerable body of evidence. It would seem more probable that the game at one time represented the progress of the soul from earth to heaven through various intermediate states, the name given to the last court being most frequently Paradise or an equivalent, such as Crown or Glory, while the names of the other courts correspond with the eschatological ideas prevalent in the early days of Christianity. Some such game existed prior to Christianity, and the author considers that it has been derived from several ancient games; possibly the strange myths of the labyrinths may have had something to do with "Hop-Scotch," and a variety of the game played in England under the name of "Round Hop-Scotch" is almost identical with a game described by Pliny as being played by the boys of his day. The author believes that the early Christians adopted the general idea of the ancient game, but they not only converted it into an allegory of heaven, with Christian beliefs and Christian names, they Christianised the figure also; abandoning the heathen labyrinth, they replaced it by the form of the Basilicon, the early Christian church, dividing it into seven parts, as they believed heaven to be divided, and placing Paradise, the inner sanctum of heaven, in the position of the altar, the inner sanctum of their earthly church.

Mr. George Campbell, M.P., read a paper entitled *The Rule of the Road from an Anthropological Point of View*, in which he maintained that for all right-handed people the rule of going to the left hand in passing people was the most scientific and the most convenient. There was nothing, he maintained, to be said in favour of going to the right, and he held that the British rule should be maintained both for roads and for footpaths, and that we should give in to no right-handed innovation.

Miss Jeanie M. Laing read a paper on *The Modes of Grinding and Drying Corn in Old Times*. In some parts of Aberdeenshire are found the remains of the straw kilns that were used for drying corn before sending it to the mill. The kiln was conical in shape, joists called cabers were laid across, some distance from the ground, and above these were roughly-hewn sapplings called simmers; on the top of these was spread straw, and on the straw was laid the corn. A fire was kindled on the ground, and the heat therefrom dried the corn. A stone called a sparker was placed above the fire to catch the sparks, but in spite of this precaution the kiln sometimes took fire. At an early period corn was ground between two millstones, with an iron rod by way of a handle; this primitive mill was called a quern, and was generally turned by two women, as in Eastern lands. In later times querns were used for grinding malt.

Mr. A. J. Evans contributed a paper on *The Flint-Knappers' Art in Albania*, and exhibited some beautifully-worked gun-flints and strike-a-lights, partially cased in ornamented lead sheaths studded with glass gems.

Mr. W. M. Flinders Petrie read a paper on *The Discovery of Naukratis*, the remains of which city had been brought to light during the work of the Egypt Evploration Fund in the first half of this year.

Mr. Thomas Wilson read a paper on *A New Man of Mentone*, in which he described the discovery, in March, 1884, in one of the famous caverns at Mentone, of a skeleton, believed to belong to the Palæolithic age. The excavations were made during the winter of 1883-4 by M. Louis Julien, of Marseilles, and at his expense, aided by the advice of M. Bonfils, Curator of the Museum at Mentone. This cavern had been searched many times before, and about 9 or 10 feet in depth had been removed from the original surface, which, however, was plainly marked by a large piece of *brèche* which still adhered to the perpendicular side wall. The formation of the floor of the cavern and the process of its filling up presented all the usual evidences of human occupation and industry: charcoal, burnt earth and ashes, hearthstones, split and broken bones of animals (estimated to the number of 15,000 pieces), flint instruments, chips, nuclei, &c., &c., were found in sufficient number, quantity, and distribution to indicate an indefinitely long occupation. No morsel of pottery was found, nor were any of the stone implements polished. At the depth (from the original surface) of 8 metres 40 centimetres was found the skeleton of this "new man of Mentone." He was laid on his back with his limbs extended, and had for funeral equipments three large chips of flint (*éclats de silex*), 6 or 7 inches long and 2½ inches broad, in the form of the largest scrapers, placed one on each shoulder like epaulettes, and one on the brow. It was evidently an interment. This became more evident when it was found that the body was placed in a sort of natural vault or tomb, formed on one side by the wall of the cavern, and on the other by an immense block of stone with an overhanging edge, which reached to a line perpendicularly over the centre of the skeleton. This placing of the body required an excavation between these rocks of 3 or 4 feet in depth. The skull was broken into sixty fragments by the pick of the workman; it was carefully taken up and put together by M. Bonfils, and is now exposed in the Museum at Mentone. This was a fortunate accident, for while the rest of the skeleton was being exhumed a quarrel broke out as to ownership, which ended in the theft and utter destruction of all that remained. Mr. Wilson maintained that the new discovery of the skeleton dissipated all idea of disturbance, for while disturbance might exist for one or two, or even five or six feet, to the depth of twenty or thirty feet it would be impossible. It must be conceded that the human industry as manifested by the objects found in these caverns, indicated their occupation during the palæolithic age, for of the thousands found, all bear the impress of that age, while none denote particularly the age of polished stone. Mr. Pengelly said that he had visited the cavern where M. Rivière's new man of Mentone was found, and he was of opinion that the man found by M. Rivière had not been interred at all, but had died where the body was found, and had been buried by the sand blown into the cavern, and the waste of the walls of the cavern. He had measured the place himself where the body was found, and found that it was only eight feet below the surface. The skull of the man was so good that he should have been glad to have possessed such a skull. It was a large skull, and the measurements he made of the bone showed that the man must have been of great stature. The bones of animals found in the cavern were partly those of animals now extinct, and partly those of existing species. With reference to the age in which the man found by Rivière lived, his impression was that it was the palæolithic age. He would not say so positively, however, and from the information they possessed he did not think that the man would be of any value whatever for or against the doctrine of human antiquity.

Dr. R. Munro read a paper on *The Archæological Importance of Ancient British Lake-Dwellings and their Relation to Analogous Remains in Europe*. Dr. Munro commenced by giving a short introductory notice of the discovery and investigation of the crannogs of Ireland and the lake-dwellings of Central Europe. He then gave a *résumé* of the more recent explorations made among the crannogs of Scotland and the remarkable objects recovered from them. From a comparative examination of these relics with other collateral antiquities of the Celts, he arrived at the conclusion that the lake-dwellings of Scotland were essentially the product of Celtic genius, that they were constructed for defensive purposes, and that those in the south-west parts of the country attained their greatest development in post-Roman times, after Roman protection was withdrawn from the provincial inhabitants, and they were left single-handed to contend against the Angles on the east and the Picts and Scots on the north. Having established the Celtic origin of the crannogs of Ireland and Scotland, Dr. Munro proceeded to inquire if there is any ancestral relationship between them and the lake-dwellings of Central Europe. Taking into account the recent discovery of lacustrine abodes in the Holderness and the few previous records of their existence in Wales and other parts of England, together with the statement of Cæsar that the Britons were in the habit of making use of wooden piles and marshes in their defensive works, he thought that such indications are not merely solitary instances, but the outliers of a widely distributed custom which prevailed in the southern parts of Britain at an earlier date than that assigned to the crannogs of Scotland. Hence he suggested the theory that the British Celts were an offshoot of the founders of the Swiss lake-dwellings, who emigrated into Britain when these lacustrine abodes were in full vogue, and so retained a knowledge of the custom long after it had fallen into desuetude in Europe. On this hypothesis it would follow that subsequent immigrants into Britain, such as the Belgæ, Angles, &c., being no longer acquainted with the subject, would cultivate new and perhaps improved methods of defensive warfare; whilst the first Celtic invaders, still retaining their primary notions of civilisation, when obliged to act on the defensive would naturally have recourse to their inherited system of protection. In support of this hypothesis the author pointed out that the geographical distribution of lake-dwellings, so far as they are known in Europe, closely corresponds with the area formerly occupied by the Celts; that no lake-dwellings have been yet found either in the northern or southern parts of Europe, though the topographical and hydrographical conditions of these regions are not unfavourable for such structures; that the *fascine* dwellings in Europe were identical in structure with the crannogs; and that, though the pile-dwellings were not largely used in the British Isles, the principles on which they were built were not unknown, their disuse being due to topographical and other considerations. Finally, he argued that the wideness in the chronological gap which is supposed to separate the crannogs from the lake-dwellings of Europe is more apparent than real, as the latter existed during the Roman occupation of Gaul, and in one instance at least the custom survived to about the tenth century.

Prof. D. J. Cunningham exhibited a large coloured plate of sections of a young chimpanzee, illustrative of some important points of comparison between the chimpanzee and man. Prof. Cunningham said that he had purchased a male chimpanzee, which was said to have died in the process of second dentition, and which he believed to be about six years of age. The body of the chimpanzee was frozen for two days, and he now exhibited the sections of the chimpanzee for the purpose of showing one or two points of comparison between the chimpanzee and man. Any one looking at the plate would be attracted to the region of the face, where the protrusion was shown which was so well seen in the living animal. If they compared it with the corresponding section of man they would find brought out very forcibly the elongated brute-like tongue of the chimpanzee. An anatomist looking at the section now exhibited would fix his attention at once upon the spine. In man the spinal form was beautifully curved. It showed an alternation of curves in the different regions of the body, and to these curves in the spine of man in a great measure was due in his erect attitude. It was remarkable that the chimpanzee even at six years of age there was a very manifest lumbar curve. In the Biological Section that day there had been described the spine of a child six years of age, and it was remarkable that the lumbar curve in this chimpanzee of a corresponding age was very much more marked than in the child. At six years the chimpanzee was much more advanced in life than a child six years old, and therefore his lumbar curve was correspondingly greater. If they wished to get at the distinction between the spine of man and the chimpanzee they must look lower down at the sacrum. After noticing one or two other points, Dr. Cunningham drew the conclusion that the human child occupied an intermediate position between the chimpanzee and the human adult. In the plate he now exhibited they would see compared the skull of the chimpanzee with that of man, bringing out that the cerebral or larger brain in man extended a good deal further back than in the chimpanzee; and there was not much difference between the New World ape and the chimpanzee in that respect.

Dr. J. G. Garson, one of the secretaries of the Section, read a paper on *Abnormal and Arrested Development as an Induction of Evolutionary History*. Dr. Garson began by stating that, perhaps, the most fertile source of information regarding the history of man's evolution was derived from a study of his embryological development. Another source from which much valuable information regarding the early history of our own specialisation, and that of other animals, might be gleaned, was Teratology, which had for its domain the consideration of abnormal conditions of development. Many of the conditions included under this branch were of a pathological nature, and due to the effects of disease; others, however, were not—such, for example, as an abnormal and an unusual production of normal structures and cases of arrested development. It was to a consideration of some conditions occurring under one or other of these categories that he ventured now to call attention. The examples which he had selected had come more especially under his own observation. Persons were occasionally found with abnormal development of hair on their bodies. The type of mammal was an animal whose body was covered with hair. Under certain circumstances the hair might more or less disappear, according to the conditions under which the animal lived. In man it was only feebly developed, except on the head; and in the cetacea or whales it had entirely disappeared, with the exception of a very few bristles near the mouth. Dr. Garson proceeded to explain how excessive development of hair takes place in man. In ordinary cases the hair-growing apparatus in the embryo remained stationary, instead of keeping pace with the growth and development of the other organs of the body, with the result that no hairy covering such as was found in other mammals was present, but only short rudimentary hairs appeared at intervals. But in some exceptional cases this stationary condition of the hair follicles did not occur, and they went on actively developing with the rest of the body, with the result that a hairy covering was produced over the body. The hairless condition now normal in man had evidently been gradually acquired through a long period of time, as such a change could not take place rapidly and become such a stable condition as it was found to be otherwise. Abnormal development of fingers occurred sometimes in man, but must be classed entirely apart from such forms of abnormality as had been considered in the hair-growth. In arrested development the abnormal organ or portion of the body, instead of going through the various stages it usually does till it arrives at the condition it normally assumed in the group of animals in which it occurs, stops short at one or other stages. The stage at which it stops may correspond to that which is normal in a lower grade of animal life, and so gives direct evidence that the higher forms of animal life, such as man, pass through and beyond the stages at which the lower stop. It must not be forgotten also that in some respects an animal of a lower grade may possess specialisations in some structures or organs of a higher ground than animals much higher in the scale of life.

Dr. Robert Laws, from Livingstonia, Lake Nyassa, East Central Africa, read a long and interesting paper descriptive of the manners and customs of the Bantu tribes living around Lake Nyassa in Eastern Central Africa. In the outset of his paper Dr. Laws said that Lake Nyassa was 350 miles long, and varied from 16 to 60 miles broad, and around that vast inland sea they knew of fifteen different tribes, speaking so many different languages, besides dialects of these languages. Though these tribes had much in common, they differed among themselves in many of their habits, customs, and religious beliefs. He proceeded to notice the names and residences of the leading tribes, and gave a brief summary of what was known of their history. As a rule, he said, the people of all these tribes were physically developed, but their vigour and general healthy condition differed considerably, depending chiefly on the climate, soil, and food. Where maize and mapira were the staple foods, the natives were strong and hardy. Where cassava root was their chief food, and especially if along with that there was a state of actual or dreaded warfare, the people were weak and sickly. On the hills the people were hardier and more vigorous than on the lake-shores and on the river-banks. Mental energy was greater on the hills than at the lake-side, and at places where there was most radiated heat this was less than where the breezes played freely. Keenness of vision and acuteness of hearing were spoken of as being remarkable in civilised tribes, and among the lake tribes these faculties attracted the attention of travellers, but Dr. Laws was inclined to attribute these characteristics to training and exercise in given directions rather than to any radical superiority in the organs of sight and hearing among the tribes. All the tribes depended principally on agriculture for their support, and the only appearance of a rudimental division of labour was to be found in the classes of fishermen and blacksmiths. No traces of a Stone age had been found among these tribes. Yet in certain districts they were to be found cultivating their gardens with tools of hard wood instead of iron, distance from markets being the cause of their use. At the east side of Nyassa many lake-dwellings were found in 1875, and often on war being threatened the inhabitants of the lake shore took refuge by living in such constructions. Iron mines had been found, and copper had been found in one of those near the Livingstone range. The iron of the mines was usually near the surface. Charcoal was used for smelting. Dr. Laws went on to describe the manner in which the tribes made their canoes, their nets, and their huts. Fire was procured among them by the rapid rotation of rods of wood between the hands, the spark being caught in cloth and kindled into a flame. The natives exhibited great surprise when they saw the traveller strike a lucifer match, and that was regarded by them as an unquestionable proof of his superior knowledge. The natives indicated time by pointing to the position of the sun. They named Sunday as the day of God, Monday as the day for beginning work, Saturday as the day for stopping work. The intermediate days were indicated by numbers. The eclipse of the moon was described as the moon put in a bag, and comets as stars with tails. Slavery was common in all the tribes, and half of its horrors had not been told. Infanticide was not practised, but infant mortality was very high, and cases had been found of children labouring under a lingering disease having been buried alive. Polygamy was common, and the number of a man's wives taken as an index of his wealth. One chief told him he had a hundred wives, and he (Dr. Laws) believed he was rather under-estimating than over-estimating the number. The early marriage of girls was the rule, and in one tribe a girl was often betrothed before she was born. In buying land they had to buy it first from the chief and then buy the tenant-right from the cultivators. After describing the customs of the tribes relating to the punishment of crime, Dr. Laws concluded his paper by noting the leading peculiarities of the language of the tribes, directing especial attention to the complications in the forms of speech, and especially to the extraordinary number of variations in the verbs.

Mr. E. H. Man contributed a paper on *The Nicobar Islanders*. —In the interior of Great Nicobar there is a wild race, styling themselves "Shab Dawá," of whom as yet little information has been obtainable; they are distinct from the inhabitants of the other islands and of the villages on their own seaboard, who are of Malay origin, and by whom they are called "Shom Peñ" ("Shom" denoting tribe," and "Peñ" being the tribal designation). It appears certain that they are the descendants of a very ancient aboriginal population of Mongolian origin. The first mention that we find of them is from the pen of pastor Rosen, a Danish missionary, who, while resident at the Nicobar Islands between the years 1831–34, spoke of them, from hearsay, as in much the same degraded condition as we find them at the present day. He said that "they wear no clothes, possess no houses, live like animals in the depths of the forest, and shun the sight of men, never leaving their lairs except to search for food, which they sometimes steal from such of the coast huts as are temporarily vacated or occupied only by a few aged or infirm folk whom they are able to surprise or overpower." In 1876 and 1881 a few members of this tribe living near the north-east of Great Nicobar were seen by the late Mr. de Röepstorff, who was accompanied in the latter year by Col. T. Cadell, V.C., Chief Commissioner of the Andamans and Nicobars. During the last eighteen months Mr. E. H. Man, while in charge of the Nicobar Islands, has paid six visits to Great Nicobar, on four of which he succeeded in seeing and photograhing parties of this tribe, both near Ganges Harbour and on the west coast. On the first of these occasions (viz. February 1884) two youths, aged about eighteen and fourteen years respectively, were persuaded to leave their friends for seven days, at the end of which they were conveyed back from Nancowry in the settlement steamer. During their visit to Mr. Man they proved themselves tractable and timid, and submitted with a good grace to ablutions which were found very necessary. Although this is the first recorded instance of a Peñ having ventured from his savage haunts, these lads exhibited the Oriental characteristic absence of wonderment at all the novel surroundings and tokens of civilisation in the Government settlement. They were fair specimens of their race, the members of which are found to be usually well nourished, of good physique, and, while young, favoured with pleasant features. The height of the males appears to range between 5 feet 2 inches and 5 feet 8 inches; their skin is fairer than that of the generality of the coast people, who, on their part, are less dark than the Malay; the hands and feet seem to be decidedly large, and bear evidence of the rough work of their daily lives; the hair, which is straight, is commonly worn uncut and unkempt, and, as habits of cleanliness are manifestly foreign to their nature, its condition can better be imagined than described. As a result of their friendly intercourse in recent years with the coast people, they have acquired the habit, so universally practised among the latter, of chewing the betel-nut (*Chavica betle*) with or without quicklime, and are consequently beginning to be similarly disfigured with black teeth, though not yet to the hideous extent common among their more civilised, or, rather, less savage, neighbours. They likewise now imitate the latter in respect to clothing, the men adopting the narrow loin-cloth and the women a small cloth skirt. Their dwellings are small, and cannot compare with those of the coast people, and are indeed but little, if at all, superior to those of the Negritos in Little Andaman, but they more nearly assimilate the former in design as well as mode of construction, for they are erected on posts; the floors being raised 6 or 7 feet above the ground necessitate the use of ladders. It is impossible, within the limits of this abstract, to make further mention of the dwellings, or to describe the peculiar sack-like cooking-vessels of this strange race. Mr. Man hopes before long to be able to supplement in many particulars the rudimentary information which has hitherto been obtainable regarding the Peñ, but the task is one of considerable difficulty, for, apart from the dread entertained by this tribe towards aliens, their frequent feuds place from time to time a temporary barrier to all intercourse between them and our friends on the coast, through whom at present all our communications have to be conducted. The nearest portion of Great Nicobar Island is, moreover, about 60 miles distant from the Government settlement at Nancowry.

SCIENCE IN RUSSIA

THE Kazan Society of Naturalists continued last year its valuable explorations of Eastern Russia, and we have before us several new fascicules of its *Memoirs* and *Proceedings*.[1] M. Ivanitsky publishes a list of plants of the Government of Vologda, which contains 804 Spermatophytæ, Gymnospermæ, and Sporophytæ. As to these last, only 6 Equisetaceæ, 5 Licopodiaceæ, and 20 ferns being given, the list obviously will be much extended by subsequent research. The flora of Vologda, which is situated on the limits of the middle and Arctic Russian floras, offers a certain special interest, and M. Ivanitsky has not neglected to mention the wild and cultivated plants which find their northern limits within the province. It consists chiefly of Compositeæ (107 species), 49 Cyperaceæ, 48 Gramineæ, 41 to 34 each of Ranunculaceæ, Caryophylleæ, Rosaceæ, and Cruciæeræ, 27 to 22 Papilionaceæ, Scrophulariæ, Labiatæ, Salicineæ, and Polygonaceæ, and 21 to 19 Umbelliferæ, Filices, and Orchideæ. The list of plants is prefaced by a masterly sketch of the physical conditions of separate parts of the province. The same volume contains a paper by. M Mislavsky on the irritability of the nervous-muscular system, being an inquiry into the causes of the well-known differences of the effects of electrical irritation on the frog, when measured by the methods of Dubois-Reymond. All causes which may depend upon the conditions of the experiments themselves having been eliminated, there still remain notable differences which must be ascribed to the state of the system altogether. A paper, by Th. Tsomakion, on the laws of transmission of electricity through gases, embodies the results of several new experiments in this field. In a former inquiry the author, by introducing into the chain of condensation a discharger where the discharge could take place only at close contact of the two electrodes, had experimentally proved the law, already deduced by Forselman and Heer, that the whole amount of heat produced at the discharge of the condensator does not depend upon the composition of the chain. But as soon as he introduced a layer of gas between the electrodes, he found that his results widely differed from all previously obtained by other students; he undertook a series of experiments for discovering the sources of that discrepancy of results, and he has arrived at a long series of conclusions which are of great interest, but ought to be submitted to a closer inquiry. This last is continued.—To the same vol. xiii. M. Zaitseff contributes a paper on the petrography of the crystalline rocks in the neighbourhood of Krasnovodsk, on the eastern shore of the Caspian. The chief rock in the Shakh-Adam Mountains, which reach about 600 feet above the sea, is a massive, unstratified quartz-dioritic porphyrite (according to the classification of Herr Rosenbusch). Between the bays of Muravioff and Soymonoff the rocks are closely akin to the above, and might be described as a quartz-mica-diorite. The former extends also for some miles east of Krasnovodsk, and is intersected by veins of a muscovite-granite (according to Herr Rosenbusch's classification) and quartz porphyry of rare occurrence, its magnesial mica being replaced by a potassium mica.—The same author contributes two papers on the petrography of the Soymonoff valley in the south-east part of the district of Ekaterinburg, which incloses the 3200 feet high Yurma summit and several high ridges of mountains. The author makes a detailed inquiry into the structure of the crystalline rocks of this locality (granites, gneisses, and various schists), and is inclined to admit that at least one part of the olivine-bearing serpentines endow their origin to the metamorphism of the actinolite schists. The iron ores and gold-bearing deposits are also described, the age of these last being undoubtedly settled as Post-Pliocene, as they contain numerous remains of Mammoth, *Bos primigenius*, *Cervus tarandus*, and *Cervus alces*. We may remark that the very high position of several gold-bearing deposits on the slopes of the valleys and their structure is one testimony more in favour of their glacial origin, but the author does not touch this interesting question. He mentions also—a fact which has often been doubted, but is now confirmed more and more—that the gold of these deposits is derived from the decomposition of the chloritic slates. The papers are accompanied by a geological map. In the same volume (fasc. 4) we find a preliminary report, by S. Korzinsky, on a botanical excursion into the delta of the Volga. The list of plants is not yet given by the author, and he publishes only a valuable sketch of the general characters of the delta, distinguishing in it two different regions: the delta proper, which consists of fluviatile deposits; and the Steppe region, covered with the so-called *bougry*, or a kind of *kames*, first described by Karl Bear and still bearing his name, about which *bougry* the author holds a different opinion as to their origin, denying—with full right, we suppose—their origin from the retreat of the Caspian.

As to the *Proceedings* of the Kazan Society, we are glad to learn from them that three new meteorological stations (at Sarapul, Tcherdyn, and Debessy) have been added to those already organised by the Society. There was a great want of meteorological observations precisely for that part of North-East Russia. Several shorter papers are embodied in the *Proceedings*:—On the geology of the Vetluga region, by P. Krotoff (a polemic concerning the Permian and Trias, as also the southern limit of the boulders).—On the fauna of Kazan (between the Kama and Vyatka), by N. Varpakhovsky. The author gives the lists of fishes found in the lakes and rivers, and lists also of serpents and amphibians of the region.—On the preparation

[1] *Trudy Obschestua Estestvoispytatelei pri Kazanskom Universitete*, vol. xii. fasc. 5 and 6; vol. xiii. fasc. 1 to 4.—*Protokoly* (*Proceedings*) of the same for the years 1883 and 1884.

of tripsine, by V. Nikolsky.—On the *bougry* of the Caspian, by A. Zaitseff. They do *not* have the uniformity of structure supposed by Baer; they often cross one another at angles of 20° to 30°, and some of them follow a north-eastern direction, while others, close by, run west and east; and they contain not only broken mussels, as affirmed by Baer, but also plenty of quite full mussels of *Cardium trigonoides*, *Dreissena polymorpha*, *rostriformis*, and *caspia*. The theory of Baer altogether is based on an insufficient supply of data, and the structure of the *bougry* ought to be better explored before pronouncing as to their origin.—On the sulphur ores at Tetushi, on the Volga, by G. Wilenius.

The fourth volume of the "Collection of Materials for the Description of Caucasus,"[1] published by the schoolmasters of Caucasus, contains, as usual, much valuable information, especially of historical and ethnographical character. M. Hahn contributes a most valuable paper of 250 pages, in which he has compiled all information on the Caucasus he was able to discover in authors since Homer up to the fifth century of our era. The information gathered from Byzantine writers who have much more written about the Caucasus, will be embodied in a second part of the work. The importance of this very careful work, where textual translations are given of passages dealing with the Caucasus and its inhabitants from no less than eighty Greek and Latin authors, will be fully appreciated by all those who have to deal with the geography of the country. A complete index will much facilitate the research. M. Eivazoff gives a description of the Aisores of Koilasar, of their manner of life and customs, followed by an Aisor alphabet; and M. Arkannikoff contributes a detailed description of the town Temruk and of the Temruk mouth of the Kuban River. In the second part of the same collection we find a series of interesting notes on the Tchokh village in Daghestan, on Daghestan legends, and on the life of Abkhazes; a collection of Little Russian songs from Kuban; and two lectures on the beautiful seven-centuries-old Georgian poem of Shota Rustaveli.

[1] "Sbornik materialov dla opisania myestnostei i plemen Kavkaza." Tiflis, 1884.

SCIENTIFIC SERIALS

THE *Journal of Physiology* for July contains:—Note on the cause of the first sound of the heart, by G. F. Yeo and J. Barrett.—An experimental investigation to ascertain the action of veratria on a cardiac contraction, by S. Ringer (plate 2).—Concerning the action of small quantities of calcium, sodium, and potassium salts upon the vitality and function of contractile tissue and the cuticular cells of fishes, by S. Ringer and D. W. Burton.—A study of the action of the depressor nerve, and a consideration of the effect of blood-pressure upon the heart regarded as a sensory organ, by H. Sewall and D. W. Steiner (plate 3).—On secondary and tertiary degenerations in the spinal cord of the dog, by C. S. Sherrington (plates 4 and 5).—On the structure and rhythm of the heart in fishes, with especial reference to the heart of the eel, by S. A. M'William (plate 6).—The innervation of the heart of the Slider terrapin (*Pseudemys rugosa*), by J. Wesley Mills.—Note on the sound accompanying the single contraction of skeletal muscle, by E. F. Herroun and G. F. Yeo.

The Journal of Anatomy and Physiology for July contains: Account of some recent experiments on the effects of very low temperatures on the putrefactive process and some vital phenomena, by J. J. Coleman and J. G. McKendrick, M.D.—Accessory lobe to the left lung, by L. Humphry, M.B. (plate 17).—Case of abnormal development of the reproductive organs of the frog, by A. F. S. Kent (plate 18).—Rotation and circumduction, by Thomas Dwight, M.D.—Movements of the ulna in pronation and supination, by C. W. Cathcart, M.B.—Anatomy of a hydro-monocephalous brain, by A. Hill, M.D.—Corpus callosum in the adult human brain, by Dr. J. Hamilton, (plates 21 and 22).—Tumours in animals, by J. B. Sutton (plate 23).—Hyomandibular clefts and pseudobranchs of Lepidosteus and Amia, by R. Ramsay Wright (plate 24).—Anatomy of *Spinal bifida*, by Prof. Humphry.—Notes on some variations of the shoulder muscles, by W. B. Ransom.—Tarsus and Carpus, by Prof. K. Bardeleben.

The Quarterly Journal of Microscopical Science for July contains:—On spermatogenesis in the rat, by Herbert H. Brown (plates 22 and 23).—A simplified view of the histology of the striped muscular fibre, by B. Melland (plate 24).—On the development of a freshwater macrurous crustacean (*Atyephora compressa*), by C. Ishikawa (plates 25–28).—On the supposed communication of the vascular system with the exterior in Pleurobranchus, by A. G. Bourne, D.Sc. (plate 29).—Observations on the nervous system of Apus, by P. Pelseneer (plate 30).—Note on the chemical composition of the zoocytium of *Ophrydium versatile*, by W. D. Halliburton, M.D.—The development of *Peripatus capensis*, by A. Sedgwick, M.A. (plates 31 and 32).

The Journal of the Royal Microscopical Society for August contains:—The pathogenic history and the history under cultivation of a new bacillus (*B. alvi*), the cause of a disease of the hive bee hitherto known as foul brood, by F. R. Cheshire and W. Watson Cheyne, M.D. (plates 10 and 11).—Experiments on feeding some insects with the curved or "comma" bacillus, and also with another bacillus (*B. subtilis?*), by R. L. Maddox, M.D.—On four new species of the genus Floscularia and on five other new species of Rotifera, by C. T. Hudson, LL.D. (plate 12), with the usual summary of current researches.

The American Naturalist for September contains the reputation of the Lantern fly (*Fulgoræ lanternaria*), by John C. Brauner. To the bibliographical references made in an editorial note to this paper may be added the spirited discussion on the whole subject in the *Entomological Magazine* of 1836.—The age of forest trees, by J. T. Campbell.—The relations of mind and matter, by C. Morris.—The exhalation of ozone by odorous plants, by J. M. Anders and G. B. M. Miller.—Glacial origin of Presque Isle, Lake Erie, by J. D. Ingersoll.—Recent literature and general notes.

The Proceedings of the Linnean Society of New South Wales, vol. x. Part 1 (June 4).—The papers in this part are of great interest, and worthily sustain the credit of this most active and energetic Society. *Zoology* — Dr. R. von Lindenfeld, On Australian sponges, part iv. The Myxospongiæ, with 5 plates. On *Amœba parasitica*, a new protozoon infesting sheep. On the Phoriospongiæ.—William Macleay, On a new snake from the Barrow Ranges, and On some reptiles from Herbert River.—A. S. Oliff, On some Ceylonese Coleoptera.—J. Brazier, Synonymy of some shells described by Dr. Gray.—W. A. Hasnell, On some Australian Amphipods, with 9 plates.—Captain Hutton, Revision of the Toxoglossate mollusca of New Zealand.—J. Douglas Ogilby, Some rare Port Jackson fishes. *Botany*—Dr. W. Wools, Australian Proteaceæ. *Palæontology*—F. Rattle, On a Devonian Australian fossil allied to Worthenia, with a plate; also on the Glacial period in Australia; and on the meteorology of Mount Koskiusko, by Dr. von Lindenfeld, with two plates.

Morphologisches Jahrbuch, Band 11, Heft 1, contains:—Contribution to a knowledge of the renal organ of the Prosobranchia, by Dr. B. Haller (plates 1–4).—On the morphological significance of the nucleus, by Dr. W. Pfitzner (plate 5).—Short contributions to a knowledge of some marine Rhizopods, by O. Bütschli (plates 6 and 7).—On the significance of the *Linea semicircularis Douglassii*, by Bernhard Solger.—Notes on Apseudes, by J. E. V. Boas.—Short Notes.

Zeitschrift für wissenschaftliche Zoologie, Band 42, Heft 1, July 24, contains:—A biographical sketch of Carl Theodor Ernst von Siebold, one of the founders of the *Zeitschrift*, by Ehlers (with a photograph).—On the significance of the nucleus from the point of view of evolution, by Prof. A. Kölliker.—Researches on some Flagellates and kindred organisms, by Dr. C. Fisch (plates 1 to 4).—On the anatomy of the Amphisbœna, by Dr. Carl Smalian (plates 5 and 6).

Band 42, Heft 2, August 18, contains:—An essay on the history of German slugs, and on their European allies, by Dr. H. Simroth. This monograph is illustrated by five plates, that of the species being coloured.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 5.—M. Bouley, President, in the chair.—Spectral analysis of the elements of the terrestrial atmosphere, by M. J. Janssen. The author describes the special arrangements that have been made at the Meudon

Observatory for the study of the hydrogen, oxygen, and other substances present in the terrestrial atmosphere. Four tubes, one 60 metres long, have already been fitted up in a chamber in which solar, electric and other lights can be employed under favourable conditions.—Thermic studies of the aromatic series: the phenols of complex function, by M. Berthelot. New characters derived from thermo-chemistry have been determined for the purpose of distinguishing the various isomerous groups of the aromatic series and disclosing the phenolic function belonging more particularly to some of these groups. In order to establish the general character and importance of this new instrument of research, the author continues his experiments with the compounds derived from the oxybenzoic acids, to which the synthesis of vanilline and the allied substances has given so much interest. The results already obtained establish a perfect agreement between the thermic indications and the chemical theories respecting the complex phenolic functions.—The treatment of mildew and rot with a mixture of lime and sulphate of copper, by M. A. Millardet. During the present season M. Nathaniel Johnston has applied this new process to 50,000 vines in the Médoc district with complete success. The plants so treated are in a perfectly healthy state, while those not treated are in a wretched condition.—On the destruction of mildew by the sulphate of copper, by M. A. Perrey. A solution of 5 per cent. of sulphate of crystallised copper has this year been successfully and economically applied to vineyards in Burgundy hitherto unsuccessfully treated with sulphur.—Ravages of mildew in the northern districts of Touraine during the present year, by M. Larreguy de Civrieux. The disease broke out suddenly a few days after a violent storm in July, attacking several varieties of the vine and the oak trees of the surrounding plantations to the exclusion of all other plants.—Note on the quadratic forms in the theory of the linear differential equations, by M. Halphen.—On the physiologic action of the salts of rubidium, by M. Ch. Richet. Subcutaneous and intra-venous injections of the chloride of rubidium applied to frogs, fishes, rabbits, guinea-pigs, and pigeons, show that this metal has the same toxic effect as potassium, but somewhat less virulent.—On the internal phenomena of muscular contraction in the striated primitive fasces in *Corethra plumicornis* and the frog, by M. F. Laulanié.—Line of development followed by the inoculated virus of tuberculosis in man, the rabbit, and guinea-pig: application to the study of inoculation and re-inoculation for tuberculosis, by M. S. Arloing.—A remarkable vegetable centre in the peninsula of Brittany, by M. L. Crié. Of this vegetable zone the characteristic species appear to be *Narcissus reflexus*, Lois.; *Eryngium viviparum*, Gay; *Omphalodes littoralis*, Leh.; and *Linaria arenaria*, D. C.—Application of thermo-chemistry to the explanation of geological phenomena; general principles; ores of manganese, by M. Dieulafait. The principle is laid down that of all the natural combinations of each metal, that which developes the greatest heat in its formation occurs most extensively in nature, and must be regarded as its principal ore. Applying this principle to the study of manganese, the author finds that the ores of this metal exist in nature in the relative proportions and under the conditions anticipated by the laws of thermo-chemistry.—On the whirlwinds observed by aëronauts, by M. Diamilla-Müller. These whirlwinds are attributed to the collision of two atmospheric currents coming from opposite directions, and are compared with the eddies produced in streams by analogous causes.—Note on a meteor observed at Saigon, Cochin-China, on August 22, 1885, by M. Réveillère.—Kinematics of the locomotion of quadrupeds: trajectories and comparative velocities of the pastern and hoof of the horse at the different phases of its motion.

Stockholm

Academy of Sciences, September 16.—The following paper was presented and accepted for publication in the *Proceedings*:—"Nouvelles Observations sur les Traces d'Animaux et d'autres Phénomènes, d'Origine purement mécanique, décrits comme Algues fossiles," by Prof. A. G. Nathorst.—Experiments to determine with the galvanometer the limits of elasticity and the absolute tension of iron wire of different thickness and with varying contents of carbon, by Dr. P. Isberg.—Researches on the influence of temperature on the electromotoric force of certain electric pile combinations, by Dr. F. Kahlmeter, both the latter papers being presented and explained by Prof. Edlund.—Prof. Wittrock referred to a report left by the late Dr. Lönnroth on his botanical journey to Gothland and Östergötland, chiefly to study the Hieracia, at the expense of the Academy, and to a paper presented at a previous meeting and prepared in the Botanical Section of the Natural History Museum by Herr R. Boldt.—Contributions to our knowledge of the chlorophyllophyceæ of Siberia. He further presented and explained the two following papers, viz.:—Contributions to our knowledge of the development of the physiological tissue of some algæ, by Herr N. Wille, and contributions to the flora of the American Desmidicæ, by Herr G. Lagerheim.—Prof. Chr. Aurivillius presented a paper, "Conspectus Generum et Specierum Microceridarum," and gave a review of the same. He further exhibited living specimens of the slave-keeping ant, *Polyergus rufescens*, recently found by him near Stockholm.—Prof. Nilsson presented a paper prepared by himself and Prof. O. Petterson, "Nouvelle méthode pour déterminer la densité de vapeur des corps volatisables en même temps que la température y appliquée," and gave a review of its contents.—The Secretary (Prof. Lindhagen) presented the following papers, containing the results of researches made at the Upsala Chemical Laboratory:—On the production and nitrification of kumenylacryl acid; on the ortoderivates of kumenylacryl acid and the new indigo and chinolin-derivates obtained from the same; on the meta-derivates of kumenylacryl acid, and on derivates of kumenylacryl acid formed through substitution in the group of the acryl acid: all four by Dr. O. Widman.—Researches on the dependence of galvanic resistance in certain alloys of tin and bismuth on time, by Dr. G. Bäcklin.—On capacity of saturation and atomic weight, by Dr. J. R. Rydberg.—On Polyarsenite, a new mineral from the mine Sjögrufvan, in the province of Örebro, by Herr L. J. Igelström.—Remarks on the genus Cysteosoma, Guérin-Méneville, by Dr. C. Bovallius.—On the Lake Wettern and the formation of Visingsö, an island, by Dr. G. Holm.

CONTENTS

THURSDAY, OCTOBER 22, 1885

AMERICAN ANTHROPOLOGY

Reizen en Onderzoekingen in Noord-Amerika. Van Dr. H. F. C. Ten Kate, Jun. (Leyden: Brill, 1885.)

Prehistoric America. By the Marquis de Nadaillac. Translated by N. D'Anvers. Edited by W. H. Dall. (London: Murray, 1885.)

The Lenape Stone; or, the Indian and the Mammoth. By H. C. Mercer. (New York: Putnam, 1885.)

DR. TEN KATE (son of the celebrated Dutch painter) has published the account of his late anthropological journey in the regions about Arizona and New Mexico. His exploration was supported by the Government of Holland, for whose Rijks Museum at Leyden he brought home a collection illustrating the peculiar civilisation of the Pueblo Indians and their wilder neighbours of the plains; also by several scientific bodies, among them the Anthropological Society of Paris, for which he took body-measurements of the various tribes he met with. Belonging to the school of observers who depend on the measurement of skulls as a means of classing the natives of America into stocks of the general Mongoloid race to which they primarily belong (p. 432), he has to deal with the interesting problem, what relation the ruder and fiercer tribes bear to the comparatively cultured and peaceable dwellers in the pueblos. This, however, is confused by the fact that among neither is the type uniform. Dr. Ten Kate (p. 173) recognises among the Apaches two or three varieties, one more Mongolian and especially seen among the women, the others more of the bold-featured Redskin-type. The brachycephalic and occipitally flattened skull which he considers especially characteristic of the Pueblo Indians, enables him to contradict (p. 155) the opinion that the handsome Pimas belong to these. But then he finds it necessary to divide the Pueblos into much the same Mongolian and Redskin types (see his remarks on the Moquis, p. 253). On the whole his observations do not seem incompatible with the view that the difference between the roving Indians of the skin tents and the tillers of the fields around the towns of mud-brick houses depends less on race than on difference of stage of civilisation, itself due in great measure to the respective circumstances of a wild life of war and plunder or a tame life of peace and industry. That the neighbourhood of the nations of Old Mexico may have influenced the civilisation of the Pueblo tribes is likely enough, but Dr. Ten Kate argues on grounds both of skull-measure and language (pp. 265, 221) against any identification of Zuñis or Moquis with Aztecs. Indeed, it is the general experience of anthropologists, in spite of resemblances in such matters as the step-pattern on the pottery, that the language, customs, and religion which the natives of Zuñi or Tehua have preserved since the Spanish Conquest, show original and peculiar types which are not to be accounted for as borrowed from Mexico. Thus the designs on the earthen water-vessels, when explained, prove not to be copies of Mexican ornaments, but mostly direct symbolic pictures, a spiral for the whirlwind, a semicircle with descending lines for a rain-cloud, &c. This even affects the argument that the celebrated "cliff-dwellings" of the district were the strongholds of the ancestors of tribes such as the Moquis, who claim to continue and interpret the designs on their pottery (p. 265). Dr. Ten Kate had the good fortune of visiting Hualpé with Major Powell and seeing the Moqui snake dance (p. 242). He was allowed to go down the *estufa* to see the paraphernalia of the dancers and the vessel of drink taken as prophylactic against rattlesnake-bites, and his account of the dance itself, particularly as to the way in which the rattlesnakes are carried in the mouths of one set of dancers while another set by tickling them with feathers prevents their striking, is much in the same terms as that given by Capt. Bourke (see NATURE, vol. xxxi. p. 429). Mr. Cushing was still at the pueblo of Zuñi under his Indian name of Ténatsali or "Medicine Flower," and with his guidance Dr. Ten Kate had opportunities of studying the social life of the interesting matriarchal community. The main features of the family system are now clear, as to the young man being chosen by the young woman as "hers to be" (*yiluk'ianiha*) and his being taken by her father into the house as pupil (*talahi*); thus he passes into the position of a husband who can be sent back to his home, and the father of children who belong to their mother and inherit only from her. But in this and other accounts there are indications of what is evident to every traveller who has visited a Zuñi home—that the father after all has real power even in that matriarchal household. It is to be hoped that Mr. Cushing, when he gives the world his long-expected treatise on Zuñi language, manners, and religion, will be able to make the practical working of the matriarchal life more perfectly intelligible to the prejudiced patriarchal mind of the white man. Dr. Ten Kate inspected characteristic tribes throughout the New Mexican district, from these comparatively high Zuñis down to the low Utes, noting details of customs and other anthropological material which at times illustrate the effects of intercourse through a yet wider range of culture. Thus the wooden plough and creaking ox-cart of ancient Rome, introduced into America by the Spanish conquerors, are to be seen at work in the fields around the pueblos; and white men passing near an Indian cairn still throw each a stone upon it for luck (p. 271).

The well-known questions as to America before the time of Columbus may be counted on more than ever to arouse the interest of even the "general reader"—whether and how the natives came across from Asia, whether they made or imported the peculiar civilisations of Mexico and Peru, and so on. Thus it was quite worth while to translate the Marquis de Nadaillac's "Amérique Préhistorique," with its summaries of information and illustrations borrowed from the best sources. The work has been improved by being edited by Mr. W. H. Dall, whose own researches in the Aleutian region form one of the most interesting chapters in the anthropology of America. In the first place, the interesting though as yet hardly clear evidence is fairly given as to man's existence in America before the recent geological period. One of its most curious details is the description by Ameghino the geologist (p. 29) of his finding human remains on the banks of the Rio Frias, some twenty leagues from Buenos Ayres, associated with charcoal, potsherds, and stone arrow-heads, near the carapaces of gigantic extinct armadillos (Glyptodon) which had served as ready-made roofs to the pits in the ground which formed the dwellings of the ancient savages of the Pampas. It seems that, though the relater was a well-known geological explorer, his account was received with such incredulity, even in the district, that the Argentine Scientific Society refused to allow a paper to be read before them. The present volume, however (p. 477), contains particulars of a further discovery of the same kind, a human skull and most part of the skeleton having been found below an inverted Glyptodon carapace. This is not indeed conclusive, on account of the frequent displacement of the Pampas soil by floods, and even were the contemporaneity of man and Glyptodon made out, the upper bed containing the remains of this huge edentate may be more recent than the quaternary date. But no doubt there will be more finds, and it may help the discussion to point out that there seems nothing improbable in a man's living under a Glyptodon shell four or five feet long, inasmuch as there is classical authority for such habitations in the Old World. The natives of Ceylon, according to Ælian, could live under their great turtle-shells as roofs; so Pliny mentions the Chelonophagi of the Persian Gulf covering their huts with the shells of turtles and living on the meat. It is to be feared that the late Dr. Lund's researches in the limestone caves of Brazil, claimed as proving that the American man was a contemporary of the extinct megatherium and horse, were not made accurately enough to be relied on now, but it is well to keep them in view to encourage similar research. On the northern continent, Dr. Abbott's rude implements of argillite trap are the most remarkable objects claimed as the work of Glacial man, and they have proper description and drawing here, while every other discovery worthy of any consideration receives it. As is usual in French works, proofs of the high geological age of man are received somewhat more readily than in our more sceptical English literature. An unusually full account is given of the shell-heaps which fringe the coasts of both Americas, sometimes fifty feet thick and more, so as even to be valuable for the supply of lime to the builders of neighbouring towns. The high age of some of these rubbish-heaps is shown by elevation of the ground having lifted them high above the sea-level where the shell-fish were doubtless cooked and eaten, while the cannibal habits of the rude savages of the shores are shown by the usual evidence of human bones split for the marrow. Probably the more recent heaps are those characterised by tobacco-pipes, and stone pestles and mortars like those in which the modern Indians bruise seeds. This seems at least a reasonable opinion notwithstanding that such stone pestles and mortars have been put forward as evidence of man inhabiting California far back in the Tertiary period. M. de Nadaillac's chapters on the mound-builders and cliff-dwellers, and the nations of Mexico and Peru, give much popular information. The original French work discussed at some length the native American legends of deluges and other catastrophes, commemorating the mythic forefathers of nations and introducers of religious laws, and arts; but the American editor, with better judgment of the historical value of these tales, has pared them down, leaving the reader to form his judgments on more solid matters. Should a new edition of "Prehistoric America" be demanded, it will be well to have the press more carefully corrected. So well-known a living authority as Prof. Marsh figures as "March," and it is with an effort that one recognises the ancient Chinese emperor "Fo-hi" under the designation of "Fo-Fli." At p. 271, M. de Nadaillac yields to the common temptation of finding the name of the *Nahua* nation in the name of the country *Anahuac*, as if it meant "the country of the Nahuas by the water;" but this is grammatically impossible, and indeed the etymology of *A-nahuac*, meaning simply "near the water," is quite indisputable.

The interest felt by Americans in the antiquity of man on their continent is shown by the appearance of forged relics. The so-called "Lenape Stone" is one of the flat perforated stones known as gorgets, common in Indian graves, but on it is scratched a rude representation of hunters attacking a mammoth. When it was produced, Mr. Carvill Lewis at once called attention to the obvious point, that the mammoth is a palpable imitation of that of the cave of La Madeleine, whereas the hunters are imitated from the childish modern American Indian pictures on bark or deerskin. The artistic power of the men of the mammoth-period is shown by its being unconsciously conveyed through the hand of so stupid a copyist.

E. B. TYLOR

PHYSIOLOGICAL PLANT ANATOMY

Physiologische Pflanzenanatomie im Grundriss dargestellt. Von Dr. G. Haberlandt. (Leipzig: Wilhelm Engelmann, 1884.)

WHEN one recognises the immense importance of continually keeping before the student, the fact that from whatever standpoint the plant is viewed, physiological considerations must never be lost sight of, one cannot but welcome the appearance of Dr. Haberlandt's text-book on physiological plant anatomy, and one is disposed to do so with more than ordinary favour, recalling those chapters on physiological organography which appeared some three years ago in Prof. Sachs's "Vorlesungen." The subject is one to which Dr. Haberlandt has specially devoted himself, the present volume being in fact the most recent of a series of detailed publications. On this account it is not surprising to find that much of the subject-matter is not new, and that of the twelve sections into which the book is divided five have already appeared in the article in Schenk's handbook entitled "Die physiologischen Leistungen der Pflanzengewebes." Dr. Haberlandt's aim on the present occasion is to publish as complete an account as may be, of the present history of the subject, and the great point upon which he insists, is that the whole anatomical structure and the mode of arrangement of the various tissues composing the plant, are simply so many illustrations of the phenomenon of adaptation to physiological needs.

The first two sections are devoted to the consideration of the cell and the formation of tissues. The third treats of the tegumentary system, and as far as regards the epidermis special stress is laid upon Westermaier's discovery that the epidermal cells serve for the storage of water, in addition to their well-known protective function.

The important influence of cuticular wax and epidermal hairs upon transpiration is also discussed.

In Section IV. the mechanical system is considered. With much of the subject-matter of this section we have been acquainted since the appearance of Schwendener's classic "Das mechanische Princip;" but it is of interest to note that in the fungi, *e.g.* *Usnea barbata*, evidence exists of a mechanical tissue which in the higher plants takes the form of sclerenchyma, collenchyma, and bast. The absorptive system includes roots, rhizoids, and like structures; attention being also drawn to the absorptive tissue of the scutellum. This organ in *Briza minor* is peculiar on account of the pronounced development of the absorptive cells, and their striking resemblance to root hairs.

Section VII. deals with the assimilative system, and one is much struck by the marked manner in which the whole structure of the leaf illustrates the principles of which Dr. Haberlandt is the exponent. The pallisade layers are naturally regarded as being the chief seat of assimilative activity, and it is pointed out that the cells below these layers, which are of the nature of spongy parenchyma, and contain comparatively few chlorophyll grains, are distinguished by the remarkable manner in which they abut on to the pallisade cells. Their special function appears to be to conduct or absorb the products of assimilation, and to be the means of conveying them to other parts of the plant. They are in consequence designated as receptive or conducting cells (Aufnahme oder Sammelzellen). The infoldings which occur in numerous pallisade cells and are so well developed in the leaf of the various species of Pinus, have for their object the increasing of surface-area, and consequently also the number of chlorophyll grains in the cell.

Some space is devoted to the consideration of the conducting system, which includes the parenchyma of the cortex and pith, the medullary ray parenchyma, &c., the vascular bundles and laticiferous tissue.

Dealing with the vascular bundles from the point of view of physiological anatomy, a special terminology has been adopted. The whole bundle is known as the Mestom, the xylem as the Hadrom, and the phlœm as the Leptom. The idea of Mestom includes purely vascular tissue, and excludes the mechanical sclerenchymatous and fibrous tissue (stereom), consisting usually of prosenchymatous cells (sterëides), such as occur accompanying the bundles of most monocotyledons. Dr. Haberlandt's experiments demonstrate that in the moss stem the central strand of tissue is to be regarded as consisting of rudimentary hadrom, having for its function the conduction of water. To the layer surrounding the vascular bundle in roots, &c. (endodermis of De Bary) is applied the term "protective sheath," or "protective layer," on account of its function with relation to the bundle.

For a more complete understanding of the nature of laticiferous tissue we are again indebted to Dr. Haberlandt, whose observations upon this point appear to be of extreme importance. These observations demonstrate that in many of the thick-leaved Euphorbias, those portions of the laticiferous cells which enter the leaf become repeatedly branched in the leaf-tissue, and in such a manner that the extremities or blind ends of these branches abut directly on to the pallisade parenchyma cells, and are thus brought into the closest possible relation with the seat of greatest assimilative activity. The natural inference as to the function of laticiferous tissue has consequently everything to be said in its favour.

In Section IX. the intercellular space system is dealt with, and the various forms of stomata and their mechanism described. Much importance must necessarily be attached to this system when one bears in mind the relation of transpiration and gaseous diffusion to plant-life. The remaining sections are devoted to the secretory and excretory organs, and to the phenomena attending the normal and abnormal mode of increase in thickness of the stem and root.

The few remarks that have already been made are sufficient to show that the book contains numerous points of much interest. It is, moreover, carefully written, and furnished with a copious bibliography.

We cannot conclude this review without pointing out as Dr. Haberlandt has so fitly done, the importance of recognising that in every system there is not only the chief, but also the subsidiary, function, and that in considering any one of them which is especially significant, the less pronounced but still existing functions must be kept in mind. By such means alone will the true advance of physiological anatomy be maintained.

W. G.

WILLIAM HEDLEY

William Hedley, the Inventor of Railway Locomotion on the Present Principle. By M. Archer. Third Edition. (London: Crosby Lockwood and Co., 1885.)

IN this little book the author endeavours to place on record more exact facts with regard to the invention of the locomotive, and to give prominence to the name of the man who first made the locomotive a practical and financial success.

Richard Trevithick is perhaps the only man, before Hedley's time, who narrowly missed the fame now accredited to Stephenson and Hedley. In 1808 Trevithick constructed a circular railway in a field, now forming the southern half of Euston Square. On this railway he placed a locomotive of his own construction, having flanged wheels, a tubular boiler, and a vertical cylinder, driving by means of a cross head the hinder pair of wheels. This engine was attached to a coach, and the few people who would venture in it were taken round the railway at so much per head. After running for a few weeks, a rail broke, causing the engine to leave the rails, and turn over on its side. At this time Trevithick had expended all his means, and was compelled to give up his endeavours to convince the public of the many advantages to be obtained from the use of the locomotive; had he been backed up by influential men, no doubt he would now be known to fame as its inventor.

Many men before Hedley's time had tried their utmost to make a workable locomotive, such as would supersede horses on a colliery railway. Trevithick, Blenkinsop, and Chapman all exercised great ingenuity in their designs, but success was as far off as ever, owing to the general idea prevailing that some mechanical connection must exist between the engine and the railway, believing that the mere adhesion between the smooth wheels and smooth rails was completely insufficient to prevent slipping.

In the year 1812 William Hedley was viewer at the Wylam Colliery, and in order to reduce the working expenses he endeavoured to construct an engine to haul the coal waggons from the colliery to the river, and to do it cheaper than by horse haulage. At this time he had a knowledge of what others had done in this direction, but was forcibly impressed with the idea that the weight of an engine was sufficient for the purpose of enabling it to draw a train of loaded waggons. After having made successful experiments to prove the idea correct, he set to work and constructed his first engine, which, when completed, did not prove a success owing to shortness of steam, and a second one was made. The second one, the well-known "Puffing Billy," was put to work in May, 1813, and was a complete success. This may be safely called the first practical and efficient locomotive ever constructed. It had a return-tube boiler of wrought iron, vertical cylinders, and was placed on four wheels. Very soon after the engine commenced to work the exhaust steam was turned into the chimney to create a blast on the fire. This engine worked nearly continuously until 1862, when it was bought, and has now found an honourable resting-place in South Kensington Museum.

Puffing Billy was put to work in 1813, nearly a year before Stephenson's first engine was tried at Killingworth in 1814, thus proving without doubt that William Hedley was the first man to construct the first practically successful locomotive engine, and the first economical substitute for animal power.

It should not be thought that our author claims for Hedley the fame of being the first to develop the railways. Puffing Billy was at work sixteen years before the celebrated Rainhill contest took place, and ten years before locomotives were allowed to work the goods traffic on the Stockton and Darlington Railway.

Stephenson's success may be dated from the Rainhill contest in 1829; and he was one of the first men to bring the present railway system forward and develop it. At the same time William James must not be forgotten; he surveyed the Manchester and Liverpool Railway before Stephenson was placed in charge of the Railway Works, and had it not been for a difference of opinion on certain technical points, William James would have been the engineer of the line until open for traffic. Again, William James went to see Stephenson's engine, before Stephenson came to Liverpool, finding him an intelligent working man and the engine a success, he brought Stephenson to Liverpool, where he eventually commenced his successful career.

The author is to be congratulated on having proved his case, and in the preface he truly says: "Without William Hedley, George Stephenson might have lived in vain. It was William Hedley who gave the locomotive its life and power, and made the work of other men possible."

The book is very interesting, and is useful as a book of reference, the appendix containing extracts from the opinions of many writers, and letters from men able to give information on the subject. This little book will prove useful to all who wish to know the facts concerning William Hedley and his inventions. N. J. L.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Shotfiring in Mines

For some time past I have been conducting a series of shot-firing experiments at Dowlais and elsewhere on behalf of the Royal Commission on Accidents in Mines. Towards the end of August last Prof. C. G. Kreischer, of Freiberg in Saxony, visited me at Cardiff for the purpose of conferring with me on the coal-dust question. The experiments at Dowlais have a direct bearing on that subject, so, after pointing out to Prof. Kreischer the perfectly private nature of the investigation and the delicate position in which I would be placed were the results allowed to transpire through any channel other than the Royal Commission, and having received his assurance that such a contingency was impossible as far as he was concerned, I asked him to accompany me to Dowlais, so that he might witness some of the experiments on August 28 and September 1.

On the second (?) day Prof. Kreischer asked my permission to write to his friends in Germany, suggesting that they might make a few similar experiments privately in an apparatus that had been set up at Zwickau, at the expense of the Saxon Government, for the purpose of conducting a series of experiments with coal-dust. He again assured me that no publication of results would take place until after those obtained here were made known, and offered, if I had the least doubt as to the integrity of his friends, not to put it in their power to anticipate our results by not writing to them at all.

I did not feel justified in resisting such an appeal to my trustfulness, and agreed to his proposal.

A few days ago I received the following letter, which I shall be glad if you will kindly publish, along with my answer.

Sir F. A. Abel is the inventor of the dynamite water-cartridge, and not myself, as might be inferred from the article in *Glückauf*. W. Galloway

Freiburg, October 2, 1885

Hochgeehrter Freund.—Es war mir unmöglich wieder nach Cardiff zurückzukehren da wir uns zu lange im Durhamreviere aufgehalten hatten und die Zeit meiner zulässigen Bleibens in England sich allzusehr dem Ende zuneigte. Leider bin ich dadurch um das Vergnügen gekommen noch einmal mit Ihnen persönlich verkehren zu können, doch hoffe ich, dass wir uns bald einmal wieder sehen, vielleicht in Zwickau.

Die Schiessversuche mit Wasserbesatz und Pulver———der Versuchsstrecke haben sowohl in Zwickau als auch in Neunkirchen zu guten Resultaten in so fern geführt als die Gasen nicht entzündet wurden. Versuche mit Pulver und Wasserbesatz in der Plauitzer Kohle ergeben aber in so fern keine guten Resultate, als die Schüsse nicht werfen.

Leider hat Assesser Nonne, welcher den Versuchen beiwohnte, ganz gegen unsere Verabredung sogleich die Resultate; dieser ersten Versuche in einer kurzen Notiz im *Glückauf* veröffentlicht, jedoch ohne ihre Priorität zu nah zu treten, da Sie besonders darin erwähnt sind. Ich hatte ausdrücklich vor jeder Publication gewarnt ehe die Ihrige nicht erschienen sei, ein ordinärer Character kümmert sich aber um so etwas nicht.

Bei späterer Veröffentlichung der Zwickauer Versuche kann eventuel darauf Bezug genommen werden.

Nochmals für alle Liebe und Freundschaft, die sie mir so vielfältig erwiesen haben bestens dankend,

Verbleibe ich mit herzlichem Glückauf,

Ihr,

Ergebenster,

C. G. Kreischer

Herrn Bergingenieur Galloway, Cardiff

Cardiff, October 9, 1885

Dear Professor Kreischer,—I have received your letter of the 2nd inst. I observe that the friends to whom you sent a description of the shot-firing experiments have violated the conditions under which I gave you permission to make your communication to them by already publishing their results, as if they were in some sort original. You mention as a kind of palliative that, although my priority is not distinctly admitted, my name is mentioned in a prominent manner.

Personally I consider this a very small affair. Long experience of having my name mentioned in a similar manner, or mixed up with the names of others, or altogether omitted in connection with certain coal-dust matters in which I have undeniable priority, has hardened me; and I confess that this part of your letter gave me no concern. But although I could afford to pass it over in this way as far as I am myself concerned, I cannot adopt the same course when the interests of some of the members of the Royal Commission on Accidents in Mines are also at stake.

I must therefore ask you to give me a token of your good faith by restraining your friends from publishing anything further until the English Royal Commissioners shall have seen fit to make known the results obtained here. At the same time also I would suggest it as a simple matter of duty on your part to take immediate steps to let it be known to those before whom your friends' communications have appeared that the credit, if any, of the original investigations in this case rests with Sir Frederick Abel and Mr. W. Thomas Lewis quite as much as with me. Believe me yours very faithfully,

W. GALLOWAY

Herr Bergrath Kreischer, Professor der Bergbaukunde, Freiberg, Sachsen

The Resting Position of Oysters

IN books on Conchology, such as Woodward's "Manual of the Mollusca" and Jeffrey's "British Conchology," it is stated that the oyster rests in the natural state on its left valve, which is the larger and more convex. In this respect it is pointed out the oyster differs from the animals belonging to the genera Pecten and Anomia, which rest on the right valve, the Anomias being firmly attached by muscle with the flat right valve applied closely to the surface of attachment. In his lecture on oysters at the Royal Institution, which was published in Nos. 1 and 2 of the *English Illustrated Magazine*, Prof. Huxley also states that oysters rest on the left or convex valve, the flat right valve acting as a kind of operculum. Examination of oysters from the Firth of Forth has convinced me that this statement is erroneous. I do not know on what evidence the current belief of conchologists is founded. The evidence which appears to me conclusive is that the right flat valve is always quite clean, while the convex valve is covered with worm tubes, *Styela grossularia*, and Hydroids. The latter are in this connection the most important; it would be impossible for specimens of Sertularia and Thuiaria 4 or 5 inches long to grow, as I have found them on almost every oyster, in the central part of the left valve, if that valve were the lower in position. On examining Pectens I found that they resembled the oyster in the contrast between the surfaces of the two valves, the upper convex one being covered with Balanus and other fixed animals, the lower being almost clean. It is generally stated that the Pecten lies on its right valve; if this statement rests on the evidence afforded by the condition of the surface of the valves the same criterion applied to the oyster leads to the same conclusion, that the right valve is the lower. I have never seen a young oyster in the attached condition: Huxley states that it is the left valve which is fixed; in papers on the embryology of the oyster I have not yet been able to find any definite information on the point. Whether it is the right or left valve that becomes attached when the larva assumes the sessile condition I cannot therefore say of my own knowledge, but with regard to the adult oyster it seems to me certain that the current belief is caused by the repetition of an error. My attention was first called to this point by my assistant, Mr. John Walker, who tells me that the opinion of the fishermen at Newhaven is divided on the point, some saying that the convex valve, others that the flat valve, is the lower.

J. T. CUNNINGHAM

Scottish Marine Station, Granton, October 14

Two Generalisations

Two generalisations seem to have been staring us in the face for some time, and yet I have seen no one give them a look of recognition; they may be phantasms, but they seem solid enough:—

(1) That the number of elements is infinite; the most readily-formed types of ethereal vortices being the commonest, but our knowledge of them being only limited by the scarceness of the more complex forms, and not by any limit to the infinite varieties of complexity that may exist. Their relative commonness being analogous to the relative sizes of the bodies of the solar system; a few large, and always recognisable, and a greater number of examples as we descend in size to mere meteors. We already see that there are far more rare elements known than common ones.

(2) That the reduction of an electric current to heat in an imperfect conductor is solely due to the independent heat-motions of the molecules, which check and divert more and more of the current as their motions are larger; if there were no pre-existing heat-motions there would be nothing to resist a complete transmission of the current motion, and hence there would be no limit to conduction at the zero of temperature except the cohesion of the material.

Bromley, Kent W. M. FLINDERS PETRIE

Meteors

ON the morning of October 13, at 2h. 26m., I saw a fine meteor giving a bright flash at the end point and leaving a streak for about 12 seconds. It shot from the Lynx towards the pointers in Ursa Major, and while carefully fixing its direction relatively to the stars near, another conspicuous meteor, about as bright as Jupiter, crossed the lingering streak in a path but slightly inclined to it and of nearly similar length. I have never before observed two large meteors almost simultaneous and with paths so nearly identical.

I subjoin the observed paths of these meteors, also of five other bolides recently noted here during the progress of my habitual watches for shooting stars:—

1885	G.M.T. h. m.	Mag.	Path From ° °	To ° °	Length °	Radiant ° °
Sept. 9	15 48	♃	149 +82	152 +64	18	335+71
,, 15	15 11	♃	37 + 6½	26½+ 7	10½	70+ 4
Oct. 7	10 51	♃	51½+22	71½+24	18	31+18
,, 8	15 9	♃	155 +53	162½+46½	8	42+55
,, 12	14 26	♀	119 +51	151 +60½	20	88+18
,, 12	14 26	♃	119½+50	143 +60½	16½	103+33
,, 16	16 35	♃	213 +47½	226 +41	11	143+49

The radiant points are derived in each case by combination with many other meteors registered on about the same nights. I have seen 357 meteors since early in September, and those selected in the above table comprise all the brighter specimens estimated to equal Jupiter. W. F. DENNING

Bristol, October 17

Statigrams

THE increasing use of graphic representations of statistics by means of lines, areas, &c., seems to render it convenient to have some word which would specially designate diagrams exhibiting the progress and tendencies of the numerous tables of figures which do not pretend to strict scientific accuracy. The word *diagram* is used in most elastic senses and by all sorts and conditions of men.

May I suggest the word *statigraph* as a definite and convenient one for adoption? This might be sometimes shortened to *graph*; whereas *statigram*, if preferred, would not admit of this abbreviation. Most, if not all, graphic results of statists, economists, anthropologists, &c., might thus be termed *graphs*, whilst mathematicians and the experimental men of science would be left with the use of their own words, such as *curves*, *indicator diagrams*, &c. Each class would possess its own degree and limits of accuracy: mathematical precision and the doctrine of energy would apply to the latter, but *graphs* would be understood to involve human elements with intricate factors whose recognition or relationships the statistics are intended to elucidate and compare rather than to define and measure.

12, Merton St., Oxford J. F. HEYES

THE GEOLOGICAL SURVEY OF BELGIUM

PROBABLY no country of Europe has had its geology more attentively studied and mapped than Belgium. From the early labours of the veteran and pioneer

D'Omalius down to those of Dumont and his contemporaries, the structure of this country has engaged the attention of many able observers, and in its broad features is now well known. The map of Dumont, on the scale of 1-160,000, is one of the most excellent geological representations of any part of the European continent. But a good many years have passed away since its publication, and though it remains essentially accurate, it is now capable of improvement as regards details. Accordingly, after many discussions of the subject, a Commission was appointed to undertake a more detailed and exhaustive geological investigation of the country. This Commission consists of five members of European reputation, viz., M. Brialmont, Inspector-General of Engineers, one of the most distinguished engineer officers in Europe; M. Maus, Honorary Director-General of Bridges, Roads, and Mines, who made the preliminary plans for the piercing of the Mont Cenis Tunnel; M. Stas, the well-known chemist; M. Liagre, Perpetual Secretary of the Royal Academy of Belgium, who measured the geodetic base-line of Belgium; and M. Houzeau, Director of the Royal Observatory, whose writings on geological geography are widely appreciated. These able and thoroughly representative men of science were constituted as a Board of Control by which the operations of the Survey were to be governed, the practical carrying out of the work being placed in the hands of M. Dupont, Director of the Royal Museum of Brussels—a geologist of established reputation.

The work was begun in 1878 with the topographical map of the Engineer Department on the scale of 1-20,000th, or, roughly, about 3 inches to the British statute mile. It was estimated that the survey of the whole of Belgium on this scale would be completed in seventeen years from that date. This detailed map is divided into 430, or, excluding the frontier sheets, 369 sheets. Each of these is oblong in form, comprising an area of 10 × 8 kilometres, or 8000 hectares, or nearly 20,000 English acres. To produce upon this larger scale a map which should be only an enlargement and rectification of that of Dumont was very far from the object of the Commission. It was determined to adopt a monographic method of surveying. Each important geological system or group of formations has been entrusted to one or more specialists, who have given particular attention to its investigation, and who have been charged with the duty of tracing the same system or group completely across the country. Each geologist is furnished with two assistants who detach rock-specimens, collect fossils, make borings, and in other ways save the time and labour of the officer under whom they serve. Every actual outcrop of rock is marked on the map, and where the rock is fossiliferous the fossils are noted and the various palæontological subdivisions of the strata are traced, the collector being afterwards sent back where more ample collections are thought necessary.

It was from the first determined that the detailed geological map should be not merely a scientific undertaking, but a work of as much practical utility as possible. Special attention was accordingly given to the soils and subsoils, and care was taken to express upon the map the variations in the agricultural character of the ground. For greater exactness in this respect a system of boring was adopted. A stout auger was constructed which could be thrust a yard or so into the ground and bring up samples of the soil and subsoil. This instrument is made use of at intervals of 100 metres along the lines of traverse, so that the variations in the superficial layers can be accurately noted.

To secure harmony in the work, each officer entrusted with the survey of a particular series of strata from time to time confers with his colleagues who are engaged on contiguous bands, and thus the general geological structure of the country is worked out on a uniform plan.

Up to the present time thirteen sheets have been printed off, and many more are in various stages of engraving and preparation. It is believed that one-third of the entire work of the survey has been completed. The ordinary topographical maps of the État-major are printed from zinc plates, and with their crowded contour-lines and rather blurred printing are but ill adapted for the insertion of further geological details and the reception of colour. The Commission of the Geological Map accordingly decided to engrave this map on copper, adding new roads and other features, but leaving out all non-essential topographical details. By this means an admirably clear base has been secured for the delineation of the geological structure, while at the same time copper-plate engraving has been introduced as a new industry into Belgium. Comparing the ordinary sheets with their geological equivalents we are struck with the great beauty and clearness of the latter. Even for every day topographical use they are immeasurably superior.

One of the great problems of geological cartography is how best to pourtray at once the superficial accumulations and the solid rocks that lie underneath these. In this country it has been found practicable on the detailed six-inch maps of the Geological Survey to represent the surface-deposits by various kinds of stippling on the copper plates, the alluvia and the solid rocks being expressed by tints of colour. On the one-inch maps, however, which show the surface features by shading, this method cannot be employed. It has accordingly been necessary to issue two versions of each sheet of the one-inch map—one showing the solid rocks, the other representing the distribution of the various drifts and other detrital accumulations. These maps are coloured by hand, and are often of great beauty, but of course are somewhat expensive, more especially as two editions are needed to complete the representation of each district. M. Dupont deserves the admiration of geologists for having solved this difficult problem in an altogether novel way, and for having produced a series of maps which will probably inaugurate a new departure in geological cartography. His principle is to represent all the geological formations of a district, ancient as well as modern, upon the same sheet. As the superficial accumulations extend across much the largest area of ground, they are shown by various broad washes of colour over the tracts which they respectively cover. These colours, though they necessarily spread over most of each sheet, are kept so subdued in tone that they do not interfere with the easy legibility of the stronger tints employed to denote the underlying solid rocks. Every actual outcrop of these rocks is marked by a patch of the colour chosen for the particular formation. We thus note at a glance the localities where the rocks of that formation can be seen at the surface. At these outcrops, signs are inserted to mark the dip, and any lithological or palæontological subdivisions which have been noticed, and regarding which a detailed legend on the sides and bottom of the map gives ample explanation. So far the map is merely a transcript of what is observed in nature. But it is of course necessary to express the limits of the several rock-groups. And it is here that M. Dumont's ingenuity is most remarkable. He shows these limits by dotted lines, the dots varying in strength according to the importance of the limit which they define, and by strips of colour. Each stage has its margin defined by a shaded strip of its characteristic colour where the actual boundary is concealed, while where the junction of two stages or sub-stages is actually seen on the ground, the colours are not shaded, but of the full strength. The eye can thus easily follow the windings of such sub-division across the map, and can at a glance mark where the actual exposures are to be observed on the ground.

As the maps are chromo-lithographed it is quite simple to secure harmony of tone and great clearness and accuracy. We at once perceive what is actual observation and what is inference. One is put in possession of the data on which the geological boundaries have been traced, and can thus judge where and how far these are conjectural. We are not aware of any other published maps where this confession has been so frankly made.

The pale yellows and greys adopted for the superficial deposits cover so much of each sheet as to show at once how large a part of the ground is occupied by them. The detrital material is traced up to its source upon the table-lands, and being of poor agricultural value its colour on the map shows where farming operations are least likely to be successful. Where observations by boring or otherwise have been made on the nature of the soil and subsoil these are marked on the spot by the requisite sign, and as the borings are numerous these indications abound all over the map.

During the progress of the work improvements have been made in the methods of surveying and also in the modes of expressing geological details on the maps. In the Brussels area, for example, besides the ordinary borings into the soil and subsoil, deeper borings have been made to ascertain the nature and succession of the strata underlying the uppermost deposits. Messrs. Rutot and Van den Broeck, two of the staff, have invented an ingenious instrument with which they can ascertain the nature of the formations down to a depth of even 10 metres. By its means they have pierced below the sub-soil in all directions, and have accurately traced out the areas of the younger deposits around Brussels. The results obtained by them at each boring are clearly engraved on the map; so that at numerous points all over the district the farmer, the water-engineer, the railway-contractor, the quarryman, and others can learn precisely through what layers they must pass in any cutting or excavation beneath the surface. By another ingenious device, the section of each artesian well at Brussels is represented on the map beside the position of the well, and so clearly that the succession of rocks bored through may be taken in by the eye at once.

Each sheet of this detailed survey is so crowded with information that to those who have been accustomed only to the ordinary style of geological map-making it may at first seem a little confused. But if any one will take the least trouble he will soon find that the confusion is only in appearance. No maps have yet been published in any country giving so large an amount of accurate information with such clearness and precision, and where the actual facts are kept so clearly apart from inference. These sheets are not wall-maps to be looked at from a distance, but detailed maps to be closely studied in the hand. And they will well repay an attentive study. There is probably no national Geological Survey in any part of the world which may not find in them some useful hint or suggestion for its own improvement.

On completion of the detailed survey it is part of the original plan to prepare a smaller or wall-map like that of Dumont. But such a map is hardly needed; at least its preparation can well stand over until the whole country has been surveyed in detail by the methods so well conceived by M. Dupont. But besides the maps, the work of the Belgian Survey has included the preparation of ample explanations illustrative of the maps. Each sheet is intended to be accompanied with an "Explication" giving the detailed structure of the ground, descriptions of the rocks, natural sections, lists of fossils, and all the information required as supplementary to the geological maps. A number of these memoirs have already been printed. Each of them contains fundamentally three sections running N. and S. across the formations, which in Belgium have a general E. and W. strike. These sections are described in detail, and full local references are given. The books are well printed, and the coloured plates of sections are excellent, while a novel attraction is given by the insertion into the text of coloured engraved sections of special localities.

None of the maps or explanations, though they have been ready for some time, have yet been published. They are to be seen, however, in some of the public libraries and museums in Europe. Belgium has every reason to be proud of them, and we trust that the delay in their publication will speedily be followed by the issue of the whole series now ready and by the completion of those in progress. It is impossible to over-estimate the practical utility of such a detailed survey in a country like Belgium. No time should be lost in pushing on and bringing to a conclusion a work which has been so admirably begun.

ARCH. GEIKIE

THE THIRD INTERNATIONAL GEOLOGICAL CONGRESS

THE third International Congress of Geologists, postponed last year on account of the spread of cholera in southern Europe, has just been held at Berlin. Each successive gathering has far surpassed its predecessors in numbers and in the representative character of its members, the numbers attending the meeting at Berlin being no fewer than 255. Of these of course the large majority were Germans, who mustered in all 163. Italy, however, furnished 18 representatives; Austria, 16; Great Britain, 11; France, 10; United States, 9; Belgium and Russia, 6 each; Sweden and Switzerland, 3 each; Norway and Holland, 2 each; Spain, 1; Brazil, 1; India, 1; Japan, 1; Portugal, 1; Roumania, 1. The meetings were held in the buildings of the Reichsrath, or Parliament, the large room set apart for the deliberations of the Congress being that of the Lower House of Representatives, and no little interest was taken by the foreign geologists in the names of the Members of Parliament inscribed on the backs of the seats. The door also was pointed out from which the great Chancellor emerges to launch his philippics against the contumacious opposition. But the *genius loci* inspired no flights of eloquence nor much disputatiousness among the geologists. The use of French as the language of discussion was no doubt one effective cause of silence on the part of many members who would otherwise only too readily have made themselves heard. Under such circumstances the Latin races have of course a considerable advantage over the Teutonic. One of the Berlin papers gave articulate expression to the complaint that in an audience nearly two-thirds of which were Germans, French should have been chosen, and great was the delight expressed by the German element in the Congress, when the Minister of Public Instruction, who officially welcomed the assembly, gave his eloquent and appropriate address in German. But by common consent, and with much good humour, though often with a disregard for the claims of grammar, idiom, and pronunciation that must have been infinitely ludicrous to the French-speaking members, the international official language was used throughout the proceedings.

The ostensible work of the Congress, which lasted nearly a week, may be divided into five parts. Of these the first in order of treatment and also of importance was the report of the Commission entrusted at the previous (Bologna) meeting with the preparation of a geological map of Europe. During the four years that have elapsed since the Congress determined to undertake this work, satisfactory progress with it has been made. The topographical outlines of the map have been completed and engraved, and the Commission were able to show upon the wall a mounted copy of the outline map. The materials necessary for filling in the geology have already been supplied for a large part of Europe, and it is expected that in the course of next year the work will be so far advanced that proofs in colour of many of the sheets of the map will be ready. There can be no doubt that the preparation of this great map is the most important and useful undertaking of the Congress. It is an eminently practical piece of work, with an attainable aim which unites the geologists of all European States in a common definite labour. The engraving and colouring of the map are carried on in Berlin. Judging from the present state of the engraving and from the scheme of colours adopted, we may confidently anticipate that the completed map will be a singularly clear and beautiful specimen of cartography, and will form a noble monument of international co-operation.

The second subject, to which the Congress devoted most of its time, was the unification of geological nomenclature. Reports had been received from different countries as to the names and classification of the various subdivisions of the geological record. But the wide differences of opinion expressed in these reports showed how little prospect there was that anything approaching to unanimity on such a subject would be reached by the Congress. It is to be feared, indeed, that the endeavour to unify stratigraphical nomenclature all over the world is more Utopian than practical. Nature is not everywhere uniform, and it seems almost puerile to strive after a uniformity of classification and terminology which has no counterpart among the rocks themselves. The Congress itself appeared to realise this, for it wisely postponed the consideration of all questions about which there could be any serious differences of opinion, and adopted only those propositions which nobody would controvert, and which hardly required an international congress to settle. Thus it was agreed that the Archæan rocks should be divided into sections according merely to petrographical characters and without expressing any opinion as to their relative age. The vexed question of the Cambrian and Silurian classification was postponed until the next Congress three years hence. A day was spent in discussing the position of the Permian system, with the result of leaving it for the present where it is usually placed. The subdivisions of the Mesozoic and Tertiary rocks were rapidly enumerated, but no discussion of them was possible in the time. In truth, it is difficult to see how any real effective discussion of these subjects can be attempted at the ordinary meetings of the Congress. The assembly is so large that probably only a fraction of the audience is really competent to express an opinion on the particular subject under debate. Some of the members who might contribute most valuable suggestions are deterred from so doing by their timidity in the use of the French language. To count the heads of so miscellaneous an audience and say that such and such are the decisions which it has voted can really carry little weight with the geologists of the world at large. Such at least was the opinion freely expressed among the members at Berlin. There was a very general feeling that the less the Congress attempts in the way of authoritative decision or legislation the more likely is it to carry on effectively other functions which are of far more general importance and usefulness.

Thirdly, the reading of communications on geological questions of general interest. Several good papers were read, but the thinned audience showed that this part of the programme was not very popular. There seemed to be no careful selection of papers, for some of those that were read hardly deserved a hearing before an international gathering of geologists. If this section of the proceedings is retained, it might be well to invite beforehand a few men of acknowledged reputation to give discourses, each on his own subject. There would be a strong desire to hear the masters of the science, and if three or four of them of different nationalities could be induced to accede to this proposal, there would be no need for catering among the rank and file of the assembly for papers to fill up the time.

Fourthly, an exhibition of geological maps, sections, specimens, and models. This collection was arranged in the room of the Bergakademie, and proved a source of much interest and instruction. The series of national geological surveys represented on the walls embraced a large part of Europe, and included some admirable examples of cartography. Among the specimens special attention was given to those exhibited by Mr. Reusch, showing Silurian fossils in the crystalline schists of Norway, those of Dr. Lehmann illustrating his work on metamorphism, the wonderful group of amphibian remains shown by Prof. Credner, the series of fossils brought by Dr. Torell from the Primordial and Lower Silurian rocks of Sweden, various collections from different localities among the Cretaceous rocks of Germany, and a remarkable assemblage of specimens of northern rocks and fossils from the drift of North Germany, exhibited by Dr. A. Remelé.

Fifthly, excursions to places of geological interest. At the close of the Congress a large number of the members proceeded in a special train to Potsdam, and spent a day seeing the sights of that royal demesne. Next morning they started for Thale in the Harz, whence, under the able guidance of Prof. Lossen, they were enabled to see some of the more interesting features connected with the protrusion of the granite and the metamorphism of the surrounding rocks, likewise the succession of stratified rocks up to the Chalk, thrown against the flanks of the Harz. From Thale the party travelled to Stassfurt, and descended into the salt mines, which were illuminated in its honour; thence to Leipzig, where Prof. Credner acted the part of host and guide, and from which an interesting excursion was made into the Saxon granulite region.

But it is not by its formal and ostensible proceedings that the usefulness of the Congress is to be measured. There was a widespread feeling which constantly found audible expression, that the opportunities it afforded for personal intercourse and exchange of views were amply sufficient to justify its existence and to give assurance that it would long continue. The discussions among the animated groups in the corridors and ante-rooms were much more vivacious and probably quite as conclusive as those held in the large room. But most useful and enjoyable of all was the nightly *Kneipe* held in some beer-saloon. There in a thick and pungent atmosphere of tobacco-smoke, amid the clattering of beer-jugs and shoutings for the *Kellner*, many of the foremost geologists of the Congress gathered together — stratigraphists, petrographers, palæontologists, mineralogists — full of scientific enthusiasm and good fellowship. Loud and long were the debates in these dim retreats. Tongues that had been shackled by French articulation now shook themselves free in the unrestrained vernacular of the country. There were no reporters of course, and no record remains of the discussions. But the recollection of these evenings will not soon pass away from the memory of those who took part in them. Men from distant parts of the world who had only known each other's writings, or at most had exchanged letters, were here brought face to face, and the foundations of many a pleasant and profitable friendship were doubtless laid.

Great praise is due to the organising Committee at Berlin, and especially to its indefatigable General Secretary, Herr Hauchcorne, for the arrangements made for the business of the Congress and the comfort of the visitors. Every detail seemed to have been carefully planned, and the result was evident in the smooth working of the whole machine. It was a great gratification to see the venerable Dr. Von Dechen presiding over such an assembly of geologists, and to hear his reminiscences of the early days of European geology. The *bonhommie* of the President, Prof. Beyrich, put everybody in good humour, and the active guidance of the former President, Prof. Capellini, contributed largely to the success of the Congress.

The next session of the Congress is to meet in London between August 15 and September 15, 1888, and Messrs. Blanford, Geikie, Hughes, and Topley have been nominated a committee to make the necessary arrangements.

BOTANICAL EXPLORATION OF THE CHILIAN ANDES

WE are indebted to the Kew authorities for the accompanying extract from a letter dated August 21, 1885, addressed to Sir Joseph Hooker by Dr. R. A. Philippi, the Professor of Botany at Santiago:—

"My son made in the summer during 110 days a voyage from Copiapo to the River Camarones, the actual boundary between Chili and Peru. He went first from Copiapo to Antofagasta de la Sierra (26° 5′ lat., 27° 20′ long., 3570 metres above the sea), where about 60 to 100 people are living, and thence (nearly always on the high table-land of the desert at an elevation of 3500 to 4200 metres) to Huasco de Tarapacá, from whence he descended to the tamarugal. The voyage extended over 8 degrees of latitude. This high table-land is nearly a single bed of trachytic lava, on which are scattered a number of extinct volcanoes, three of which are higher than Chimborazo—viz. the Llullaillaco, 6600 metres (I was, twenty-one years ago, at its west foot); the Tumiza, 6540; and the Pular, 6500 metres. There are many large salt lakes, several entirely dry. The vegetation in this easterly part of the desert is not so scanty as in the westerly, visited formerly by me, perhaps owing to a slight influence of the trade wind; and the water-places are more numerous and nearer one to the other.

"The number of species of plants brought home exceeds 400, of which half are not described. Amongst them is one *Polylepis* (without flowers), found only in one quebrada, and *Pilostyles Berterii*, a parasitic plant belonging to the same family as *Rafflesia*, found at the height of 3700 m.!—of course on an *Adesmia*. The three species of ferns are: *Pellæa ternifolia*, *Cheilanthes micropterus*, and a beautiful *Cincinnalis* which seems to be new. The most numerous family is, of course, Synanthereæ, with 94 sp.; Gramineæ has 42 (among them a new species of *Munroa*); Leguminosæ, 28-29; Verbenaceæ, 15; Solanaceæ, 28; Chenopodiaceæ, 15. Amongst these plants nine or ten must form, in my opinion, new genera. Some are very curious, as a Verbenacea, which grows in small hemispherical tufts and has the aspect of a Synantherea, with sessile flowers and pappus. This pappus proved to be a deeply-divided calyx with long cilia. There is another genus which I took at first sight for a *Tribulus*. I hope that my age, my health, my eyes, and my time will allow me to draw up the generic diagnosis, at least, of these plants."

KRAKATÃO

THE publication of the first part of Verbeek's "Krakatão," which chiefly contained the *history* of the great eruption of 1883, had raised many expectations regarding the promised description and discussion of the *phenomena* then observed. In his completed work, which contains 25 coloured drawings and 43 large and small maps, those expectations are fully realised. Immediately after the great outburst of August, 1883, the Dutch Indian Government sent him to visit Krakatão and to investigate the causes and effects of this awful catastrophe, more sudden and destructive than the famous eruption of Vesuvius. The great facilities they placed at his disposal enabled him to do this in the most satisfactory manner, and the really beautiful character of his completed work reflects the greatest credit not only on the learned author, but on the zeal and public spirit of the Dutch-Indian Government, who have aided him in making so valuable a contribution to scientific knowledge. So much interest has been taken by the general public, as well as by men of science, in this remarkable eruption, that we feel certain they also will welcome this volume, since it is lucid in style and profusely illustrated. With an expression of his gratitude to various institutions and individuals who have rendered him valuable assistance, the author gives in the preface a list of the weights and measures, together with a summary of the most recent ideas that geological science has received from the Krakatão eruption.

Krakatão itself lies on the point of intersection of three fissures or cracks in the earth's crust, and from this position is naturally exposed to volcanic disturbances. The earthquake of September 1, 1880, which damaged the lighthouse on Java's First Point, probably affected the Sunda fissure and facilitated the entrance of greater quantities of water into the volcanic furnace underlying the Straits of Sunda. Accepting the theory that volcanic eruptions are caused by steam at high pressure, we have thus the probable explanation of the terrible outburst of 1883. From the observations of earthquakes in the Indian archipelago during the year 1883, it appears that the eruption was neither preceded nor accompanied by heavy shocks. It is even far from certain that any trembling of the surface took place at the time, since the vibration of the air caused by the explosion was sufficient to shake houses and crack walls, and thus might easily have been mistaken for earthquakes. The author further treats of the ejected materials; their thickness, which, on some parts of Krakatão, amount to 60 metres; their size, varying from bodies of one cubic metre to the finest dust; the velocity with which they were thrown out, which must have been considerably greater than that of projectiles from the heaviest rifled ordnance; the elevation which they reached has been calculated at 50 kilometres, or nearly six times the height of Mount Everest, the highest mountain of the world, and the ashes have fallen over an immense area. From investigations made at fifty different places regarding the thickness of the fallen ashes and also the change in the depth of the sea around Krakatão, M. Verbeek has calculated that at least 18 cubic kilometres of matter must have been ejected. To give an illustration: imagine a box of ashes as large as Hyde Park and as high as the dome of St. Paul's, a hundred such boxes will give an idea of the mass of matter thrown out by Krakatão in 1883.

For three days after the eruption various ships to the westward found ashes falling on their decks; the names of these ships are given, as well as a map showing their exact position at the time. Mr. Verbeek believes that the finest particles, forced by the steam into the upper air, did not descend, but were carried westward by strong east winds, making twice the circuit of the earth and causing the phenomena observed at various places of a blue and green sun and moon. The passage of this cloud has been reported from islands and ships in the Pacific Ocean and its velocity must have been as great as that of a hurricane. After the steam and dust-cloud were dispersed over a wider area the beautiful red sunsets occurred, which were owing to the presence of such a large volume of aqueous vapour, while the blue and green colours of the celestial bodies were caused by the solid particles in the air.

The author goes on to elucidate the geology of Krakatão by two maps and four very instructive sections, showing its development during that number of periods. The first period was marked by the destruction of the great cone, probably 2000 metres high; during the second period the peak Rakata was formed by a lateral eruption, while in the third period two parasitic cones, Danau and Perbvewatan, were added, and these, by their successive eruptions, built up the island of Krakatão. In the fourth period two of these cones have been destroyed by the terrible eruption of 1883. As our authentic records of Java only date back 300 years, we have absolutely no data respecting anything that occurred in the first three of these periods. We have accounts of an eruption of the Perbvewatan in the year 1680 from two travellers—Vogel and Hesse—to which I drew attention in the *Algemeen Dagblad van Ned. Indie* of May 23, 1884; but they say nothing as to whether that crater was formed at that time or had been already active. After a rest of 203 years the Perbvewatan became again active in May, 1883, and the Danau joined it in activity during the following June, forming the principal crater in the centre of the old volcano. In August, at the great eruption of the 27th, this part of the volcano was again destroyed; the Perbvewatan and the Danau, with the northern half of Rakata Peak, disappeared, and the site of the old crater is now covered by the sea between the islands Lang, Verlaten, and Krakatão.

If the volcano resumes its activity, which is to be expected since the island lies on such a favourable point for eruptions, then small islands will appear between the three already mentioned. Krakatão has been at rest since 1883, although it has erroneously been reported to be active. The roll of thunder and the flashing of lightning over the ruins of the crater wall have been mistaken for the action of subterranean forces, while the volcanic dust swept off from the crumbling summit by the wind appears at a distance like smoke.

A very curious and interesting feature of the recent eruption of Krakatão was the ejection of fragments of underlying sedimentary rocks. The base of the Krakatão volcano, and in general the entire bottom of the Straits of Sunda, consists of eruptive rocks of the miocene period covered with horizontal layers of diluvial and recent marine deposits, the materials of which have been derived from the various volcanoes in the vicinity.

The first volume of Verbeek contained a valuable report from his colleague, Mr. J. A. Schuurman, on the phenomena of the eruption of May, 1883, as observed by himself, and the second volume has a lengthy and minute description by the mining engineer, Mr. J. W. Retgers, of his microscopical examination of the ash which fell at Buitenzorg, and of the various substances thrown out by the eruption of 1883, as well as of the older rocks.

A portion of the pumice which covered the sea after the eruption was carried westward by winds and currents and driven on the shores of various islands, even so far as the east coast of Africa. Another portion, which floated in the bays of Semangka and Lampong for several months, being driven in the beginning of 1884 by westerly winds along the coast of Java toward the Moluccas and Australia, is at present encountered in the Pacific Ocean between the Caroline and Marshall Islands. The author has calculated that this pumice will arrive on the west coast of America at Panama early in 1886.

With regard to the spherical bodies of a calcareous and clayey nature, called "Krakatão marbles," found lying loosely on the surface, Mr. Verbeek at first supposed them to have been formed by the rotary motion of particles ejected from the volcano, but as they were afterwards found imbedded in ejected fragments of claystone and marls, this theory must be given up; he considers it possible that there may have been concretions in the tufa, although their presence in rock sometimes quite destitute of lime is certainly surprising, and this form of concretions has not been observed hitherto.

The chemical analyses of the rocks of Krakatão can be fully relied upon, as they have been made by Dr. Cl. Winkler, Professor of Chemistry in the well-known Mining School of Freiberg, in Saxony. Dr. P. J. van der Stok, Director of the Meteorological Observatory at Batavia, proves that the disturbance in the position of the magnetic needle observed during the falling of volcanic dust was due, not to the eruption, but to the presence of magnetite therein, since the disturbance only lasted during the shower of ashes.

The low temperature observed at that time at Batavia, Buitenzorg, Kroë, Moeara-Doea, Bandar, and elsewhere was not due, according to hygrometrical observations, to the evaporation of the humidity of the ash; near the volcano and on ships in the vicinity it was oppressively hot, but the ashes thrown into the icy regions of the upper air and falling at a distance from the volcano had become cooled in their passage. Heavy electrical discharges occurred continually in the ash cloud around Krakatão. On Java's First Point and at Flat Point the lighthouses were struck by lightning.

On Sunday, May 20, 1883, all Batavia was in great commotion as to the cause of the mysterious sounds and detonations which apparently came from the west and in fact did come from Krakatão. At Serang and Anjer, which are situated much nearer to the volcano, no sounds had been heard. Again at Batavia on the morning of Monday, August 27, after the tremendous detonation at 8h. 26m., the eruption seemed to have ceased; they heard nothing at all of another enormous explosion which took place between 11 and 12, as reported from Middle and East Java. The explanation of this curious phenomenon is that earlier in the morning an ash cloud like a gigantic lamp-shade settled over the volcano, extending as far as Bandong, and that the quantity of these ash particles floating in the air prevented the transmission of sounds. Above the ash cloud the detonations were transmitted in all directions, but naturally were most distinctly heard to the windward. The farthest points where the sounds have been heard are Doreh, in New Guinea, some points of Central Australia, among others the telegraph stations of Daly Waters and Alice Springs, the islands of Rodriguez and Ceylon. Accounting for the difference in time and taking the rate of transmission of sounds, the author has calculated for different places which grand detonation in particular has been heard. The detonation of Monday morning, 5h. 30m., has been heard in Australia; that of 10h. 2m. a.m. has been heard at Banca, Billiton, the west coast of Borneo, the southern and eastern divisions of Borneo, Bawean and Banda; that of 10h. 52m. a.m. at Riouw, Middle and East Java, Bali, &c.; the last two detonations have not been noticed at Batavia and Buitenrorg. The area within which the explosions have been heard is represented on a map; it amounts to one-fourteenth of the whole surface of the globe—a quite extraordinary transmission of sound over so large a space. From the vibration of the air caused by the heavy detonations houses, doors, windows, clocks which hung against the walls, objects which stood on cabinets or were suspended from the ceiling were set trembling; but the swinging movements given to hanging objects by earthquakes have nowhere been observed. That some walls have been cracked, and houses been damaged so as to be no longer habitable, can be accounted for, according to the author, by the probability that they were already weak, and thus had an opportunity of showing it.

The greatest air-disturbance caused by the eruption has transmitted itself as a regularly moving atmospheric wave, with Krakatão as centre, over the whole earth; and to the discussion of this entirely new phenomenon the author has devoted about seventy pages. With the assistance of very accurate barograms from Sydney, N.S.W., he calculated the heaviest explosion and fixed it at 10h. 2m. a.m. Krakatão time. The same result has been arrived at by another calculation based on the markings of the indicator of the gasworks at Batavia. That indicator marked fifteen oscillations, corresponding with as many explosions, of which the four severest occurred in the forenoon of Monday, August 27, at 5h. 30m., 6h. 44m., 10h. 2m., and 10h. 52m., Krakatão time. Of these four, that of 10h. 2m. a.m. was by far the greatest, and it is probable that the air-wave then formed made the tour around the world. Forty places in Europe, America, and Australia are named where the disturbance of the air has been indicated by barometers, and with the help of these data the author has been able to calculate the velocity of the air movement, which has been found to be considerably less than the velocity of sound at 0° C.; consequently the movements took place at a great height and in cold-air strata.

According to the author's calculation this air-wave required 35½ hours to make the circuit of the earth; it would have been of great interest to know just when the wave returned to Batavia, but, unfortunately, the diagrams of the indicator at the gasworks that might have marked such a return have been lost.

Part of Chapter V. treats of changes in the sea-bottom. The sea now covers to a depth of 200 to 300 metres what was formerly the northern part of Krakatão, and the small island called Polish Hat has also disappeared. Between the remaining islands, which are fragments of the old crater ring, an area has subsided of at least 41 square kilometres, or about 10,000 acres. Outside these islands, within a triangular space of 34 square kilometres, the sea is also deeper than formerly, so that altogether a surface of 75 square kilometres has subsided, which is clearly shown on maps 1, 2, and 4.

The part of the Peak which has disappeared must have been 1 cubic kilometre in size, and the fall of such a mass into the sea is quite sufficient to cause the great sea-wave which swept away thousands of human beings. Nowhere is there the slightest vestige of any upheaval, from which we may be certain that no seismic movement of the sea-bed has occurred. In Bantam and in the Lampong districts, after the disaster, the remains of the macadamised roads along the coast were everywhere as high above the sea as before, and soundings in Sunda Straits showed that no change of sea-bottom has taken place there. The shallower depth in the immediate vicinity of Krakatão, and between Krakatão and Sebesi, has probably been the result of fallen materials, to which also the islands Steers and Calmeyer, which have since disappeared, for the greater part, no doubt owed their existence.

As the last of the phenomena which accompanied the eruption of 1883, the movements of the sea are discussed, as shown by the destructive waves which have made this catastrophe so terrible. It is certain that the greatest wave of all started from Krakatão at 10 a.m., and that wave completed the destruction of Telok Betong, Anjer, and Tjiringin. This great wave had been preceded by small waves on Sunday afternoon at 6, and Monday morning at 6h. 30m., by which these places were already partly submerged and destroyed; but the really very remarkable phenomenon was observed that not every wave reached all the places situated along the coasts of the Straits of Sunda. For example: the wave which destroyed on Monday morning, at 6, a part of Anjer, and at 6h. 30m. the lower part of Telok Betong, has not been noticed at Tjiringin. The author explains this by the supposition that the preceding waves were not caused by the falling in of parts of the volcano, but by the enormous quantities of ejected matter that splashed into the sea. Suppose on Sunday evening during the eruption of 5h. 7m. a large quantity was thrown out on the spot where Calmeyer lies, the wave thus formed was noticed everywhere around —at Merak, Anjer, Tjiringin, Beneawang, Telok Betong, and Ketimbang. If, during the eruption on Monday morning (5h. 30m.), the matter was thrown down on the spot where Steers lies, then the wave would be obstructed in a south-easterly direction by Calmeyer, and Tjiringin, lying behind it, be protected, whilst the wave would roll to Anjer, where it must have arrived a little after 6 a.m. In like manner, at the explosion of Monday morning (6h. 44m.), Anjer and Tjiringin were protected by Krakatão, and Telok Betong by Lagoendie, whilst Beneawang in the Bay of Semangka was nearly destroyed; but the wave of 10 o'clock being of such enormous magnitude, swept over all obstacles.

Most careful calculations fix the time of the formation of the great wave at 10 a.m., the same hour at which the heaviest detonation was heard, so that the ejection of a stupendous quantity of ashes, pumice, and mud, the rushing in of the sea upon the mass of glowing lava, and the falling in of half the mountain, must have taken place almost simultaneously. From the height registered by the tide-gauges at Tandjong-Priok on Monday at 7h. 30m. p.m. it is evident that Batavia narrowly escaped a second inundation. The data collected from all parts of the world regarding an extraordinary movement of the sea soon after the eruption, made it possible to compute the velocity of the great wave, and this velocity enabled the author to calculate the average depth of the sea along the path the wave travelled. In this way he has ascertained that the depth of the sea between Krakatão and South Africa must amount to 4200 metres; between Krakatão and Rodriguez, 4560; and between Krakatão and South Georgia, 6340 metres; which shows that west and south-west of Australia there must be a deep-sea basin, the existence of which has not yet been revealed by soundings. Mr. Verbeek considers that, if the irregularities of the tide noticed at Aspinwall happened at the hour reported, they were not caused by the Krakatão wave, but by volcanic activity in the Antilles; that wave, however, was observed on the coast of France, at San Francisco, and even in Alaska. Its velocity was so great that it reached Aden in twelve hours, a distance of 3800 nautical miles, usually traversed by a good steamer in twelve days.

It is greatly to be regretted that our knowledge of this phenomenon beyond the Indian Ocean remains incomplete, on account of the small number of tide-gauges on the Atlantic and Pacific coasts; the author suggests that this want shall be promptly supplied, so that in future no important movement of the sea shall escape notice.

Chapter VI. is devoted to a consideration of the volcanic phenomena which have been observed during the eruption of Krakatão at other places within or beyond the Indian Archipelago. Simultaneously the volcano Gœnong Api, on the island of Great Sangi, the Merapi on Java, the Merapi on Sumatra, and also, it is supposed, a volcano in the Moluccas were in activity. A seismic movement of the sea-bottom occurred in the whole region of the Moluccas, which could not have been due to Krakatão, and this movement has been noted by three tide gauges in the Straits of Madura. Over a large part of Australia, from August 27 to 29, more or less serious earthquakes were felt—a phenomenon the more remarkable because Australia suffers very seldom from any shaking of the earth. It is probable that sudden displacements of steam—perhaps of lava—occurred in the subterranean cavities, caused by a change of pressure through the great discharge of lava and steam at Krakatão. We must therefore conclude that the underground recesses between Krakatão and Australia are in some way connected, so that any change of pressure in one cavity causes a change of pressure in the other.

Even at points in the neighbourhood of the antipodes of Krakatão shocks and volcanic effects were noticed, and if, as is probable, some point in the Antilles was in activity, then evidently the whole surface of the earth during the terrible discharge of Krakatão was agitated, and apparently the crust of our earth is not so solid as many of its inhabitants fondly imagine.

The author maintains the doctrine that part of our globe remains still in a molten state, and he disputes the theory, which has been advanced, that the heat of the volcanic furnaces is entirely due to local chemical action. He, however, acknowledges that it is very difficult to explain why, during the Krakatão outburst, the antipodes was more favourably situated for an eruption than the other volcanic regions of the earth. A similar tendency during former eruptions has not been recorded, and we must wait until another great outburst enables us to decide whether it is of any importance.

The coloured drawings, twenty-five in number, are all by Mr. Schreuders, who accompanied Mr. Verbeek in October 1883, and give a faithful picture of the devastated regions as they appeared two months after the eruption. The most striking picture is that of the stupendous wall, 832 metres high, which was laid bare by the destruction of the northern part of the peak. No one who has gazed upon this grandest of nature's ruins can forget its solemn desolation.

The careful typographical execution of the work reflects great credit on the Director of the Government Printing Office at Batavia. We can heartily congratulate the learned author on the successful completion of his most valuable and exhaustive work, interesting alike to the scientific and general reader.

ON THE COLOUR-SENSE

THERE is an interesting paper in the *Nineteenth Century*[1] for February last in which the colour-nomenclature in the Homeric poems and that of the modern Hindústání language are compared with modern English usage. The writer traverses to a great extent Mr. Gladstone's suggestion[2] that the ancient Greeks were deficient in colour-sense (*i.e.* compared with modern Englishmen), and propounds the idea that the natives of India have a keen colour-sense.

It will be shown below that the use of colour terms in modern English is not only loose, but even incongruous. Illustrations will be taken from both the papers referred to, with additions from the author's experience in India.

Natural Objects.—Uniformity might surely be expected in the use of colour terms with bright-coloured natural objects. There is, however, no uniformity in their use, even when intended to be real colour designations; and opposite and sometimes unnatural colours are—in a figurative sense—ascribed to a single object.

Thus the colour of fresh blood and the tint arising therefrom in the healthy cheek and also in the blushing cheek (of a fair person) are probably among the most well-marked, definite, natural colours. Yet the blood itself is styled *blood-red*, *gory*, *crimson*, *red*, *scarlet*, whilst the healthy cheek is described as *carnation*, *vermeil*, *red*, *ruddy*, *rosy*, and *pink*, and the blushing cheek as *scarlet*, *crimson*, *red*, *aflame* (perhaps rather a heat than a colour term). These terms, though used as real colour designations, are by no means synonymous, whilst in a figurative sense quite different and even unnatural colours are ascribed. Thus *blue blood* is used of aristocratic descent, *black blood* and *white* or *pale blood* of descent from dark or fair races.

Again, healthy bile is bright yellow, and a yellowish tinge in the "white" of the eye is often called a *bilious* colour; yet in the figurative sense black is ascribed to the condition known as *melancholy*, *atrabiliousness*, *black bile*.

The colour of good milk is so characteristic as to give rise to the term *milk white*, whilst skim-milk or poor milk which has merely a blueish tinge is styled *sky-blue*.

Again, the parts of the human eye and of a bird's egg styled from their characteristic tint the *white* of the eye and the *white* of an egg, always bear the *name* of *white*, although occasionally of a decidedly blueish tinge, stronger than that of skim-milk.

Colour is usually ascribed to the human eye from the tint of the iris, probably as being the part most subject to colour-variation—*e.g.* *black*, *dark*, *pink*, *brown*, *hazel*, *green*, *blue*, *gray*, *light*. Of these, *black* is loosely applied (*e.g.* in the phrase *black-eyed*) in the case of any dark-coloured iris, whilst *green* and *blue* are used in the case of a mere tinge of green or blue.

On the other hand the phrase *red eyes* indicates either redness of the eyes (as from weeping) or a bloodshot state of the "whites," whilst a *black eye* implies only a dark-coloured bruise of the skin near the eye; *green in the eye* is a figurative expression implying freshness or ignorance, and *green-eyed* is a condition ascribed to jealousy.

The colour of sea-water varies from greenish (aquamarine) to a deep blue (ultramarine); but a wide range of colour-names is applied to various seas—*e.g.* the *Black Sea*, *Red Sea*, *Yellow Sea*, *White Sea*, and this in many languages.

The colour of river-water varies from turbid yellow to blueish and colourless; but in this case there is an equally wide range of colour-name—*e.g.* *Blackadder R.*, *Blackwater R.*, *Red R.*, *Orange R.*, *Green R.*, *Blue R.*, *Blue Nile*, *Grey R.*, *White R.*, *White Nile*, *Whiteadder R.*

Human Colouring.—Colour-terms, applied to races of men, or to the complexion or hair, are loosely used to cover a wide range of colour. Thus *black*, *dark*, *dusky*, *swarthy*, and *nigger* (*lit.* black), are applied to any merely dark skins; *red* and *coppery* to the whole of the North American (so-called) Indians; *white* and *pale* to any fair skin. The terms *dark* and *fair* (shade- rather than colour-names) are loosely applied both to the complexion and to personal description. Thus any complexion darker than the average in a fair race, or fairer than the average in a dark race, is called *dark* or *fair* respectively; the two terms being merely *relative* in this usage.

Also among a fair race, a person with dark eyes and dark hair is called *dark*, and one with light eyes and fair hair is called *fair*, without reference to complexion. Again, the terms *red*, *carroty*, *fiery* are often applied to hair which has merely a reddish tinge.

Among races of different complexion in the same country curious figurative usages of the racial colour-terms arise. Thus *nigger* (*lit.* black), *black*, *dark*, *redskin* are sometimes used by a (ruling) fair race to denote inferiority, and this usage is sometimes adopted even by the (ruled) dark race—*e.g.* occasionally by both negroes and natives of India. There is a curious restricted use of the phrase *gorá log* (*lit.* fair people) in India to denote the British soldiery, but not the higher classes of English.

Animal Colours.—Colour terms applied to animals have sometimes a technical meaning quite different to the fundamental colour. Thus *bay* and *strawberry*, as applied to horses, are very different colours from those of the bay-leaf and strawberry; thus also the Hindústání term *sabz*, usually meaning green, denotes *gray* when applied to animals. Again, *red* is applied to animals—*e.g.* cows, deer, foxes, squirrels, &c., whose coats are any sort of reddish-brown. A similar usage occurs in the Homeric poems—(*e.g.* φοινιξ and its derivatives), and in the Hindústání word *lál* (*lit.* ruby).

Colour-terms are sometimes applied to animals, plants, &c., even when only slightly affected with the named colour, to indicate a particular variety of the object in question. Thus a *blue* pigeon, fox, or rabbit, is only slaty blue; a *white* elephant is only spotted with white pink patches; a *blood* orange may be only speckled with blood-markings; a *black lion* and *black* leopard are only dark with black markings. Colours differing from nature are also ascribed to animals on signboards—*e.g.* *black*, *red*, *blue*, *white* lion; *blue* bear, &c.; thus also *green* man; also (in cookery) a *green* goose.

Artificial Objects.—Among artificial objects, even of strongly-marked hue, colour-terms are often strangely mis-

1 "Light from the East on the Colour Question," by W. J. Furrell, p. 321 of *Nineteenth Century* for February, 1885.

2 "The Colour Sense," by the Right Honourable W. E. Gladstone, M.P., p. 366 of *Nineteenth Century* for October, 1877.

applied (sometimes apparently by contrast with the characteristic colour). Thus all wines which are not of some red tint are loosely styled *white wines*, though their real colours are various shades of yellow, golden, and orange. Again, light-coloured hats, usually light gray, drab, or brown, are often styled *white* hats, probably in contrast with the black chimney-pot hat so common in England. The colour-term *green* with the figurative sense of "fresh," is applied to unseasoned timber and to freshly-quarried stone.

Metals.—Whilst some few metals have a sufficiently striking colour to give rise to a special colour-name—*e.g.*, *coppery*, *bronze*, *brazen*, *golden*, *aureine*, *steel-blue*, *leaden*, *iron-grey*, *argent*, *silvery*, the most of them have a general similarity of tint, and are loosely called *white* (probably in contrast to the coloured metals), whilst a mere tinge of blue in some of them leads to their being called *blue* (*e.g.*, lead, zinc, steel).

Curious applications occur in trade names: thus, *white metal* is used of any cheap alloy resembling silver in appearance; *white brass* is a whitish alloy of copper and zinc; *gray iron* and *white iron* are cast iron whose fracture is grey or white; whilst *white lead*, *zinc white*, *white arsenic* are the white oxides of the metals in question; *red lead* is the red oxide of lead, and *black lead* is really plumbago (which resembles lead only in its property of marking paper); *white*, *yellow*, *orange*, and *red*, when applied to gold, denote alloys of gold in which the golden colour is modified *slightly* in the directions indicated; *red-short* is an epithet descriptive of malleable metals which are brittle when hot.

Blue and Black.—There is a curious confusion between *dark blue* and *black* in both English and Hindústání. Thus, in English there are *blue-black*, *invisible blue* (both used of a very deep blue almost black), *black and blue* (applied to a bruise), *black as ink* and *inky black* (although most inks are nowadays blueish) often applied to rain-clouds (nimbus) and to the deep indigo blue of the deep sea, quite like the Hindústání phrase *kálá páni* (*lit.* black water) used of the sea. Dark blue cloth is by some (even by ladies) habitually called *black;* the writer has also known *black*berries miscalled *blae*berries (by a Scotch-woman), although *blae* is literally blue; this is quite like the Hindústání word *kálá*, which is used for both *black* and *dark blue*, especially in cloth. This confusion is curious in English, wherein the terms *jet-black*, *jetty*, *coal-black*, exist for a true black. In the melody, "The Coal-black Rose," the colour is attributed really to a person of the name of Rose.

Physical States.—Colour-terms are applied to physical states, sometimes in an exaggerated sense (the name of a bright colour being ascribed to any faint tint of the same), and sometimes in a special and almost inexplicable sense.

Thus we speak of *the black death*, *as black as death*, *black looks*, *looking as black as thunder*, *scarlet fever*, *yellow fever*, *jaundice*, *turning green with sickness*, *being beaten black and blue*, *blue with cold*, *a fit of blue devils*, *pale* or *white with illness* or *with loss of blood.*

Mental, &c., States.—The connection of colour terms with mental and moral emotions, conditions, and actions, is curious and often inexplicable.

Thus *black* is associated with the idea of evil—*e.g.* the *blackest of lies*, *black as sin*, *blackened with crime*, *as black as the devil;* and also with degradation in both English and Hindústání—*e.g.* to *blacken one's face* (Hind. *munh kálá karná*) implies disgrace in both languages. Again *black*, *purple*, *crimson*, *red*, *scarlet*, *pink*, *livid*, *pallid*, and *white* are all ascribed to rage; whilst *crimson*, *red*, and *scarlet* are also ascribed to shame, in both cases doubtless from their effect on the hue of the cheek. Further *crimson*, *red*, and *scarlet* are associated with crime (probably from their connection with blood), and also with sin generally—*e.g. red-handed*, *sins as scarlet*, the *scarlet woman*, &c. Next *black*, *yellow*, and *blue* are all used of depression of spirits—*e.g.* in the words *melancholy*, *atrabilious*, *jaundiced*, a *fit of the blues.* Again, *green* and *verdant* are used of the freshness of youth and of the state of a novice, and in this use both these colour-terms are oddly attributed to the eye; whilst *green* is also applied to (unusual) freshness in old age. The terms *green*, *blue* (*e.g.* a blue funk), *pale*, *pallid*, *livid*, *ashy*, *gray*, and *white* are all used as descriptive of fear; similarly the words χλωρος (commonly translated *green*) in Homer and *zard* (commonly translated *yellow*) in Hindústání are used of fear.

Again, *blue* is sometimes associated with religious feeling, and also with literary or scientific pursuits among women, *e.g.*, *blue-stocking.* Lastly, *white* is associated with the idea of good (perhaps in contrast to black, which goes with evil), *e.g. white lie* (*i.e.* a slight or venial lie), to be *whitewashed* (*i.e.* freed from debt), and extreme *whiteness* is associated with purity (probably from the pure whiteness of snow) *e.g. sins shall be as white as snow*, *white-robed angels*, &c.

Summary.—With such a looseness in the use of colour-terms in modern English and Hindústání as exemplified above, it seems (to the writer) that it is hardly possible to draw inferences as to the strength of the colour-sense in either the past or present from the (supposed) correct or incorrect application of colour-terms by other nations. Paucity of colour-terms is probably fair evidence of a poor colour-sense, whilst an abundance of the same is probably good evidence of a fine colour-sense. Viewed by this test, the colour-sense evidenced in the Homeric poems is certainly poor, and that of the natives of India is also poor compared with that of modern western nations; as to the latter, it may be said that a great development of colour-sense is now going on, and much more rapidly than in the past, judging from the frequent additions to the stock of dyes and pigments of late years, especially since the discovery of aniline and its derivatives.

Natives of India.—The author of "Light from the East on the Colour Question" considers that there is a "highly-developed colour-sense among the natives of India," and adduces the Indian coloured textile fabrics and works of art as evidence of this. This does not agree with the present writer's experience from a residence extending over twenty-three years in North India. The textile fabrics have certainly a good blending of colours; the cloth dyes and colours laid on pottery and other art-productions are also often beautiful. But the cloth-workers, dyers, potters, and other artisans in colours, and the educated classes, are the few among whom the colour-sense is well developed, and they are few among the 250,000,000 of India. The colour-terminology of Hindústání is poor, especially out of the classes above-named. Moreover, in the writer's experience the eyesight of the uneducated masses in India is defective in every way. They have great difficulty in threading a needle, in reading small type or small MS., also in reading at all except in a strong light, in discriminating colours, and (strangest of all) in making anything out of a picture, engraving, or photograph. This last defect is at first sight most surprising to an Englishman: it would seem as if a certain "picture-education" were necessary to develop a "picture-sense." A villager in India, or a quite uneducated servant, will sometimes examine a picture sideways, or even upside down, and will hazard the most incongruous ideas as to the subject, even when it is that of an object quite familiar to him.

ALLAN CUNNINGHAM

ENSILAGE

WE have observed with satisfaction, if we may be allowed to say so, the increasing attention which is being devoted to the subject of ensilage in this country, not only in view of the importance of this method of storing fodder as an auxiliary to the farmer, but because it evokes discussions which tend to the diffusion of the teachings of biologic science, and to widen the search after natural knowledge. The harvesting of ripe crops has become stereotyped by custom reaching back into the dim past; the practice of ensilage, on the other hand, involves a view of plant life which is not only foreign to our agricultural traditions, but is based upon less obvious teachings of nature, and it therefore demands a more intelligent cooperation of human industry. Notwithstanding these features, which make it a serious innovation, the unprejudiced acceptance of the system and the impartial spirit in which it is being practically investigated, testify to the growth of scientific culture amongst our agriculturists and to the general interest taken by them in the more recondite discussions of natural science which cannot fail to be widened by the study of the profound problems presented by the subject of ensilage. In contributing to the study of these we shall do so rather as observer than investigator, and as the text of our discussion we shall take Mr. Fry's excellent little work on "Sweet Ensilage." Whatever the fate of the theory of the silo expounded by the author—and it is certainly a bold excursion into the *terra incognita*—he furnishes us with a good and clearly expressed working hypothesis for the regulation of the system to the production of "sweet" ensilage, to which his efforts as an agriculturist have converged, he has sought a warrant in the teachings of vegetable physiology, and the theoretical account of the silo which has resulted may be stated in broad outlines as follows:—The crop to be ensiled is cut in the full vigour of the growth of the plant; the tissues of the plant do not die, but continue to exercise their organic functions for some time after being deposited in the silo. The rise of temperature which ensues in the silo is due to what the author terms "intercellular oxidation," or, from what we gather from the context, to the oxygen respiration of the cells.

In consequence of this increased temperature and its maintenance for a sufficient time, the cells of the plant are deprived of organic activity. The life of the plant under the restricting conditions of ensilation, induces an "intercellular fermentation," which manifests itself in one direction by the trans-generation of sugar into alcohol, the sugar being derived from the starch of the plant by hydrolysis. In regard to this function the author goes so far as to say: "When these transgenerations in the silo have been performed, the functions of the vegetable cells are at an end and they become inert and moribund." The formation of acetic acid in the silo, as also of lactic and other acids, are referred to ferment actions. The parasitic organisms present in the original mass are reduced to inertness by exposure to the elevated temperature produced in the silo, provided this is sufficiently high; nor can they resume their functions when the temperature falls to within the limits favourable to life. The ensiled matter, therefore, having attained and maintained for a sufficient time this suicidal temperature, is thenceforward without the pale of organic change. If, however, from any cause—the author gives prominence to two: viz. insufficient robustness of the cells and too large a proportion of water, which conditions, *e.g.*, are correlated in an immature growth—this critical temperature (at or about 50° C.) should not be reached, then the contents of the silo will, on cooling, become the prey of the bacterial life which has survived, and is ready to avail itself of favourable conditions for active development. The latter conditions determine the production of "sour" silage, the former of "sweet." In the chapter on the chemical composition of silage, in which analyses of various products are given, special attention is directed to the relatively high proportion of albuminoid to amide nitrogen in those which may be ranged in the latter class, as indicating their superior feeding value.

As a necessary preliminary to our discussion of the phenomena of the silo, in which we shall follow the lines thus laid down by Mr. Fry, we will review a few of the more prominent features of the chemistry of plant life, which no writer on this subject can afford to leave out of consideration.

That they have been considered, to some extent, in the account of the silo above detailed, is evidently due to Mr. Fry's position as an agriculturist writing for agriculturists. The practical purpose of his investigation and description of ensilage was only attainable by aiming at *a* probable truth to the exclusion of the whole truth. Our attempt will be to do justice to such an aim and its results, at the same time to aid in maintaining the scientific perspective of the question.

Many fruitless definitions of the supposed ultimate distinctions between a plant and an animal have from time to time been advanced; and while the controversies to which they have given rise have but little interest to those who take the broader view of classification, still there are certain very marked distinctions between the vegetable and animal worlds, considered each as a whole, which are independent of all views as to their abstract import and of all attempts to reduce them to a typical expression. First, in regard to synthetical activity and the power of appropriating carbon and nitrogen—the characteristic elements of living matter—the position of the vegetable world is anterior to that of the animal; or, to attempt a definition, the synthetical work of plants is ultimate, that of animals proximate. Secondly, nitrogenous or proteid substances are not essential constituents of the more prominent structures, *i.e.* the fibrous skeleton of a living plant, whereas the tissues of the animal are largely composed of such compounds. With regard to the functions of the protoplasm of the vegetable as compared with those of the animal organism, we may quote Michael Foster ("Physiology," 2nd ed., 343):—"It is not unreasonable to suppose that the animal is as constructive as the vegetable protoplasm, the difference between the two being that the former, unlike the latter, is as destructive as it is constructive." Thirdly, the synthetic activity of plants does not cease with the cessation of life, but persists in some measure in the substances which it has built up. We use the term "synthetic" here in a wider sense. The vast aggregations of the vegetable life of past ages with which we are so familiar in so many forms sufficiently illustrate our meaning; and the study of the everyday work of the redistributing agencies of Nature upon moribund vegetable matter, will prove the same refractory relationship—the possession of a power of resisting change under their influence not possessed by animal matter. Resolution takes place to a certain extent, in degree depending upon the circumstances of its deposition, and the surrounding physical conditions, but there is always to be observed the tendency to *accumulate* the characteristic element carbon, at the expense of the oxygen and hydrogen; we have every reason to regard the processes by which this result is attained as a self-contained re-arrangement of the matter and energy, localised in and by the plant during its life, and as the result, therefore, of the same activity. The life-history of a perennial plant also points to a high endowment of the molecules which are built up into its permanent parts; for these are not, as in the animal, subject to perpetual removal and renewal, but fixed and permanently localised. At the same time they run a long course of adaptation to the ever-changing condition of the structure which they compose, for which the necessary energy must be either concurrently or aboriginally supplied, or, as is probably true, both conditions of supply obtain. The study of the chemistry of liquification, and of the fate of moribund vegetable matter, therefore proves the possession of a high degree of intrinsic energy by plant substances, and the tendency to retain this energy in the form of derived compounds in which the carbon is proportionately accumulated.

Let us consider this endowment of energy of plants from a point of view more nearly that of the subject of these remarks—viz. the formation of the seed in an annual. We take it that every cell is impressed with the striving, so to speak, to bring about this result. In regard to the energy necessary, again we may conceive a storing up in the earlier processes of elaboration, together with a continuous supply from the external world. Supposing, now, the organic existence of the plant arrested by cutting during the period of inflorescence; the one supply is cut off, but what becomes of the other, the intrinsic energy and tendency of the organised matter in this direction? Analogy leads us to conclude that it flows on, expending itself on an unattainable end, until it fails from failure of the co-operative supply.

Now if this account of the relationship of the matter and energy of plants is generally true, we think they demand first consideration at the hands of investigators of ensilage. Mr. Fry attributes the rise of temperature in the silo to "intercellular oxidation." We think the term a good one, as it points to intrinsic oxygen exchanges. But we gather from the context that the oxydation referred to is at the expense of atmospheric oxygen. We think this qualification weakens the value of the term in diverting attention to a cause inadequate to produce the result. How much oxygen is contained or is supplied to the silo? Supposing it completely burned to carbonic anhydride and all the resulting heat effective in raising 100 times its weight of water 30° C. in temperature, is this sufficient on the most favourable calculation to raise the whole mass to 60°–70° C., the temperature which usually obtains? Why does the temperature continue to rise for some weeks after the crop has been ensiled, when from all causes the supply of oxygen must continually diminish? Apart from these considerations the conditions of the matter in the pit are surely unfavourable to oxidation by atmospheric oxygen, chiefly in the impediments to gaseous circulation and the absence of light. As we wish to confine ourselves to suggestions and to avoid statements of opinion, we do not hazard any conclusions on this point, but we ask for a comparison of the considerations drawn from the study of the intrinsic energy of plants with those from their relationships to the external world, in regard to this first phenomenon of the silo.

In regard to Mr. Fry's theory of "intercellular fermentation," we again think the term conveys a wider truth than his exposition. As an agriculturist he recognises two main kinds of ensilage products—sweet and sour—and we have already alluded to his account of their production.

Now, on what does this terminology turn, in as far as it is correlated with the chemical composition of the silage? Upon quantities of certain constituents which are a small fraction of the whole. It is, on the other hand, an axiom with the chemist, in his study of reactions, not to be led away by issues which are obviously subordinate. From a number of considerations which follow directly from the previous discussion, the cellulose fabric of the plant studied comparatively with the changes which it undergoes in the silo, is best calculated to throw light on the general nature and tendency of these changes. These changes involve a commerce of molecules, if we may use the expression, of which the appearance of small quantities more or less of particular acids or other compounds are minor results. We prefer the term "intercellular *commerce*" as less specialised than "fermentation"; and and in so far as the problems involved are essentially chemical, we think a study of the matter changes from this point of view in the order pointed out by relative quantity and permanence of relationship to the plant structure, is better calculated to elucidate the nature of these transformations.

In regard to sour ensilage, and the view of it as resulting from bacterial fermentation, we have little to say. The study of the life of such organisms under the very peculiar circumstances of the silo has been thus far very slender. From the later researches of Nägeli and others, which have considerably modified the theory of anærobic fermentation as propounded by Pasteur, we are inclined to attach less weight to this probable factor of the changes in the silo than Mr. Fry.

Generally speaking, and as he admits, the whole subject needs a very exhaustive investigation, and as we would point out, on the widest basis, and altogether independently of its special bearings upon agriculture The scientific method must be followed, even though in particular experiments the silage were rendered unfit for food. The factors of the result must be caused to vary artificially that their influence may be severally measured. The silo may be heated in any suitable way, the organic matter may be sterilised as regards parasitic germs, substances may be added to modify the reactions, and many other and similar self-suggestive means employed to test particular issues. In conclusion we revert to our original text, and we congratulate Mr. Fry on having laboured well in a good cause. As an agriculturist he has exceeded in his investigations what was to be expected; but in his endeavour to give a scientific account of the silo simultaneously with the agricultural, we think he has disposed of the complications of the subject by repressing their consideration. It is to the somewhat thankless task of reproducing certain of these that we have addressed ourselves, with the view, as already stated, of aiding to keep the subject in its true perspective.

NOTES

Thomas Davidson, LL.D., F.R.S., of Muirhouse, Midlothian, died, from an attack of lung disease, at West Brighton, on the 16th inst., in his sixty-ninth year. Dr. Davidson, who was so well known in the scientific world, more especially for his work on the "Fossil Brachiopoda," was a Fellow of the Royal, the Geological, and many other learned Societies, foreign as well as British. In 1851 he began his description of the "British Fossil Brachiopoda," which has been published from year to year by the Palæontological Society, the concluding supplements having appeared in the last volume of that Society in December 1884. Numerous memoirs on similar subjects have been published in the *Transactions* of several scientific Societies. Recently Dr. Davidson prepared a "Report on the Brachiopoda dredged by H.M.S. *Challenger* during the Years 1873–76." At the time of his death he was engaged upon a further monograph on recent Brachiopoda, the first part of which is now appearing in the *Transactions* of the Linnean Society. Dr. Davidson latterly resided at Brighton, and notwithstanding his other scientific avocations he devoted a considerable portion of his time to the perfecting of the town museum.

President Cleveland's invitation to Prof. Agassiz to assume the direction of the United States Coast Survey has been hailed in America as an assurance that the new administration will encourage scientific work, and is not indifferent to survey, but is desirous of placing it under a head whose name and character would be a guarantee of success. The health of the Professor precluded his acceptance of the post; but beyond this he is of opinion that the guidance of the Coast Survey requires an expert. The problems to be decided, the methods to be employed, the men to be engaged, should, he thinks, be determined by one who knows the business. Any other person would be in danger of failure. In concluding an article on the subject *Science* says:—"The correspondence of Secretary Man-ning and Prof. Agassiz is to us an assurance that science will not be retarded, and that scientific men will not be slighted by any act of President Cleveland."

Science comments in a recent issue on an extraordinary statement published in certain New York and Boston journals to the effect that a committee which had been appointed to investigate the geological survey of the United States had found that illegal practices prevailed in the work of that department. It appears that no such committee ever sat; the whole was pure fiction. There was no report, no illegal proceedings, no examination. The officer to whom it was said the committee made this report has no authority to appoint or superintend such a committee, and the whole story had its origin in the fertile brain of an imaginative newspaper correspondent. It is well that this should be understood in this country, in case the baseless statements referred to should have made their way here.

THE Annual Meeting of the London Mathematical Society will be held on Thursday evening, November 12, and will be made special for the purpose of considering alterations in the rules, which will be proposed by the Council. At the same meeting it will be proposed to elect Mr. C. Leudesdorf and Capt. P. A. Macmahon, R. A., as new members of the Council in the place of Dr. Hirst, F.R.S., and Mr. R. F. Scott, who retire.

THE following are the conclusions of the Scientific Commission appointed by the Spanish Government to examine Dr. Ferran's method of treating cholera patients. They are abbreviated by the special correspondent of the *Times* in the cholera districts of Spain, writing from Valencia on October 12: (1) Dr. Ferran's inoculations cannot be considered inoffensive. (2) The attenuation of the comma bacillus has not been demonstrated. (3) The prophylactic measures conceived by Dr. Ferran are empiric, for they are in no wise governed by scientific rules or laws. (4) By means of the vaccination the epidemic is propagated. (5) It is not demonstrated by the results ascertained that the inoculations secure immunity from cholera. (6) The individual during the first days following his inoculation is rendered more susceptible to contract any other form of disease. (7) This is due to the fact that the inoculation disturbs more or less profoundly the physiological equilibrium which it is so necessary to maintain during a period of epidemics. (8) The results as seen by the Commission do not prove immunity from cholera. Neither is it possible to obtain conclusions from statistics relating to inoculations, because general laws cannot be deduced from isolated facts.

DR. QUAIN delivered the Harveian oration on Monday afternoon before the Royal College of Physicians. He set himself to answer two questions: first, why it is that among a vast number of persons, alike in ancient and in modern times, medicine has not enjoyed that high estimate of its value, as an art and as a science, to which it is justly entitled; and, secondly, whether we have any grounds for anticipating a more satisfactory future for medicine, either in the security of the foundations on which it is laid, or in the consequent appreciation of it by the public. In the course of the oration Dr. Quain spoke of the progress of medical science before the foundation of the College of Physicians; the advances made in our knowledge of etiology, especially in the practice of arresting the diffusion of disease by limiting the spread of contagion, and of improvements in our knowledge of pathology. Having pointed out the progress which science and art have made in every direction, Dr. Quain produced statistical evidence that the improvement has been productive of substantial results. In answer to the second question he quoted the words of "one of the most eminent of our statesmen," to the effect that in a generation or two the medical profession would be far in advance of the other arned professions."

WE lately quoted in NATURE, with a comment on the exceedingly unusual character of such an announcement from America, a statement to the effect that the Astronomical Observatory of Beloit College was being closed on account of want of funds. We are very pleased to learn from *Science* that this statement is quite erroneous. On the contrary, Prof. Bacon, the Director of the Observatory, states that new arrangements have been made for carrying on additional observations in meteorology, and that especial attention will be paid to solar and spectroscopic work with greater facilities than before. This, we may observe, is happily by no means a surprising or novel announcement from across the Atlantic.

THE new School of Metallurgy which has recently been added to the Birmingham and Midland Institute, was formally opened on September 24, when Prof. Chandler Roberts, F.R.S., delivered a lecture on the Development of Technical Instruction in Metallurgy. Prof. Roberts pointed out how very recent has been the introduction into this country of systematic instruction in metallurgy. After referring to the important share which Dr. Percy has had in the development of metallurgical work in England, and to the steps taken by the Committee of Council on Education for its practical working, Prof. Roberts insisted on the importance of combining theory and practice, and referred at length to the methods adopted in the School of Mines. A full report of Prof. Roberts' lecture will be found in the *Chemical News* of October 9.

THE increasing efficiency with which electric lighting can be applied has recently been shown by Messrs. Woodhouse and Rawson, who, at a *soirée* at Guy's Hospital, lit up the building with their incandescent lamps, worked off Faure Sellon accumulators, which were only delivered on the morning of the *soirée*. Equally efficient was the lighting supplied by the same firm at the Leicester Exhibition of the Sanitary Institute of Great Britain. It is certainly a great convenience that such temporary illuminations can be effected under almost any conditions.

IN an article on the use of the French Academy, *Science* says:—"But, aside from all personal considerations, there remains a question whether an organisation like the French Academy may not perform an important service to the country by giving its collective authority to the encouragement of excellence in the use of language. May not its criticism of its own members, its judgment of works presented to it, its bestowal of academic honours, its election of associates, its public discourses, and its serious scrutiny of the vocabulary and phraseology of the language in their combined influence, be a very powerful agency in the promotion of literary excellence? May it not become a sort of schoolmaster to the nation, incapable of making good writers out of bad, but helpful in discipline? Who can tell what has been the net gain to France from such a society? Is the clearness, the precision, the symmetry, the finish of a good French style worth having? What would the German language be to the world if there had been a German academy at work for 250 years smoothing its roughness and insisting upon clear, unencumbered, and pleasing forms of expression?"

THE Calendar of the University College of North Wales, at Bangor, has just been published. Besides the usual information, examination papers and lists, it contains a brief sketch of the establishment of this college, which now enters its second year, and which promises to have a success worthy of the efforts by which it was founded. The thirst of the Welsh people for knowledge and for the education of their children is well known, and the introduction to the "Calendar" states that never before in so short a period have so many persons, either in England or in Wales, subscribed towards a movement for the promotion of higher education. In twelve months the list rose to upwards of 30,000*l.*, and by the end of 1884 it had exceeded 37,000*l.*

WE have received Prof. Rockwood's account of the progress in vulcanology and seismology in the years 1883, 1884, from the Smithsonian Report for 1884. Under Vulcanology he treats of the volcanic eruptions during the two years (dealing mainly with the Krakatoa eruption), and of the investigations of former volcanic activity. In seismology he divides his subject into earthquake lists of 1882 and 1883, special earthquakes of 1883 and 1884, lists of former earthquakes, and theories of earthquakes. In seismometry Prof. Rockwood deals with instruments and their records. The pamphlet, which should be a *vade mecum* for all engaged in investigating seismic phenomena, concludes with a bibliographical list of all the books and papers relating to the subject, which appeared during the two years under review. This list is surprising for its length and variety.

VUIBERT'S *Journal de Mathématiques Élémentaires*, which has had an existence of nine years in a lithographed form, commences its tenth year in print. It may be called the French schoolboys' mathematical journal, for it is addressed specially to them, and all the solutions are contributed by them. It appears fortnightly from October 1 to July 15, and the terms of subscription are very moderate. We have unfortunately in this country nothing to correspond to it, and it may therefore be useful to signalise its existence to mathematical masters.

AT a meeting of the Council of the National Fish Culture Association held on Friday last under the presidency of the Marquess of Exeter, it was resolved to take immediate steps to conduct a series of investigations and observations on the ocean in regard to its temperature at various depths; also as to the habits of fish, their spawning grounds, their enemies, and the cause of their erratic migrations. The Duke of Edinburgh, it was stated, had much interested himself in the subject, and had obtained the cooperation of the Admiralty and Trinity Board in aiding the Association to carry out the observations with the view of promoting marine fish culture and undertaking it on a thoroughly scientific basis.

THE Severn Fishery Board have made arrangements with the National Fish Culture Association to incubate salmon ova. When hatched out the fry will be placed in the waters under the control of the Board, which is doing its utmost to cultivate all species of Salmonidæ. The National Fish Culture Association will, it is understood, render similar service gratuitously to other Boards, in order to assist in developing the inland fisheries of the United Kingdom.

THE Institute of Chemistry has obtained a Royal Charter of Incorporation from the Privy Council, and it is intended to celebrate the occasion by a dinner on November 6.

THE following Penny Science Lectures will be given at the Royal Victoria Hall and Coffee Tavern, Waterloo Bridge Road, during the ensuing weeks.—On Tuesday, October 27, Mr. W. D. Halliburton will lecture on the "Circulation of the Blood"; on Tuesday, November 3, Sir John Lubbock will lecture on "Ants"; on Tuesday, November 10, Mr. W. Lant Carpenter will lecture on "Electrical Fire Alarms in America."

A SHOCK of earthquake was felt at half-past seven o'clock on the morning of the 13th in Granada and the surrounding country. The movement is described as a long trepidation, with a rumbling noise. At Palermo a shock occurred on the morning of the 15th. A house, three storeys high, fell in, and a number of persons were buried in the *débris.*

IN connection with the General Italian Exhibition held in Turin last year, the Italian Meteorological Society has just issued an interesting *brochure* on the present state of astronomical, physical, and meteorological studies in the peninsula. In these departments the show was thoroughly national, special prominence having been given to those branches which are at present most widely cultivated in Italy. Thus in terrestrial physics full scope was given to seismology, vulcanology, and geodynamics, all which studies, owing to the special local conditions, have here been associated with some of the most illustrious names in science. Meteorology was well represented by specimens of the best apparatus from the chief meteorological stations in the country, and in astronomy the progress of all the local observatories was fully illustrated. Amongst the objects on view were astronomical, physical, and meteorological apparatus; charts, maps, designs, photographs; printed and manuscript works on these subjects. Although still far behind some other countries in the production of scientific instruments, the display showed that in recent times Italy has made considerable progress in this branch of mechanics. To illustrate the history of these sciences the exhibition included some curious old instruments associated with the names of illustrious pioneers, who laboriously prepared the way now followed by their more fortunate successors living in better times and enjoying the advantage of more perfect appliances. The pamphlet contains a complete list of the ninety-one meteorological and geodynamic stations already established throughout the peninsula, as well as the names of exhibitors, to whom diplomas, gold and silver medals, and other distinctions were awarded.

MR. MELLARD READE'S presidential address to the Liverpool Geological Society was on "The North Atlantic as a Geological Basin." After discussing the form and nature of the ocean-bed so far as is disclosed by the latest soundings and dredgings, he pointed out that all along the coast of Spain and North Africa the bottom was exceedingly irregular, as proved by the soundings for the telegraph cables, consisting apparently of mountains and valleys. On the opposite coast of South America, and especially about the mouths of the Amazons, the soundings were comparatively shallow and of nearly uniform depth. Taken together with the known great depth of alluvial deposits at the mouths of all the great rivers where borings had been made, and the undoubted great age of the Amazons Basin, Mr. Reade arrives at the opinion that this plateau is a submarine extension of the delta proper, consisting of geologically modern sediment probably thousands of feet thick. The same reasoning, he points out, will apply to other great rivers and coasts where similar conditions exist.

FROM a series of experiments by Herr Graber, relating to the effects of odorous matters on invertebrate animals, it appears probable that in the case of many insects neither the antennæ nor the palpi can be absolutely pronounced the most sensitive organ of smell, inasmuch as the one organ is most sensitive for some odorous matters, and the other for others.

THE additions to the Zoological Society's Gardens during the past week include a Purple-faced Monkey (*Semnopithecus leucoprymnus* ♀) from Ceylon, presented by Major Norris; a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mr. J. H. Fielding; a Common Marmoset (*Hapale jacchus*), a Black-eared Marmoset (*Hapale penicillata*) from Brazil, presented by Miss Knowles; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Lady Cowley; a Common Hare (*Lepus europæus*), British, presented by Mr. F. J. Allpress; a Mexican Souslik (*Spermophilus mexicanus* ♂) from Mexico, presented by Dr. Stuart; a Herring Gull (*Larus argentatus*), British, presented by Mr. J. G. Taylor; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, deposited; an Ariel Toucan (*Ramphastos ariel*) from Brazil, purchased; a Hoolock Gibbon (*Hylobates hoolock* ♀), received in exchange.

OUR ASTRONOMICAL COLUMN

The Variable-star V Cygni.—In Dr. Hartwig's ephemeris of the variable stars for the present year a maximum of V Cygni is doubtfully assigned to November 15. The change in the brightness of this strikingly red star was notified by the late Mr. Birmingham in May, 1881. The several determinations of the time of maximum in the following year were very discordant; thus, Dr. Lindemann (who made an interesting communication on this star to the St. Petersburg Academy in January 1884) fixed it on August 31 "auf wenige Tage sicher"; Schmidt gave July 17, while Prof. Safarik considered it was reached on June 17. This divergence induced Dr. Lindemann to commence regular observations of the star in August 1882, details of which will be found in his paper (*Bulletin de l'Academie Imperial des Sciences de St. Pétersburg*, t. xxix.). The variation appeared to be from 6·8 m. to below 10 m., and the period indicated by the observations of 1882 and 1883 was about a year, though a longer one is now assigned. Several of Dr. Lindemann's notes are worthy of attention. On July 19, 1881, the star had a nebulous cometary aspect, with sensible diameter. On August 13 in the following year it was more stellar, and had no longer the nebulous appearance it presented in 1881, though a month later this was again suspected. On May 13, 1883, we read: "V funkelt sehr stark, leuchtet momentan auf und verschwindet dazwischen beinahe," though a comparison star DM + 47°, 3162 showed a steady light. On July 27 it shone as steadily as the neighbouring stars, without any nebulous appearance. On October 8—"sehr verschwommen"; a week afterwards, this aspect was not remarked, though the images of surrounding stars were very indifferent. At the end of the same month V was again stellar. Variations in the intensity of the colour were also remarked.

The place of this star for 1885·0, according to meridian observation at Pulkowa is in R.A. 20h. 37m. 35·7s. Decl. + 47° 43′ 53″.

Occultation of Aldebaran on November 22.—The Greenwich mean times of disappearance and reappearance of this star and the corresponding angles from north point, in the occultation on the evening of November 22, may be pretty closely determined for any place in this country from the following formulæ:—

$$\text{Time of disap.} = 9^{h}\ 45^{m}{\cdot}7 + [0{\cdot}2259]\,L + [9{\cdot}3110]\,M$$
$$\text{,, reap.} = 10\ 56{\cdot}2 + [9{\cdot}8575]\,L + [9{\cdot}4779]\,M$$

$$\text{Angle at disap.} = 104^{\circ}{\cdot}1 + [0{\cdot}3581]\,L - [9{\cdot}307]\,M$$
$$\text{,, reap.} = 281{\cdot}6 - [0{\cdot}412]\,L + [9{\cdot}246]\,M$$

In which the latitude of the place is put = 50° + L, and M is the longitude in minutes of time counted positive towards the east. The quantities within brackets are logarithms.

The above equations are founded upon the following results of direct calculation:—

	Disappearance h. m. s.	Reappearance h. m. s.	Angles from N. Point °	°
Greenwich ...	9 48 9 ...	10 57 15 ...	108	278
Edinburgh ...	9 53 5 ...	10 56 39 ...	120	264
Dublin	9 46 10 ...	10 51 0 ...	117	268

Double-Stars.—Two important series of measures of double-stars have lately appeared in the *Astronomische Nachrichten*: the first in Nos. 2677-78, by Dr. R. Engelmann, of Leipsic, in continuation of a series previously published; the second by M. Perrotin, made at the Observatory of Nice, in Nos. 2684-85. According to the Leipsic observations of Σ 2173, for which Prof. Duner found a period of 45 years only, calculation is not yet so much in error, as for a first approximation, and so difficult a star, might well have been anticipated. Dr. Engelmann's mean result is, for 1883·88, position, 24°·8; distance, 0″·23; the orbit gives 34° and 0″·2. The Leipsic series contains measures of many of Mr. Otto Struve's and Mr. Burnham's stars.

ASTROPHYSICAL NOTES

Stars with Spectra of the Third Type.—Prof. Dunér has published an important catalogue of stars having banded spectra. Following Prof. Vogel's classification he prefers to regard the spectra with bands fading away towards the violet as a subdivision of the same type as those in which the bands fade away towards the red, rather than, with Secchi, to make them into a separate class. Dunér's type III. *a*, therefore, corresponds to Secchi's third type and his III. *b* to Secchi's fourth type. Prof. Dunér's purpose in forming this catalogue is to supply the means for future observers to detect changes in these spectra should any such occur, for, as he points out, these stars are probably in a very advanced state of development, and we may therefore, perhaps, hope to discover some day changes in their spectra which, carefully studied, may lead to important results as to the nature of suns. They are the more interesting, also, because variable stars of long period usually belong to this class.

With this view Prof. Dunér has carefully examined all the known objects of this type which are visible in his latitude, and for which the optical means at his command were sufficient, and he has catalogued 297 stars of type III. *a*, that is, with bands shading off towards the red, and 55 of type III. *b*, with bands shading off in the opposite direction. An important section follows giving a list of stars which different astronomers have regarded as belonging to the third class, but which Dunér cannot so classify. Only in a very few instances, however, is there any good reason to suspect a change in the spectrum. In the great majority Secchi, whose observations supply most of these cases of discrepancy, had himself at one time or another registered the star as being of the second type, *i.e.* without bands, or else had especially remarked on the extreme feebleness of the bands which he thought he saw. There are, however, three stars observed by D'Arrest for which the evidence of change seems stronger, viz. 24034 LL., D.M. + 60° 1461 and D.M. + 36° 2772. Prof. Dunér has also failed to find Schjellerup No. 249. which is, perhaps, a long period variable, and he draws special attention to R Andromedæ, a star the spectrum of which, though of type III. *a*, presents some very marked peculiarities. Great care has been taken in the determination of the positions of the bands in the different spectra. It is clear, as many spectroscopists have already observed, that the bands of type III. *a*, occupy the same positions in all the spectra of the type, and the same is true for the bands of type III. *b*. With regard to the former class, the sharp dark edges on the more refrangible sides of the bands generally coincide with strong metallic lines; thus one of the most prominent bands is terminated by the *b*-lines of magnesium. The nature of the connection between the bands and these metallic lines is not at all clear at present, the symmetrical arrangement of the bands seeming to suggest that they are due to some one substance rather than to several. The three principal bands of the spectra of the other type Prof. Dunér considers to be unmistakably those of a carbon compound, and to correspond to the bright bands so familiar in the spectra of comets. The determinations of the wave-lengths of the bands in spectra of this type are necessarily not quite so accurate as those of the bands in spectra of type III. *a*, but if Prof. Dunér's measures are accepted, this most important correspondence may be considered fully established. But, apart from the value of these measures, Prof. Dunér's catalogue, with the full and clear descriptions he has appended to every star, will be of the utmost service to future observers of these interesting and beautiful objects.

The Comet of 1866 and the Meteors of November 14.—Prof. D. Kirkwood has recently pointed out in a paper read before the American Philosophical Society, that there is distinct evidence that there are three meteoric swarms travelling in the orbit of Tempel's comet. Of these the principal group is the one which produced the great showers of 1833 and 1866, the period of which Prof. Adams showed to be about 33·25 years. In 1875 Prof. Kirkwood identified a second group from the dates of meteoric showers given by Humboldt and Quetelet, the period of which would be about 33·31 years. The next shower from this group will be due about November 13-15, 1887; but the display may perhaps commence in November 1886, or even in the present year. The third cluster has been less observed; its period is about 33·19 years, and its next return will be from 1912 to 1915. Prof. Kirkwood suggests that the very great diminution in brightness in Tempel's comet since 1366, the comet of that year being now generally regarded as one of its apparitions, may possibly be due to the separation of the first and largest swarm from the comet having taken place in that year, the meteoric shower of that year being nearly contemporaneous with the apparition of the comet.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, OCTOBER 25-31

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on October 25

Sun rises, 6h. 44m.; souths, 11h. 44m. 7·5s.; sets, 16h. 45m.; decl. on meridian, 12° 16′ S.: Sidereal Time at Sunset, 19h. 2m.

Moon (two days after Full) rises, 17h. 32m.*; souths, 0h. 46m.; sets, 8h. 11m.; decl. on meridian, 12° 52′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 18	12 7	16 56	14 22 S.
Venus	10 56	14 38	18 20	24 54 S.
Mars	0 1	7 26	14 51	15 30 N.
Jupiter	3 15	9 32	15 49	2 33 N.
Saturn	20 13*	4 21	12 29	22 17 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Oct.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
25	B.A.C. 987	6½	3 0	4 10	137 313
26	B.A.C. 1256	6	22 3	near approach	151 —
28	B.A.C. 1930	6½	0 0	1 6	51 249
29	1 Cancri	6	22 5	22 26	115 164

Phenomena of Jupiter's Satellites

Oct.	h. m.		Oct.	h. m.	
25	4 3	II. occ. reap.	29	6 0	IV. occ. disap.
28	6 32	I. tr. ing.	29	6 10	I. occ. reap.
29	3 7	I. ecl. disap.	30	3 19	I. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Oct.	h.	
28	17	Saturn in conjunction with and 4° 8′ north of the Moon.

GEOGRAPHICAL NOTES

A recent Blue-book (Siam, No. 1, 1885) contains a report by Mr. Archer, of the Consular service in Siam, on silk-culture in the province of Kabin, which lies on the eastern side of the Siamese delta, at the foot of the mountains separating the Meinam valley from that of the Meiking. In the course of his journey Mr. Archer came across certain Laos settlements, of which he gives an interesting account which is deserving of note, on account of the very little known of the Laos. He says the settlements in the provinces of Pachim and Nakon Nayok are, as it were, the south-western outposts of the Laos race, which forms the bulk of the population of Eastern and Northern Siam, but they are "phung khao," or "white-bellied," and therefore distinct from the "black-bellied," or inhabitants of the Chiengmai provinces. They are not, however, the original inhabitants of these provinces, but captives from Muang Kalassin, a province to the north east of Korat, formerly dependent on Wien Chan, who, after the war waged successfully by the Siamese against that ancient kingdom about sixty years ago, were transported to and allowed to settle in the country extending from the province of Nakon Nayok to that of Battambong. This country consists, for the most part, of a series of slight and gradual elevations and depressions, the dwellings, gardens, and any other plantations being generally situated on the former, whilst rice is cultivated in the latter. The population is sparse, and consequently the greater part of the country is covered with jungle. The inhabitants are exceedingly indolent, and appear unable to exert themselves to procure more than enough rice for their bare sustenance. Their mode of living is of the simplest description, and their country being far from any commercial centre and outside any trade route, hardly any foreign goods, with the exception of cotton, are to be found amongst them. All Laos tribes, however, are not characterised by such indolence. Those living in the provinces closer to Korat are much more active, and devote more attention to agriculture, especially to the rearing of silkworms. This is stated to be due to the latter having a poorer soil at a higher altitude, which compels the inhabitants to devote more attention to silk-producing as a means of livelihood.

Mr. Coutts Trotter read a paper at the Aberdeen Meeting of the British Association "On Recent Explorations in New Guinea," bringing up to date the information he laid before the Section two years ago. It deals with certain hydrographical and other physico-geographical questions on which light has been lately thrown by Mr. Chalmers's journey, and by the ascent of the Amberno River, and points to the conclusions to be drawn from certain temples, with a special priesthood and objects of worship lately discovered—implying an order of religious ideas quite foreign to the Papuan mind. As regards the natives of New Guinea, he believes the conflicting jurisdiction, and different views as to the mode of dealing with them, must be prejudicial to their interests.

The Arctic steamer *Alert* returned to Halifax on October 18 from Hudson Bay with the observation party who have spent fifteen months there testing the practicability of that route for navigation from the Canadian north-west to Europe. The result of the observations shows that the average temperature is not so low as was expected, nor so low as the average winter temperature in the North-West. The lowest monthly average was 30° below zero. The ice observations show that the Hudson Straits and Bay are navigable by properly built and equipped vessels for from three to four months—from July to October. While this report is somewhat favourable, doubts are expressed in Canada whether the Hudson Bay route can ever be made practicable.

THE GREAT OCEAN BASINS[1]

II.

The advances during recent years in the knowledge of the forms of life inhabiting the floor of the ocean surpass those in any other department of oceanic investigation. Thousands of new organisms have been discovered in all seas and at all depths in the ocean, and either have been, or are now being, described by specialists in all quarters of the world. There does not seem to be any part of the ocean bed so deep, so dark, so still, or where the pressure is so great as to have effectually raised a barrier to the invasion of life in some of its many forms. Even in the greater depths all the great divisions of the animal kingdom are represented.

As might have been expected, forms of life are most rich and varied in the shallow water surrounding the continents, where there is abundance of food, sunlight, and warmth; where there is motion, rapid change of water through currents, and other congenial conditions. At the depth of half a mile there are still numerous animals, though many of them differ from those of shallower depths, but plant-life seems to have wholly disappeared, if we except the diatoms and calcareous algæ, whose frustules and skeletons have fallen to the bottom from the surface, carrying with them some of their protoplasm and chlorophyll.

At the depth of one mile there are a few animals which are barely distinguishable from, if they be not identical with, shallow water forms; but the majority of the animals are specifically distinct from those found within the 100-fathom line, and many of them belong to species peculiar to the deep sea, and are universally distributed over the ocean bed in deep water.

As we descend into still deeper water, and proceed further seawards from the borders of the continents, species and the number of individuals become fewer and fewer, though they often present archaic or embryonic characters, till a minimum is reached in the greatest depths furthest from continental land. Distance from continental land is, indeed, a much more important factor in the distribution of deep-sea animals than actual depth.

If we neglect the Protozoa and compare the results of twelve of the *Challenger's* trawlings and dredgings in the central line of the Pacific, in depths greater than 2000 fathoms, on globigerina ooze, radiolarian ooze, and red clay, with twelve trawlings and dredgings taken under similar conditions and depths, but on the blue and green muds within 200 miles of the continents, we find that the Central Pacific stations have yielded 92 specimens of animals belonging to 52 species, all, with two doubtful exceptions, new to science, and among them 13 new genera; on the other hand, the stations near the continents have given over 1000 specimens belonging to 211 species, of which 145 are new species and 66 belong to species previously known from

[1] Lecture delivered at the Aberdeen meeting of the British Association by Mr. John Murray, Director of the *Challenger* Reports. Continued from p. 584.

shallower water. These numbers are not final, but the proportions are not likely to be greatly altered when the whole of the *Challenger* Reports are completed. These facts may be in part explained by the greater abundance of food present in the continental *débris* which forms the chief constituent of the terrigenous deposits; but it is probably more closely connected with the greater distance of the seaward stations from the original place of migration. We must suppose that all deep-sea animals have been derived originally from shallow water; those which descended first into deeper water have, generally speaking, been able to migrate to a greater distance seawards than those which set out later, and being derived from older stocks they have retained in the great deeps some of the characters which are now regarded as archaic and embryonic.

Although no new types of structure have been discovered in organisms from the deep sea, the peculiar modifications which animals have undergone to accommodate themselves to abysmal conditions are sufficiently interesting and remarkable; the eyes of some fish and crustaceans have become atrophied or have disappeared altogether, while in others they have become of exceedingly large size or have been so modified as to be scarcely recognisable as eyes: for instance, in the case of the scopelid fish *Ipnops*; fins and antennæ have become extraordinarily elongated and at times appear to simulate the alcyonarians of the deep sea. The higher crustacea and some families of fish have very few and very large eggs in the deep-sea species, while their shallow-water representatives have a very large number of very small eggs, showing apparently that the deep-sea species have relatively few enemies. While some groups, for instance the Pycnogonids, Tubularians, and Nudibranchs, have much more gigantic representatives in the deep sea than in shallow water, the representatives of the majority of groups, and especially the Gasteropods and Lamellibranchs, are much smaller, and generally speaking have a dwarfed and delicate appearance, the shells being poorly supplied with carbonate of lime. Indeed the solid tissues of most deep-sea animals are but feebly developed when compared with shallow-water forms. The experienced dredger has, as a rule, little difficulty in recognising a deep-sea species in a dredging from its general appearance. Many deep-sea animals emit, and some have special organs for the emission of, phosphorescent light, which appears to play a large *rôle* in the economy of deep-sea life.

One of the most striking facts with respect to deep-sea animals is their very wide distribution—the same species being found in all the great ocean basins. At the depth of half a mile identical species are dredged off the coast of Scotland and off the coast of Australia at the Antipodes; the nearly uniform conditions, existing everywhere at depths greater than half a mile, facilitates the wide distribution of species which have once accommodated themselves to a life at that depth. The same consideration probably explains the occurrence of some identical and nearly identical species in the shallow waters of the temperate and polar regions of both hemispheres.

Among the higher crustacea the Brachyurans, which are regarded as a modern group, are found in great numbers in shallow waters, but have very few representatives in deep waters, and appear to be quite absent from the abysmal regions. On the other hand, the representatives of the Schizopoda, Anomoura, and Macrura, which are regarded as older groups, are widely distributed in the deep sea; many similar instances of this kind could be given. The stalked Crinoids, the Elpidiidæ among the Holothurians, the Pourtalesiæ and Phormosomas among the Echinids, and other groups, have now no representatives in depths less than 100 fathoms, but are widely distributed in all greater depths; while many genera are confined to the abysmal regions. We are not as yet, however, in a position to fully discuss many curious points in distribution, even did time permit.

It may be urged that after all the few hundred scrapings of our small trawls and dredges can give but a very inadequate idea of the condition of things over the millions of square miles covered by the ocean, but against this it may be argued with great force that as the same animals and deposits occurred again and again with little variation, we doubtless have even now a tolerably complete knowledge of deep-sea life.

When we turn to the surface waters, one may exclaim: it is a dull and stupid soul that would not rejoice at the first acquaintance with the teeming pelagic life of the ocean, rich in bizarre forms and varied colours, or that would not be struck with wonder at the magnificent displays of phosphorescent light sent forth on a dark night from the surface of an equatorial ocean, like flashes of "spirits from the vasty deep."

> "Beyond the shadow of the ship
> I watched the water snakes;
> They moved in tracks of shining white,
> And when they reared the elfish light
> Fell off in hoary flakes.
>
> "Within the shadow of the ship
> I watched their rich attire;
> Blue, glossy green, and velvet black,
> They coiled and swam, and every track
> Was a flash of golden fire.
>
> "Oh, happy living things! No tongue
> Their beauty might declare.
> A spring of love gushed from my heart,
> And I blessed them unaware."

Experiments with tow-nets have shown that life exists in all the intermediate waters of the ocean, between the surface and the bottom, yet sparingly there when compared with what occurs just above the bottom, or more markedly when compared with the abundant and luxurious development of life in the surface and sub-surface waters.

In mid-ocean the majority of the organisms are quite distinct from those usually found along the coasts in bays and estuaries, though, like the deep-sea animals, they were, in all probability, originally derived from the shallow waters around the continents. There are species of diatoms, calcareous and other algæ, many foraminifera, siphonophora, a few annelids, many crustaceans, numerous pteropods, heteropods, and other molluscs, the pelagic tunicates, and many fishes whose home is in the great systems of oceanic currents. It is only occasionally, or in special localities, that some of the species are borne to continental shores, for the members of this oceanic pelagic fauna and flora appear to be killed off where the ocean is affected by the fresh waters from the land. In the equatorial regions the species and individuals are most abundant, and they vary with temperature, latitude, and the salinity of the water.

In the Antarctic or Southern Ocean diatoms abound at the surface, and in the same region the sea-floor is covered with their dead siliceous frustules, which form a *diatom ooze*. In the middle and western Pacific, where the surface water is less salt than in the Atlantic, the radiolarians, which likewise secrete silica from sea water, occur in vast numbers at the surface and in intermediate waters, and in these regions their dead shells and skeletons make up the chief part of the deep-sea deposits, known as *radiolarian ooze*.

But it is those species belonging to the varied pelagic oceanic organisms which secrete lime for their shells and skeletons that are principally forced on our attention, both from their prodigious numbers and the part played by their remains in the formation of deposits. These species flourish especially in the warmest and saltest waters. In a square mile of equatorial water 600 feet deep it is estimated that there are over 16 tons of carbonate of lime in the form of shells, which belong to about 30 species of calcareous Algæ, Foraminifera, Pteropods, and Heteropods. When these surface organisms die and fall to the bottom they form the deposits known as *pteropod* and *globigerina oozes*. In descending they, as well as other surface organisms, carry down with them some of the organic matter of their tissues, which, not decomposing rapidly in the cold deep water, forms the chief source of nourishment for deep-sea animals, and the chlorophyll which Prof. Hartley has discovered in some deep-sea deposits is probably derived from diatoms which have fallen to the bottom in this way.

It is, however, a very remarkable fact that the dead shells of these Foraminifera and Pteropods are not found on the bottom of the sea beneath all the regions where they flourish abundantly at the surface. They are found at greater depths beneath warm equatorial waters than elsewhere, but there is barely a trace of them in all the greatest depths, although in an adjacent area, where the surface and intermediate conditions are the same, but where the depth is less than three miles, they may make up 75 or even 90 per cent. of the deposit. It has been abundantly proved that when sea water, and especially sea water containing absorbed carbonic acid, passes over a dead shell or coral, the lime is gradually removed, being carried away by the water as bicarbonate in solution; and the shell or coral is removed more rapidly the more surface it presents to the water in proportion to the amount of carbonate of lime present in the shell. This is what happens to pelagic shells as they fall through the water to the bottom. Where the depth is not very great only the thinnest and most delicate shells are removed, and the others accumulate, forming vast deposits; with increasing depth other shells disappear, only the thicker ones reaching the bottom; but in the very greatest depth nearly every trace of these surface shells is removed, or we find them making up but 1 or 2 per cent. of the deposit. It is possible that this process of solution of the shells may be somewhat accelerated in the deepest layers of water by the great pressure.

In the deepest parts of the abysmal areas, where the carbonate of lime shells are either wholly or partially removed from the bottom, there are met with those peculiar deep-sea clays, the origin of which has been the subject of considerable discussion. They are principally made up of clayey matter resulting from the disintegration of volcanic rocks, and derived chiefly from floating pumice and showers of volcanic ashes. Mixed up with these clayey and volcanic materials are thousands of sharks' teeth, some of them of gigantic size, and evidently belonging to extinct species, also very many ear-bones, and a few of the other bones of whales, some of them also probably belonging to extinct species. These organic fragments are generally much decomposed and surrounded and infiltrated by depositions of peroxide of manganese, which is a secondary product arising from the decomposition of the volcanic material in the deposits. Again, we have in some places numerous zeolitic minerals and crystals formed in the clay, also as secondary products. Lastly, there are numerous minute spherules of native iron and other rare substances, covered with a black coating of oxide, which are referred with great certainty to a cosmic origin—probably the dust derived from meteoric stones as they pass through the higher regions of our atmosphere. Quartz, which is so abundant as a clastic element in deposits around the continents, is almost absent from the deposits of the abysmal regions.

In the abysmal regions, then, which cover one half of the earth's surface, which are undulating plains from two to five miles beneath the surface of the sea, we have a very uniform set of conditions: the temperature is near the freezing point of fresh water, and the range of temperature does not exceed 7°, and is constant all the year round in any one locality; sunlight and plant-life are absent, and although animals belonging to all the great types are present, there is no great variety of form nor abundance of individuals; change of any kind is exceedingly slow. In the more elevated portions of the regions the deposits consist principally of the dead shells and skeletons of surface animals, in the more depressed ones they consist of a red clay mixed with volcanic fragmental matter, the remains of pelagic vertebrates, cosmic dust, and manganese iron nodules and zeolitic crystals, the latter being secondary products arising from the decomposition of the minerals which have long remained exposed to the hydrochemical action of sea-water. The rate of accumulation is so slow in some of these clays that we find the remains of tertiary species lying on the bottom alongside the remains of those inhabiting the present seas. It has not yet been possible to recognise the analogues of any of the deposits now forming in the abysmal regions in the rocks making up the continents.

It is quite otherwise in the areas bordering the continents—the uncoloured areas on the maps. Almost all the matter brought down to the ocean in suspension is deposited in this region, which is that of variety and change with respect to light, temperature, motion, and biological relations. It extends from the sea-shore down, it may be, to a depth of three or four miles, and outwards horizontally from 60 to 300 miles, and includes all partially inclosed seas, such as the North Sea, Mediterranean, Caribbean, and many others. The upper or continental margin of the area is clearly defined by the coast line, which is continually changing from breaker action, elevation, and subsidence; the lower or abysmal margin of the region is less clearly marked out, passing insensibly into the abysmal regions and terminating where the mineral particles from the neighbouring continents disappear from the deposits. In the surface waters the temperature varies from over 80° in the equatorial to 28° in the Polar regions, and from the surface to the ice-cold water at the lower margins of the regions there is in the tropics an equally great range of temperature. Plants and animals flourish luxuriantly near the shore, and animals extend in relatively great abundance down to the lower limits of the region. Here we find now in process of formation deposits which will form rocks similar to those making up the great bulk of continental land, such as schists, shales, sandstones, marls, greensands, and chalks; the glauconitic grains of the green muds and phosphatic nodules can be traced in all stages of formation, and probably, though much less certainly, the initial stages in the formation of flint.

Throughout all geological time the deposits formed in this border or transitional area appear to have been pushed, forced, and folded up into dry land, through the secular cooling of the earth and the necessity of the outer crust to accommodate itself to the shrinking solid nucleus within. These depositions do not in themselves cause elevation or subsidence, but most probably the changes of pressure, resulting from them, tend to destroy the existing equilibrium and to produce lines of weakness along the borders of the continents and in the regions of enclosed and partially enclosed seas, with the result that the borders of continental land have been more frequently thrown into folds and have suffered greater lateral thrusts than any other regions on the surface of the earth.

On the other hand, while we know that there are vast deposits of carbonate of lime taking place over some portions of the abysmal regions, and that volcanic outbursts occur in others, still these are not comparable with the great changes which have taken place in the past, and are now taking place, on the continents and along their borders.

When the coral atolls and barrier reefs which are scattered over the tropical regions of the great oceans are examined in the light of recent discoveries, it is found that their peculiar form and structure can be accounted for by the truncation of some submarine cones through breaker action; by the upward growth of others through the accumulation of marine deposits; by the solution of dead coral through the action of sea-water; and lastly by a study of the source and direction from which the food supply reaches the reef-building animals. That this in all probability is the true history of the origin of these marvellous structures is further confirmed by the recent examination of the upraised coral atolls of the Pacific by Dr. Guppy, and the researches of Mr. Buchanan into the characters of oceanic banks and shoals. Coral atolls and barrier reefs, instead of pointing out great and general subsidences, must be regarded rather as indicating areas of great permanence and stability.

The results of many lines of investigation, then, seem to show that in the abysmal regions we have the most permanent areas of the earth's surface, and he is a bold man who still argues that in Tertiary times there was a large area of continental land in the Pacific, that there was once a Lemuria in the Indian Ocean, or a continental Atlantis in the Atlantic.

In this rapid review of recent oceanographical researches my chief object has been to show you the wide range of the observations, for every science has been enriched by a large store of new facts. It matters little whether the opinions which I have given as to the bearing of some of these be correct or not; for the observations are now or will soon be in the hands of scientific men, and errors in interpretation or deduction will soon be exposed. The great point is that there has been a vast addition to human knowledge, and it must be a matter of satisfaction that our own country has taken so large a share in these important investigations as to call forth the admiration of the scientific men of all countries. You have learnt from the President's address that there is usually not much to say in commendation of the Government for its liberality to science. But in the matter of deep-sea investigation, neglecting mere details, we can say that the successive Governments of the Queen during the past twenty years have, either from design or by accident, undertaken a work in the highest interests of the race, have carried it on in no mean or narrow patriotic spirit, and are likely to carry it to a termination in a manner worthy of a great, free, and prosperous people.

ON A SUPPOSED PERIODICITY OF THE CYCLONES OF THE INDIAN OCEAN SOUTH OF THE EQUATOR[1]

In papers printed in the *Reports* for 1872, 1873, 1874, and 1876, I endeavoured to show that there were grounds for supposing that the cyclones of the Indian Ocean south of the equator increased in number, extent, and intensity from a minimum in one year to a maximum in another, and then decreased to a minimum, the period or cycle apparently corresponding with the eleven-year period of solar activity.

From the data given in the last of these papers (*Report* for

[1] Paper by Mr. Charles Meldrum, F.R.S., read at the British Association.

1876, p. 267), it would appear that from 1856 to 1875 the years of minimum cyclone activity were 1856 and 1867, and the years of maximum activity 1861 and 1872, but that the results for each of those years did not differ much from the results for the year immediately preceding or following it, the variation near the turning-points being small.

Before giving a brief outline of the results which have been obtained since 1875, it may be well to mention that the sources of information were the same as in former years. Two clerks were constantly occupied in tabulating the meteorological observations contained in the log-books of vessels that arrived in the harbour of Port Louis from different places. The number of days' observations tabulated in each year—that is, observations extending over twenty-four hours and made in different parts of the ocean—was as follows:—

Years	Days' Observations	Years	Days' Observations
1876	... 17,017	1881	... 16,473
1877	... 17,005	1882	... 15,089
1878	... 17,050	1883	... 16,930
1879	... 15,889	1884	... 16,700
1880	... 17,306		

The tables give an average of 46 observations of 24 hours each for every day of the nine years over the frequented parts of the ocean.

All details and reports respecting hurricanes, storms, or gales were recorded in separate registers.

For each day on which there was a gale in any part of the ocean between the equator and the parallel of 34° S. a chart was prepared, showing as nearly as possible the positions of the vessels the direction and force of the wind, &c., at a certain hour, namely, noon on the meridian of 60° E.

From these synoptic charts the details given from hour to hour in the log-books, and all the information obtained from other sources, the position of the centres of cyclones at noon on each day were determined, and the tracks laid down on separate charts.

Nine cyclone-track charts have thus been prepared, namely, one for each of the years 1876–84.

These track-charts, together with the twenty that had previously been prepared for the years 1856–75, show, as far as has yet been ascertained, the tracks of the cyclones of the Indian Ocean south of the equator in each of the years 1856–84, and the tracks for the years 1848–55 are nearly ready.

With respect to the period 1876–84, the *areas* of cyclones and the *distances* traversed have not yet been determined, but upon the whole the *number* and *duration* of the cyclones decreased to a minimum in 1880, and then increased till, in 1884, they were more than double of what they were in 1880.

From the accompanying track-charts for the eleven years 1856, 1857, 1860, 1861, 1867, 1868, 1871, 1872, 1879, 1880, and 1884, it will be seen that the number and duration of the cyclones of 1856 and 1857 were much less than those of the cyclones of 1860 and 1861; that the number and duration of the cyclones of 1867 and 1868 were much less than those of 1860 and 1861 on the one hand, and also than those of 1871 and 1872 on the other; and that the number and duration of the cyclones of 1879 and 1880 were much less than those of the cyclones of 1871, 1872, and 1884.

It would appear, however, that in 1884 there was less cyclone activity than in 1861 and 1872.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The commencement of Michaelmas Term does not witness many changes in the *personnel* of scientific departments in Oxford. A lecturer in Human Anatomy has been appointed, and commences work this term. The opening of the new physiological laboratories at the back of the University Museum completes the scheme for physiological education which has been so strenuously opposed by the enemies of scientific research in the University.

One of the most noticeable changes in Oxford to outward view is the opening of the new buildings in Trinity College. The new block of buildings, designed by Mr. Jackson, stretches backward from Kettle Hall in Broad Street to the Bathurst building and college chapel, making a new quadrangle bounded on the south by Broad Street and Trinity Cottages (now thrown into the "quad"), on the west by Balliol, on the north by the chapel and Bathurst, and to the east by the new buildings. The new "quad" is only second in size to "Tom quad" in Christchurch.

With our respect and sorrow for Dr. Bulley, late President of Magdalen, who died during the vacation, is mingled a feeling of intense satisfaction and not a little surprise at the appointment of his successor.

In Mr. T. H. Warren, the new President, Magdalen has gained a man no less distinguished for his scholarship than for his liberal views on education. Under the virile direction of her new president, Magdalen, already prominent among our Colleges for her recognition of natural science, may well hope to extend her usefulness. In the liberal Oxford of to-day—in the teaching as opposed to the voting University—Mr. Warren's election has been received with enthusiasm.

The following courses of lectures and classes in Natural Science will be given during the ensuing term:—In the Physical Department of the Museum Prof. B. Price lectures on Hydro-Mechanics. Prof. Clifton lectures on Ohm's Law; Mr. Selby lectures on Electrostatics; and Mr. Walker on Elementary Mechanics. The laboratory is open for practical instruction daily.

At the University observatory Prof. Pritchard gives three courses. Firstly, on the Application of the Theory of Probabilities to Astronomical Observation; secondly, on Spherical Astronomy; thirdly, on the Astronomy referred to by Polybius and other classical writers.

At Christchurch Mr. Baynes lectures on Conduction of Heat, and has a class for practical Instruction in Electrical Measurements.

At Balliol Mr. Dixon lectures on Elementary Magnetism and Electricity.

In the Chemical Department Prof. Odling lectures on the Phenic Compounds; Dr. Watts gives a course on General Organic, and Mr. Fisher gives a course on General Inorganic Chemistry.

The laboratories are open daily for practical instruction.

At Christchurch Mr. Vernon Harcourt has a class for Quantitative Analysis.

In the Biological Departments Prof. Moseley lectures on the Comparative Anatomy of the Vertebrata; Mr. Spencer lectures on Elementary Animal Morphology.

Prof. Burdon-Sanderson lectures on the Physiology of Motion, Mr. Dixey lectures on Histology, and Mr. Thomson on Human Anatomy.

The Morphological and Physiological Laboratories are open daily for practical instruction.

Mr. Jackson lectures on Parthenogenesis, Mr. Thompson on Osteology, and Mr. Poulton on the Distribution of Animals.

Prof. Westwood lectures on the Orders of Winged Arthropoda. Prof. Prestwich lectures on Geology: Physical Questions, Volcanic Action, &c.

At the Botanic Garden Prof. Gilbert lectures on the Results of Field Experiments, and Prof. Balfour gives practical instruction in Vegetable Morphology and Physiology.

Dr. Tylor lectures at the Museum on Social and Religious Systems.

SCIENTIFIC SERIALS

THE only structural paper in the August and September numbers of the *Journal of Botany* is by Mr. Thomas Hick, on the caulotaxis of British Fumariaceæ. "Throughout the whole of this order," he states, "as represented in the British Isles, a remarkable unity of organisation prevails. In all cases, save that of *Corydalis solida*, the main stem is a sympodium or pseudaxis, composed of binodal caulomeres, except in the basal region, where they are of a higher order, and often in the apical region also, where they become uninodal." The paper is illustrated by woodcuts. In addition the student of descriptive botany will find two papers by Mr. J. G. Baker: a monograph of the genus *Gethyllis* (with two plates), and a synopsis of the Cape species of *Kniphofia*, in addition to a continuation of his synopsis of the genus *Selaginella*; and the numbers are not wanting in other papers of interest in descriptive, systematic, and geographical botany.

THE number for October is an unusually interesting one. Mr. H. N. Ridley gives descriptions and figures of two recent additions to the British flora, both belonging to the Cyperaceæ, and both from Scotland: *Schænus ferrugineus*, L., and *Carex* *salina* var. *kattegatensis*, Fries. The discovery of the former species is especially interesting. Tne genus *Schœnus* includes between 60 and 70 species, of which two are natives of the northern temperate zone; all the remainder of Australia and New Zealand. Both of the northern species are now known in Britain.—Mr. J. G. Baker completes his monograph of *Selaginella*, including no less than 312 specie·.—In addition to smaller original papers the reprints include Mr. Carruthers' report on additions to the botanical department of the British Museum during 1884, and Mr. George Murray's valuable notes on the inoculation of fishes with *Saprolegnia ferax*, extracted from the annual report of the Inspector of Fisheries.

Rivista Scientifico-Industriale, August-September.—Transport and distribution of electricity by means of induced transformers: Gaulard and Gibbs' secondary generators (three illustrations), by Emilio Piazzoli.—Remarks on the objections raised against some of the author's theories in physics and electricity, by Prof. Carlo Marangoni.—On the emissive power of the electric sparks, by Prof. Emilio Villari.—On the true nitrous ethers of the alcohols, by Prof. G. Bertoni.—On the crustaceans of the province of Rome, by A. Statuti.

Bulletins de la Société d'Anthropologie de Paris, fasc. 2, 1885.—Report of Commission of Financial Administration of Society, by M. Dally.—Presentation, by M. Mortillet, of the numbers of the journal *L'Homme* for 1885, in which the question of a Tertiary man is discussed. M. Mortillet took occasion to explain at length his reasons for believing that there existed in the Tertiary age animals of sufficient intelligence to fabricate tools for themselves, and to make use of fire. M. de Nadaillac is unable to accept the opinion of M. Mortillet, and considers it impossible to affirm with any certainty either that the flints in question belong to the period to which they are assigned, or that they have not been deposited in the strata where they are found by the agency of running water, or of some of the great telluric disturbances of which unmistakeable traces are present in the beds at Thenay (Loir-et-Cher), which M. Mortillet characterises as Miocene.—M. D'Acy drew attention to the presence of numerous flints similar to those of Thenay which he and others had found among the Maçonnais deposits, and whose cracked and fractured surfaces differed in no way from the normal and natural character presented by the argillaceous flints ordinarily referred to the Tertiary ages.—On the historic significance of the Egyptian word "heter," horse, by M. Piétrement, who refutes the various arguments advanced in proof of the existence of the horse in Egypt before the invasion of the Hyksos, and endeavours to show that its introduction among the Egyptians was due to the so-called "Shepherd" invaders, who were of mixed Mongolian and Semitic origin.—Continuation of Dr. Fauvelle's treatise on "The Will," considered from an anthropological point of view.—On Beauty, by M. Delaunay.—Report of French missionaries' account of the Fuegians in 1884, communicated by Dr. Hyades.—On the Redskins in the Jardin d'Acclimatation, Paris, by Dr. Manouvrier, with craniometric and other measurements.—On the characteristics of a native of New Caledonia in the service of M. Moucelon, who explained some of the peculiarities of language and modes of counting prevalent among the people, and described their leading physical and mental characteristics. He remarked that the half-castes, born of white fathers and native mothers, are generally strong and prolific, while they show a tendency to revert to the character of the white type. Cannibalism, however, is not yet wholly eradicated amongst them.—On an anomaly of the humerus, by M. Chudzinski. This consists in a bony excrescence immediately below the deltoid, to which a bundle of muscular fibre is attached. The case, which is believed to be unique of its kind, appears to be one of atavism.—On an anomalous muscle in the hand, by M. Baudoin. Here the presence of a well-developed muscular fascia in the right hand of a man aged fifty, which simulated a part of the muscular development of the foot, may be similarly characterised as an evidence of atavism.—On a case of congenital hypertrophy of the parietals, by M. Topinard.—On supernumerary breasts, by Dr. Blanchard.—The etiology of elephantiasis, by M. Foley.—On the influences of heredity in deaf-mutes, by M. Drouault.—A case of a muscular anomaly of the fore-arm, by M. Chudzinski.—On sterility among the descendants of a white and a mulatto, by the Marquis de Saporta.—On certain crania from Lagoa-Santa, collected by Dr. Lund, and now at Copenhagen, with comparative analysis of a similar number of Californian crania, by M. Ten Kate.

Revue d'Anthropologie, tome 8ème, 3ème fascic., Paris.—On the weight of the cerebral lobes, according to Broca's register, by Dr. Philippe Rey. The data on which Dr. Rey's tables are based were obtained from 347 subjects, of which 231 were men and 116 women. On examining the means the figures yielded for the several lobes, without reference to sex or stature, it is found that while the total weight of the right hemisphere predominates over that of the left, the left frontal is heavier than the right, this difference amounting to 1·6 gr. on the total of 231 cases. This excess of weight of the left frontal had been noted by Broca, who believed it to be due to the influence of the third convolution. The right occipital is, on the other hand, 0·5 heavier than the left. The difference of weight for the entire anterior region between men and women amounts to 69·65 gr., which constitutes a large proportion of the general cerebral excess of weight in the male sex. The weight of both hemispheres is at its maximum between the ages of 25 and 35 years, although this period is generally reached earlier in women than in men, owing apparently to the more rapid evolution in the former of some one of the lobes. Loss of weight is most marked between 55 and 75 years, when it may amount to 62 grammes.—Anthropometric instructions for travellers, by Dr. Paul Topinard. The writer, after considering the true significance of the loosely-applied term "race," and pointing out the importance of accepting one uniform and fixed system of anthropometric measurement, proceeds to describe the nature and mode of application of the various instruments indispensable for the attainment of trustworthy and available results. These admirable instructions are rendered specially serviceable through the addition of numerous comparative tables, including a useful schematic representation of the means of the measurements obtained for the European male adult when taken in proportion with the mean stature, which is estimated at 100. This code of instructions ought to be in the hands of all travellers able and willing to contribute towards the general mass of our anthropological knowledge, and its translation into our own and other tongues would be a gain to science. Numerous diagrams illustrate the way in which the instruments should be used, and the positions of the body best adapted for the purpose of each special observation.—On atavism in man, by Dr. R. Blanchard. The author considers that as the greater number of the teratological conditions observable in man may be explained by the persistence of some embryonic condition which is normally of a transitory character, we must look to atavism for an explanation of such anomalies. Beginning with the cranium, Dr. Blanchard shows that microcephalus and analogous cranial deformities must be characterised as ancestral reversions, the mean cranial capacity of civilised races having demonstratively augmented within the last few centuries, while we find on passing down to the lower animals that the cranial capacity of the gorilla, or chimpanzee, which is more than five times less than the mean given for Parisians of the present day, is only slightly in excess of that observed in microcephalic subjects. After passing in review the various anomalies to be met with in the human anatomical system, and pointing out their analogues in the normal anatomy of the lower animals, he proceeds to the muscular system, in which the writer shows that supernumerary muscles occur three or four times in every hundred cases. This branch of the subject is, however, only briefly touched on in consideration of the exhaustive work of M. Testut bearing on the question, and to this the student is referred. Finally, after considering the comparative history of the development of the human fœtus, and of the embryo of some of the lower animals, the author concludes by drawing attention to the importance of studying the normal anatomy of the lower animals, more especially of reptiles, marsupials, and lemurians, if we desire to elucidate the origin and development of the various anomalies presented by the human organism.—On Broca's method of estimating the capacity of the cranium, by M. P. Topinard. The writer gives a categorical description of the instruments to be used and the steps to be followed in the process, together with tables showing the various results that had been yielded by Broca, Ranke, and others when lead, glass beads, or millet seed had been used as the agent for gauging the capacity.

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, June 24.—The following papers were read:—Rough notes on the natural history of the Claremont Islands, by Gervase F. Mathew, R.N. Mr. Mathew gives an interesting account of the fauna and flora met with on these islands, in which he enumerates 23 species of birds and 20 species of *Lepidoptera*, of which 2 *Lycaenæ* are probably new. He also gives some notes on the habits of each species enumerated.—An afternoon among the butterflies of Thursday Island, by Gervase F. Mathew, R.N. Mr. Mathew gives an account of a few hours' ramble on Thursday Island, resulting in the capture of 48 species of diurnal butterflies. He gives a detailed description of the larva of *Ornithoptera pronomus*. He also makes brief mention of the flora and physical geography of the island.—New fishes from the Upper Murrumbidgee district, by William Macleay, F.L.S. Two new fishes are here described, and two others, probably new, are noticed. The new ones are a species of *Murrayia*, from the Murrumbidgee, near Yass, and a very blunt-headed species of *Oligorus* from the same locality. The two fishes alluded to as probably new are a species of *Gadopsis* from the Little River and a *Galaxias* from Yass River.—On a new *Diplocrepis*, by J. Douglas Ogilby. Mr. Ogilby describes, under the name of *Diplocrepis costatus*, a species differing considerably from *D. puniceus* of Richardson, and he points out that the fish is more nearly allied to the New Zealand genera, *Diplocrepis* and *Trachelochismus*, than to the Australian genera, *Crepidogaster*.—Jottings from the Biological Laboratory of Sydney University, by William A. Haswell, M.A., B.Sc., Lecturer on Zoology and Comparative Anatomy.—On a destructive parasite infesting the oyster. Specimens of diseased oysters from the Hunter River beds were found to have their shells perforated and destroyed by a small boring annelid—*Leucodore ciliata*—which, by burrowing through the substance of the shell, causes the disintegration of the valves and the death of the oyster.—On some recent histological methods and their application to the teaching of practical histology.—On the minute structure of *Polynoë*.

PARIS

Academy of Sciences, October 12.—M. Bouley, President, in the chair.—The President announced the death on October 6, at Jasseron (Ain), of the eminent histologist, M. Ch. Robin, Member of the Section for Anatomy and Zoology.—Memoir on the botanical work of the late M. Charles Edmond Boissier, who died at Valleyres, Canton of Vaud, on September 25, by M. P. Duchartre. Born at Geneva, in 1810, of a French Huguenot family, M. Boissier first devoted his attention to the Swiss Alpine flora. But he will be remembered chiefly for his explorations in the Iberian peninsula (Grenada, Sierra Nevada, &c.) in 1837, and in the Levant (Greece, Anatolia, Syria, Egypt, &c.) in 1842–46. The results of his labours in these botanical regions are embodied in his "Elenchus plantarum novarum minusque cognitarum quas in itinere hispanico legit" (Geneva, 1838); "Voyage botanique dans le midi de l'Espagne pendant l'année 1837" (Paris, 1839–45); and "Flora orientalis, sive enumeratio plantarum in Oriente a Græcia et Egypto ad Indiæ fines hucusque observatarum," five large volumes, 1867–1884.—On the neutralisation of the aromatic acids, by M. Berthelot. The results are here given of experiments made on mellic acid, $C_{24}H_6O_{24} = 342$; meconic acid, $C_{14}H_4O_{14}$, $3H_2O_2 = 254$, and acrylacetic acid, $C_4H_2O_2(C_6H_6O_4) = 114$.—On sundry phenols, by M. Berthelot. The author here passes from the study of normal phenol to that of its homologues, the cresylols and ordinary thymol, as well as the naphtols or phenols derived from naphtaline.—Note on the first volume of the *Annales de l'Observatoire de Bordeaux*, issued by M. Rayet, and presented to the Academy by M. Lœwy. Besides a full account of the foundation of the Bordeaux Observatory in 1871 and of the instruments employed in it, this volume contains all the magnetic and meteorological observations taken in 1880–81 and some of the results of the work begun in 1885 for the purpose of determining the co-ordinates of 23,000 stars in the Southern Hemisphere between $-15°$ and $-30°$, already observed by Argelander at the Bonn Observatory in 1850.—Effects of mildew on the vine as shown by a comparison of the plants successfully treated with a mixture of lime and sulphate of copper by M. Nath. Johnston in the Médoc district, with plants in the same district attacked by the disease and left untreated, by MM. Millardet and Gayon.—Observations on the nature of inverted sugar and of elective fermentation, by M. E. Maumené. Further experiments confirm the conclusion already arrived at that M. Leplay's theory of elective alcoholic fermentation is based on erroneous assumptions.—Note on the constant presence of *Amœba coli* in dysenteric secretions, by M. A. Normand.—Observations on Palisa's new planet 251, made at the observatory of Paris (equatorial of the west tower), by M. G. Bigourdan.—Observations of Brook's comet and of Palisa's new planet 251, made at the Observatory of Algiers with the 0·50 m. telescope, by M. Ramband.—Researches on vanadium: properties of vanidic acid, by M. A. Ditte.—Kinematic analysis of the locomotion of the horse by means of M. Marey's chronophotographic apparatus, five illustrations, by M. Pagès. In this paper the author explains and illustrates the trajectory and velocity of the foot and pastern in the three principal actions of the horse—the step, trot, and gallop.—Note on the internal phenomena of muscular contraction in the primitive striated fasces, by M. F Laulanié.—On the physiological action of the salts of lithium, potassium, and rubidium, by M. Ch. Richet. The mean toxic dose with the chlorides of these alkaline metals has been determined for the tench, frog, pigeon, rabbit, and some other organisms.—On the development of Fissurella, by M. L. Boulan. From a study of the biological evolution of this organism the author concludes that it is a true gasteropod, and cannot, therefore, be grouped with the order of worms; further, that the apparent symmetry of the adult Fissurella is, in reality, a disguised progressive asymmetry.—Influence of salt water on the development of the larvæ of the frog, by M. E. Yung. The tadpole perishes in three to twenty minutes in the water of the Mediterranean containing 4 per cent. of salts, and in a few hours in a solution of marine salts in the proportion of 1 per cent. But it may be adapted to this element by a gradual preparation through a progressive series of solutions from 2 to 8 per 1000.—On the apparent rotatory movement of balloons recorded by aëronauts, by M. G. Tissandier.—Memoir on the fermentation of bread-stuffs in connection with M. Aimé Girard's communication on this subject, by M. G. Chicandard.

CONTENTS

THURSDAY, OCTOBER 29, 1885

THE ANTI-CHOLERA INOCULATIONS OF DR. FERRAN

IN the spring and summer of the present year the public in Europe—lay and medical—have been greatly agitated by the exploits of a Spanish medical gentleman, who, during the cholera epidemic then raging in Spain, claimed to have discovered a means of preventing cholera. He was hailed as a great benefactor, and if his deeds had been equal to his professions, he would no doubt fully deserve to rank with Jenner, the greatest benefactor to mankind. But fortunately the medical world, at any rate the scientific medical world outside Spain, is not guided by the allegations of enthusiasts nor by wonder-doctors either. A Don Quixote, who discerns in a windmill giants, in a flock of sheep a squadron of the enemy's soldiers, may present points of interest to the psychologist: to the disciple of physiology and pathology he demonstrates an aberration of the visual nerve centres. I shall show that Dr. Ferran comes very near in rank, not to Jenner, but to his own illustrious countryman, the Knight of La Mancha.

The method of Ferran is practically this:—Ferran says that by a peculiar mysterious method of cultivation—which for a long while he was not going to divulge—he has succeeded in attenuating the action of the comma bacillus of Koch. In these cultivations the comma bacillus after very complex morphological changes, unnecessary to detail here, forms spores. Such cultures introduced in sufficient quantities into the subcutaneous tissue of animals (guinea-pigs) or man produce a disease which is a mild and abortive form of cholera; it manifests itself in local inflammation, and a general constitutional disturbance, febrile rise of the body temperature, headache, nausea, and sickness, and even diarrhœa. After a few days the person inoculated returns to his normal state. Persons once, twice, or thrice inoculated answer, or ought to answer, each inoculation with the said constitutional disturbance. Statistics collected by Ferran and his adherents in the places where these inoculations were practised, notably in Alcira, in and about Valencia, prove, so it is said, that the number of cholera cases and of deaths from cholera decreased in a conspicuous degree after these inoculations had been commenced, and also that those persons that had been inoculated remained almost impervious to cholera, while others not so inoculated fell victims to the plague in large numbers. In these assertions and practices several important questions are involved, each of which demands a direct answer, which ought to be favourable to this theory of Dr. Ferran.

First: Is the so-called cholera-bacillus, or Koch's comma-bacillus, found in the intestinal discharges of cholera patients, the *vera causa* of cholera?

Second: Does this so-called cholera-bacillus form spores, which when introduced into the living tissue germinate into the comma bacilli: in the subcutaneous tissue capable of producing only an abortive and mild form, but in the alimentary canal producing severe and malignant cholera?

Third: Do the cultivations of Dr. Ferran, when inoculated into the subcutaneous tissue, set up a disturbance which can be considered as an abortive form of cholera?

Fourth: Are persons so inoculated really protected or almost protected against an attack of real cholera; and do the statistics collected by Ferran and his adherents prove this?

(1) The first of these questions, it is obvious, forms the basis of the whole theory; for if the comma bacillus of Koch is not the real cause of cholera all the rest of Ferran's assertions, as far as cholera is concerned, fall to the ground. The claims of the comma bacillus of Koch to be accepted as the true cause of cholera, rests on very insufficient evidence: the epidemiological evidence as to the spread of cholera being dependent on soil and season, the anatomical evidence as to the comma bacilli being limited to the cavity of the cholera intestine, they being absent from the tissues and the blood, the misproportion existing between the number of comma bacilli present in the alimentary cavity, and between the severity and acuteness of the disease in many cases, and a number of other facts not necessary to mention here, prove to my mind that the comma bacillus is not the real cause of cholera. Add to this that Emerich of Munich vindicates this claim to be the real cause of cholera, not to the comma bacilli of Koch, but to small straight bacilli, probably identical with those seen and described by the English cholera Commission in India as constantly present in the alimentary canal of cholera patients, and for which bacilli I did not and cannot claim any real infective power; and further, that Emerich's view is backed up by no less an authority than Von Pettenkoffer himself. There is then at present an interesting contest going on between two rival bacilli: one, having Berlin for the head-quarters of its advocates, may be called the northern bacillus; the other, in Munich, may be called the southern bacillus. As to the actual facts, it seems to me the question is not whose claim is stronger, but whose claim is weaker.

(2) All except Ferran, acquainted practically with the comma bacillus in pure cultivations (Koch, Van Ermengem, myself, Mr. Watson Cheyne, Finkler, Emerich, Buchner, Klebs, and many others) are agreed that the comma bacillus in artificial cultivations never forms spores; having multiplied until all the nutritive material in the cultivation is exhausted, a period arrives when the comma bacilli degenerate and die; some undergo this long before the point of exhaustion is reached, others retain their vitality longer, but after weeks and months death has involved all the comma bacilli present in the cultivation. [An impurity accidentally present in the culture would effect this death of the comma bacilli in a much shorter period; in fact, in many instances, they would not have much chance of primarily reaching any considerable number.]

When this period has been reached, the culture becomes incapable of starting a new culture; and *vice versâ*: by this means the point of death of the bacilli present in the culture can be tested and accurately determined. I have a large number of tubes of pure cultivations of the comma bacilli, the nutritive medium being broth, or peptone and broth, or gelatine peptone and broth, or gelatine peptone and meat extract, or Agar-Agar peptone and broth, &c. In each of these media the comma bacilli thrive well and form copious growths. The cultures are pure, contain the comma bacilli only, as all sub-cultures from them yield again the comma bacilli, and comma bacilli only. Now the remarkable fact about such culture tubes is this: that after several months all life in them becomes extinct, as is proved by inoculating from them a series of tubes containing suitable nutritive material, no comma bacillus or any other bacteria making their appearance. I have ascertained this in a great many cases, and it is in perfect agreement with the experience of Koch and many other workers. This clearly proves that there are not present in such tubes spores of the comma bacilli, for, if the comma bacilli, like some other bacilli—*e.g.* bacillus subtilis of hay infusion, or bacillus anthracis, were capable of forming spores, such a total extinction of life could not take place; the spores, although, owing to exhaustion of nutritive material, incapable of germinating into bacilli while in the tube in which they were formed, would undoubtedly germinate when transferred into a fresh and suitable nutritive medium. This total extinction of life does occur not only in tubes in which the nutritive medium is in a fluid condition, but also in all Agar-Agar peptone broth tubes, this material, unlike gelatine, remaining in its solid state, however luxuriant the growth of the comma bacilli may be.

Dr. Ferran claims to have discovered means by which the comma bacilli can be made to produce spores. In his cultures he notices a number of peculiar things which he considers as antecedents to the formation of spores and as fully formed spores. But direct observations that these are really spores, that, like spores, they actually germinate into the bacilli, Dr. Ferran has not deemed it necessary to make. As a matter of fact those to whom Dr. Ferran has shown his specimens, in which these alleged spores were supposed to be present, failed to see them (see the Report of the French Commission headed by Dr. Brouardel; see also Dr. van Ermengem's Report).

The methods of examination and cultivation of bacteria perfected by Koch, which, owing to the thoroughly reliable results they yield, are now universally followed by all who wish to acquire correct ideas and a sound knowledge of the life-history, morphology, and activity of bacteria, have led those practically acquainted with the comma bacilli to the conclusion that they do not form spores. Dr. Ferran is of the contrary opinion; but, judging from the Report of the French Commission, and from that of van Ermengem and others, who have visited Ferran and seen him at work, it is pretty clear that this gentleman is not only unpractised in, but altogether unacquainted with the elements of technique necessary in bacterial investigations; more than this: according to a graphic description by the special correspondent of the *Times*, Dr. Ferran makes his cultivations in broth in a temporary laboratory, the kitchen of an untenanted house, reeking with the effluvia of an untrapped sewer opening into this kitchen. Dr. Ferran's cultivations have been examined microscopically by a Valencia Commission, who found that they contained a motley crowd of various kinds of bacteria; Dr. Chantemesse in a paper read before the Paris Académie de Médecine (see *Brit. Med. Journal*, Sept. 26, 1885) states that as the result of a microscopic examination of Dr. Ferran's cultures he found the fluid variable in its composition; sometimes it is a cultivation of impure comma bacilli, sometimes it contains masses of different micro-organisms, but the comma bacilli are barely present. Add to this that Dr. Ferran, as the special French Commission attested, possesses neither the skill nor uses the ordinary precautions and apparatus indispensable in investigations of this nature, and all Ferran's extravagant assertions as to the behaviour of the comma bacillus in cultivations, as to its peculiar power of forming spores, must be regarded as sheer nonsense.

3. Notwithstanding this deficiency of Ferran in his mode of preparing his so-called "vaccine," it might be said, and it has been said by Dr. Cameron in a powerful and very able article in the *Nineteenth Century* for August 1885, that by subcutaneously inoculating a cultivation of comma bacilli, no matter however impure and contaminated, *e.g.* such as were at Ferran's disposal, the effect is different from the one produced by introducing them into the alimentary canal. In the former case, *i.e.* in the subcutaneous tissue, they are planted in a soil not congenial to them, and their product is only an abortive form of cholera, whereas in the latter, *i.e.* in the cavity of the alimentary canal, they find a more suitable soil, a soil which is their natural breeding ground, and the result is virulent real cholera.

What Ferran by the inoculation of his cultures into the subcutaneous tissue of human beings actually did produce, is, according to a number of witnesses (see the letters of the special correspondent of the *British Medical Journal;* the evidence given in detail by the special correspondent of the *Times*, October 20, and a number of other independent witnesses, English and French), septic infection, the intensity of which, as might be expected, and as Ferran himself admits, depends on the quantity injected. This result, however, is not always produced, the injection being sometimes quite inert, notwithstanding the presence of the comma-bacilli in the "vaccine" fluid. In the very able letter by the special correspondent of the *Times* for October 20 we are informed that Dr. Ferran explained to this gentleman in detail that the culture fluid used for inoculation need not contain any comma bacilli at all, in order to produce the desired result; further, that the comma bacilli can be killed by boiling or otherwise, without impairing the efficacy of the fluid, and that therefore a chemical substance present in the culture fluid, and probably the product of the organisms, must be regarded as the active principle. While this latest assertion of Ferran clearly shows that he is profoundly ignorant of the theory and practice of protective inoculations, such as are employed by Chauveau, Pasteur, Koch, Gaffky, Arloing and Thomas, and many others in a variety of specific diseases (anthrax, some forms of septicæmia, fowl cholera, symptomatic charbon, &c.), and while it is in flagrant opposition to his own assertions of an earlier date, it also proves that the results obtained by Ferran by the inoculations of his "cholera vaccine" into the subcutaneous tissue of human beings harmonise well with the assumption that what he produces is simply septic poisoning, *i.e.* changes such as have been proved to follow the injection of certain chemical substances known as ptomaïnes, and produced by the growth and activity of putrefactive bacteria in media containing proteids. Brieger (" Die Ptomaine," Hirschwald, Berlin, 1885) has published a most important series of observations on the production, nature, and action of ptomaines, and has greatly enlarged our knowledge of this as yet obscure subject. The description of the symptoms observable on persons inoculated by Ferran (as given by a variety of independent witnesses and by Ferran himself), can leave little doubt that the result of these inoculations is septic poisoning, in severe cases dangerous phlegmon and ulceration, and even death. This is also the opinion of a number of medical men (Spanish, English, and French) who have had the opportunity of seeing and examining such persons, as will be seen from the Report by the Special Commissioner of the *British Medical Journal*, the Report by the Special Commissioner of the *Times*, the Report by the Special French Commission, and the Report of the Commission sent by the Spanish Government. Such being the case, the inoculations practised by Ferran and his coadjutors can have no possible prophylactic effect against cholera, even granting, for the sake of argument, that one mild attack of cholera protects against a second severe one, a question which is still *sub judice*, since some competent authorities maintain that such immunity, although holding good in a number of infectious maladies, does not apply to cholera.

4. Now, are persons inoculated by Ferran furnished with immunity against an attack of cholera? The statistics published by Dr. Ferran and his adherents on the marvellous effects of inoculation in Alcira, Valencia and other places, accepted by Dr. Cameron in his article above referred to, show us a picture of brilliant successes, favourably comparing and even surpassing the statistics of the effect of vaccination against smallpox. Those statistics collected by Ferran being endorsed by several medical men and other notabilities of the town of Alcira and elsewhere, Dr. Cameron cannot bring himself to regard as not revealing the truth; he cannot imagine that all these worthy people should conspire to pervert the truth and to prevent the truth from becoming known.

The correspondent of the *Times* in his letter, published October 20, gives a long list of places where the statistics published by the Ferranists are signed and stamped by the Alcalde of the place, the local judge, the priest, the resident doctors, and the notary; all duly signed and stamped. This Englishman, however, probably knowing what value to attach to the competency and veracity of all those worthies, examined the statistics for himself, and the result of his inquiry may be briefly summarised by saying that Dr. Ferran and his partisans have simply "cooked" those statistics. They have done these things: when a person who had been inoculated by Ferran did nevertheless become affected with cholera, and died of it, death was put down as caused not by cholera but by some other disease; false entries were made as to persons who, having been inoculated, nevertheless died of cholera, were not entered as having been inoculated; persons have been registered as having been "vaccinated" by Ferran, but on inquiry were found to have died of cholera several days previous to the alleged "vaccination."

Add to this the fact that in Alcira, for instance, the inoculations and their wonderful effects had not commenced until the population had abandoned the impure water supply; that in some places many of the inoculated persons belonging to the well-to-do classes (a fee being paid for the inoculation) were therefore less exposed to infection, and those statistics become a gross farce and a shameless imposture. And this is practically the opinion of the Special Commission sent by the Spanish Government; this Commission has reported altogether unfavourably on these inoculations, declaring them barren of all scientific value, dangerous inasmuch as persons inoculated and suffering in consequence from a form of septic poisoning become more susceptible to infection from cholera and other diseases, and further condemning them as of no value in giving immunity against cholera.

The fact that Dr. Ferran and his associates took payment for the inoculations—thousands of persons were inoculated and reinoculated in Valencia and elsewhere, for each inoculation a fee of from 5 to 12 francs being charged—gives to the whole business a very ugly look. The *Times* correspondent (*Times*, October 20) does not therefore fully express the real value of Dr. Ferran when he says that he (Dr. Ferran) "is the dupe of illusions, conceived in ignorance."

E. KLEIN

LIFE OF SIR WILLIAM ROWAN HAMILTON

Life of Sir William Rowan Hamilton, Royal Astronomer of Ireland. By Robert Perceval Graves, M.A., Sub-Dean of the Chapel Royal. Vol. II. pp. 719. With Portrait. (Hodges, Figgis, and Co.)

IN a former number of this journal it was our duty to notice the first volume of the life of the illustrious Irish mathematician. We have now to congratulate Mr. Graves on the completion of the second instalment of that great work which has evidently been to him a labour of love. This volume, like its predecessor, bears abundant testimony to the conscientious manner in which the author has sought to delineate a picture of Hamilton, told as far as possible by the letters from Hamilton to his friends and by extracts from his journal. We are again surprised at the extraordinary copiousness of the materials which were available.

The incidents in the life of Hamilton apart from his literary and scientific activity are but few. The last volume conducted us to the year 1832, when Hamilton was in his twenty-seventh year. We had there seen the troubled course of his two earlier love affairs, and at the outset of this volume we are introduced to the third with Miss Bayly, to whom he was married in 1833. His domestic happiness was in the course of years clouded over by the ill-health of his wife, though to the end he remained an attached husband, as she was an attached wife; two sons and one daughter were the issue of this union.

The reader of this work can hardly fail to be struck with the number and the worth of the friends to whom Hamilton was endeared; he possessed to a remarkable degree the power of transforming a casual acquaintanceship into a true and lasting friendship. His intimacy with Wordsworth has been already referred to, and was carried on by occasional letters and visits until the death of the poet. Among his other literary friends we may mention Maria Edgeworth, who writes to him (p. 384):—

"Take your head from the stars or from transcendental mathematics and come and enjoy Folly and Friendship."

There are also copious letters to and from Aubrey De Vere, Lord Dunraven, the Marquis of Northampton, and many others, including not a few to his intimate friend the author of the present work; one of these we would specially mention (p. 357), in which Hamilton sketches the obligations of true friendship. The scientific correspondence of Hamilton with many of the leading philosophers of the last generation occupies, as might have been expected, a large proportion of the volume.

At successive meetings of the British Association Hamilton was a well-known and a conspicuous figure. When the Association visited Dublin in 1835 he was but thirty years old, yet he had already attained a scientific renown which made him perhaps the most eminent man at that meeting. It was on this occasion that the Board of Trinity College entertained the distinguished visitors at a banquet. The guests had assembled in the venerable library of the University. The Earl of Mulgrave, then Lord Lieutenant of Ireland, called Hamilton to the centre of a little circle, and, after conferring upon him the honour of knighthood, said:—

"I but set the Royal, and, therefore, the national mark on a distinction already acquired by your genius and labours" (p. 158).

In speaking at the banquet subsequently, Whewell said, in language which the enthusiasm of the moment might perhaps excuse:—

"It was now one hundred and thirty years since a great man in another Trinity College knelt down before his Sovereign and rose up Sir Isaac Newton" (p. 159).

In the year 1842 Sir R. Murchison, then general secretary of the Association, writes to Hamilton as follows (p. 387):—

"Your letter of the 16th having crossed mine, *I am in despair* at your resolution not to visit Manchester; and in order to shake it if possible, even at the eleventh hour, I enclose you a letter from Herschel, whose resolutions were quite as firm as yours, and who yet has made them fly before Bessel. Think of this philosopher coming on purpose to see such men as Herschel, yourself, and two or three others, and finding Airy and Baily flown to Italy and Sir William Hamilton *lecturing* in Dublin!! Pray put off your class for a week. Make a noble effort and lay it all on Bessel's shoulders, and you will add to your glory."

On this occasion Hamilton had also the gratification of meeting the great mathematician Jacobi, who, after referring to Hamilton as the "Lagrange of your country," said (p. 388):—

"Provided that we give to the dynamical equations that remarkable form under which they have been presented for the first time by the illustrious Astronomer Royal of Dublin, and in which they ought to be presented hereafter, in all the general researches of analytical mechanics."

We also read how Hamilton was received at the Oxford meeting in 1847, in which, to quote his own words from a letter to the author, he says (p. 585):—

"It has several times happened to me to sit between Struve and Le Verrier (both of whom, somewhat to my surprise, and certainly beyond my deserts, assigned to me a high place among British astronomers in their speeches at the concluding meeting). And when I rose to give an account of the application of the calculus of quaternions to the theory of the moon on the Thursday of last week, and saw before me not only those two eminent foreign astronomers, but also Herschel, and Airy, and Adams, and Challis, besides Peacock and Whewell, and others scarcely less distinguished, I could not refrain from acknowledging it to be an alarming and almost an awful thing to speak on any subject of physical astronomy in the presence of such an audience."

Hamilton also records in an unsent letter the following, which refers to the same meeting (p. 585):—

"My friend Struve, of Russia, at Oxford, 1847, said: that, though I held the title of Royal Astronomer of Ireland, my astronomical brethren on the Continent would decidedly prefer my never looking through the telescope to my giving up or less ardently pursuing mathematics. 'You are,' he was pleased to say, 'our teacher.'"

Hamilton was for many years not only the most distinguished member of the Royal Irish Academy but also its president. Many interesting letters will be found in the volume relating to his election to this distinguished post. His rival, if so he can be called in what Hamilton describes as a "contest of generosity," was the late Provost Lloyd. Lloyd retired in favour of his friend, and Hamilton writes many letters, the character of which is fairly represented by one to Lloyd (p. 218), in which he disclaims

"Entertaining *even a thought* which could be construed into *treason* to our long and unclouded friendship, and that the part *you* have taken (while in some respects it adds to my pain) furnishes a new proof of the justice of the high opinion that I have ever entertained of you."

Hamilton discharged in the most exemplary manner the laborious duties of President for several years, until, as he writes (p. 510):—

"The day has at length arrived when I am to accomplish my desire of retiring from the chair of the R.I.A. How joyously, though not without a feeling of solemnity, I received the news of my being elected to the chair; how gladly now I resign it, yet not without a shade of that sadness which belongs to a farewell!"

The chief interest in this volume will be found in the account of the great invention of quaternions, with which the name of Hamilton will be for ever associated. His own appreciation of the importance of this achievement is shown in an extract from a letter to Prof. Lloyd in December, 1851 (p. 445):—

"In general, although in one sense I hope that I am actually growing *modest* about the quaternions, from my seeing so many peeps and vistas into future expansions of their principles, I still must assert that this discovery appears to me to be as important for the middle of the nineteenth century as the discovery of Fluxions was for the close of the seventeenth."

The account of the discovery which, after fifteen years of studious meditation, seems suddenly to have flashed upon Hamilton is told in an interesting letter written from his deathbed many years later to his son Archibald (August 5, 1865), p. 434:—

"On the 16th day of October, 1843, which happened to be Monday, and a council day of the Academy, I was walking in to attend and preside, and your mother was walking with me along the Royal Canal, to which she had perhaps driven; and although she talked with me now and then, yet an *undercurrent* of thought was going on in my mind which gave at last a *result*, whereof it is not too much to say that I felt *at once* the importance. An *electric* circuit seemed to close; and a spark flashed forth, the herald, as I *foresaw immediately*, of many long years to come of definitely directed thought and work, by *myself* if spared, and at all events on the part of *others*, if I should even be allowed to live long enough distinctly to communicate the discovery. Nor could I resist the impulse, unphilosophical as it may have been, to cut with a knife on a stone of Brougham Bridge, as we passed it, the fundamental formula with the symbols i, j, k;—namely, $i^2 = j^2 = k^2 = ijk = -1$, which contains the *solution* of the *problem*, but of course, as an inscription, has long since mouldered away. A more durable notice remains, on the council books of the Academy of that day—October 16th, 1843—which records the fact, that I then asked for and obtained leave to read a paper on *quaternions* at the *first general meeting* of the session, which reading took place accordingly, on Monday, November 13."

Among the most distinguished disciples of Hamilton is Prof. Tait, though *even he* has admitted that he has not read the whole of Hamilton's "tremendous volumes" (lives there indeed the man who has?). Another account of the discovery is found in a letter to Prof. Tait on October 15, 1858 (p. 435):—

"To-morrow will be the fifteenth birthday of the quaternions. They started into life full-grown on the 16th of October, 1843, as I was walking with Lady Hamilton to Dublin, and came up to Brougham Bridge—which my boys have since called Quaternion Bridge. I pulled out a pocket-book, which still exists, and made an entry, on which *at the very moment* I felt that it might be worth my while to expend the labour of at least ten or fifteen years to come. But then it is fair to say that this was because I felt a *problem* to have been at that moment *solved*, an intellectual want relieved which had haunted me for at least *fifteen years before*."

The unmathematical reader may naturally ask the nature of this notable discovery which Hamilton made at "Quaternion" Bridge.

It would seem that at this moment he solved the long-studied problem of the multiplication of directed straight lines, or vectors as he called them. Let a denote a straight line of determined length and direction. Let b denote another straight line at right angles to a, and radiating from the same origin; then the product ab denotes a third straight line from the same origin perpendicular to the plane of a and b; the product ba, however, denotes the perpendicular line on the other side of the plane, so that $ba = -ab$. This formula is eminently characteristic of the method, showing as it does that vector multiplication is non-commutative. It is, however, remarkable that the associative principle obtains in quaternions no less than in ordinary algebra; thus if a, b, c be three vectors, or more, generally quaternions, then $ab \times c = a \times bc$. This theorem, though *true* in quaternions, is still so far from being obvious that it implies the truth of an elaborate geometrical theorem.

If we could single out one point of special significance in the invention of quaternions it would be found in the *dual* interpretation of the symbol of a vector. Thus if the letter i denotes a vector or directed straight line of unit length, then the same symbol may also mean an operation of rotation through a right angle around the vector as an axis. In the formulæ of quaternions the symbols denoting vectors can be interpreted in this dual manner. A quaternion may be regarded as the operating factor which applied to one vector transforms it into another. This operation requires two quantities to specify the plane of the vectors—one to specify the angle between them and one the ratio of their lengths in all four quantities are required, whence the name quaternion.

An interesting letter (p. 536) to the Rev. John W. Stubbs, Fellow of Trinity College, dated October 19, 1846, gives a sketch of the points which Hamilton thought specially novel in his theory:—

"But did the thought of establishing such a system, in which *geometrically opposite factors*—namely, two lines (or areas) which are opposite IN SPACE give ALWAYS a *positive product*—ever come into anybody's head, till I was led to it in October, 1843, by trying to extend my old theory of algebraic couples, and of algebra as the science of pure time? As to my regarding *geometrical addition* of lines as equivalent *to composition of motions* (and as performed by the same rules), that is indeed *essential* in my theory, but *not peculiar* to it; on the contrary I am only one of many who have been led to this view of addition."

A few years later Hamilton commenced the delivery of lectures on quaternions in Trinity College. His own words are (p. 605):—

"It was on Wednesday, June 21, 1848, that I delivered my first lecture on quaternions to a very respectable audience, among the persons composing which were the Rev. George Salmon, Fellow of Trinity College, Dublin, and author of a lately-published treatise on Algebraic Geometry, and Arthur Cayley, Fellow of Trinity College, Cambridge, who first, except myself, has publicly used the quaternions."

These lectures, rewritten and greatly expanded, formed his first and classical volume—"Lectures on Quaternions." (Dublin, 1853.)

The publication of this work drew from Hamilton's many scientific friends cordial letters of congratulation. His old and intimate friend, Sir John Herschel, thus writes on July 21, 1853 (p. 681):—

"Now most heartily let me congratulate you on getting out your book—on having found utterance *ore rotundo* for all that labouring and seething mass of thought which has been from time to time sending out sparkles, and gleams, and smokes, and shaking the soil about you—but now breaks into a good honest eruption with a lava stream and a shower of fertilising ashes. I don't mean to say that there is not a good deal of cloud (albeit full of electric fire)—the good old 'stupendo e orgoglioso pino' of the fiery outbreak surrounding the bright jet, the true product—but the cloud clears as the wind drifts and leaves the hill conspicuous.

"Metaphor and simile apart, there is work for a twelvemonth to any man to read such a book, and for half a lifetime to digest it, and I am quite glad to see it brought to a conclusion."

The intercourse, both social and scientific, between Hamilton and Sir John Herschel gives many interesting pages to this volume. Thus, for instance, we find (p. 492) an account of a meeting between these philosophers at the house of their common friend, Dr. Peacock, the Dean of Ely. On Sunday they attended service in the Cathedral in company with Prof. James D. Forbes, and Hamilton recorded the incident in a sonnet which he recited to his friends. The next morning he received an acknowledgment in kind from Herschel. We quote here the two poems: that of Hamilton (p. 493) bears the title "In Ely Cathedral":—

"The sunshine, through the lofty window stealing,
Lit up that vast and venerable fane,
Ely's Cathedral, in dark clouds and rain
Wrapped lately, and shut up from joyous feeling:
In its soft progress all around revealing
Beauty or majesty unmarked before,
It shed its type of heavenly comfort o'er
Three kindred-kingdoms' sons together kneeling.
Oh, may that Church, Episcopal and pure,
One Mother of that kneeling company,
In essence one, in name and office three,
Mid outward storm and darkness still endure:
Be comforted of Christ in God's good time,
And share the sunshine of a heavenlier clime."

Herschel's sonnet in reply (p. 494) was handed to Hamilton the following morning:—

"ON A SCENE IN ELY CATHEDRAL

"The organ's swell was hushed, but soft and low
An echo, more than music, rang; when he,
The doubly-gifted, poured forth whisperingly,
High-wrought and rich, his heart's exuberant flow
Beneath that vast and vaulted canopy.
Plunging anon into the fathomless sea
Of thought, he dived where rarer treasures grow,
Gems of an unsunned warmth and deeper glow.
Oh! born for either sphere! Whose soul can thrill
With all that Poësy has soft or bright,
Or wield the sceptre of the sage at will
(That mighty mace which bursts its way to light).
Soar as thou wilt! or plunge—thy ardent mind
Darts on—but cannot leave our love behind."

We have introduced these verses not so much on account of the poetical merit they possess, which we confess appears to us to be but slight. They may, however, serve as samples of those poetical effusions with which these volumes teem—indeed they give the impression that there must be some occult sympathy between poetry and astronomy. It is well known that Romney Robinson was a poet, and though it does not appear that Sir George Airy had plunged into verse, yet when he and Hamilton were together at Parsonstown there was an amusing contest between the two Royal Astronomers as to which could repeat most English poetry. The present writer has heard this scene described by the late Earl of Rosse, who said that Sir G. Airy was admitted to have carried off the honours.

As an illustration of one of the less important mathematical labours of Hamilton we may mention his paper on the Hodograph, communicated to the Royal Irish Academy in 1846. This elegant conception is a curve whereof the radius vector to any point from the origin represents both in direction and in amount the velocity of a moving particle. Many interesting applications were made by Hamilton, and are referred to in correspondence with Whewell. A somewhat ludicrous incident in connection with the hodograph is recorded (p. 543). It appears that at the same meeting of the Academy in which the hodograph was discussed, Hamilton also exhibited Prof. Mädler's just published work on "The Central Sun." This precarious speculation was by the reporter injudiciously blended with the hodograph, and an astounding statement went the round of the papers asserting that Hamilton's wonderful calculus had succeeded in discovering the central point of the universe!

It is not, perhaps, generally known that the real discoverer of the hodograph was Bradley (see Rigaud's edition of Bradley's Memoirs, Oxford, 1832, p. 288). Bradley has there given a most elegant geometrical investigation of that circle related to elliptic motion which Hamilton afterwards named the hodograph.

The religious side of Hamilton's character demands a few words of notice. He was a member of the Establishment, and many passages show that he had the sympathies of a sound churchman. He seems to have been an admirer of Pusey, with whom he was also personally acquainted. We also find occasional reference to the midnight vigils with which he awaited the new year, and to the fasting which he sometimes practised for devotional reasons. We should imagine, however, that such exercises were but very occasional to a student so laborious yet so irregular as Hamilton.

He found time to be president of a local branch of the Society for the Propagation of the Gospel. He assumed the duties of a churchwarden, and vanquished Archbishop Whateley in a controversy on the orthodoxy of an inscription on the church window at Castleknock. At Whitsuntide we find him writing a dynamical theory of the ascension of our Lord, in which in mediæval fashion he proceeds to evaluate the *duration* of the phenomenon, which he demonstrates to have been less than the interval between Holy Thursday and Whit Sunday.

It is with evident pain that the biographer has felt himself compelled to record the one great failing of his illustrious friend. The excessive devotion of Hamilton to study and the engrossing nature of those mathematical reveries in which he indulged led to the formation of very irregular habits. He "too often found the dawn surprise him as he looked up to snuff his candles after some night of fascinating labour." The necessary hours for rest and refreshment being disregarded, he was led to the dangerous practice of an undue recourse to alcohol, and occasional intemperance was the consequence. Two or three scenes arising from this cause have been described in this volume. There is one which can hardly have been witnessed except by the biographer himself, but which his conscientiousness has compelled him to record. There is a second on a public occasion which caused the deepest grief to Hamilton's friends, one of whom called upon him with a kind remonstrance which was received by Hamilton in a manner worthy of his high character. There is also a third incident, perhaps the most painful of all, which illustrates the attempt of Hamilton to reform and the circumstances under which he relapsed.

We certainly have no intention of citing these passages in this place, for if torn from their setting in the life of this great man they would probably convey an exaggerated notion of the extent of his infirmity. We would rather record the words of Mr. Graves, where he says (p. 335):—

"It is mournful that what seems to have been an inconsiderate, and at first unconsciously indulged, defect in external regimen of life, for such in the inception was his infirmity, should avail to cast a shade over qualities so solid and so splendid as the moral and intellectual qualities of Hamilton."

We have still to look forward to the third and concluding volume of this important work. In it we are to read how Hamilton continued his stupendous labours which culminated in the appearance of his other great work, the "Elements of Quaternions." We are also promised that extensive correspondence with De Morgan, which will secure the attention of every lover of the "Budget of Paradoxes." At the close of our former notice we insisted on the duty which devolved on the University of Dublin of publishing in a collected form the mathematical writings of their illustrious son. This duty has not yet been discharged; let us hope that it will not be left to some foreign mathematician to undertake the work which it should be the glory of Trinity College to complete.

AN AGRICULTURAL NOTE-BOOK

An Agricultural Note-Book. By W. C. Taylor, Aspatria, Carlisle. (London: Longmans, 1885.)

IT is not often that note-books are published, and it is well. Notes are in their nature fragmentary, and disposed towards brevity, often lapsing into crudity. They are a sort of skeleton of imparted knowledge, or at least rather anatomical than living, moving, and breathing information. The least and the most that may be reasonably expected of them is that they should be correct. The small book which has just been published by Messrs. Longmans does not commend itself to our judgment. It is crude, fragmentary, and almost inarticulate or unintelligible. It purports to contain a body of teaching and of facts, but it really consists of disjointed sentences, the meaning of which it is often very difficult to gather. The grammatical construction of the sentences is also fearful and wonderful. To give an idea of this latest contribution to agricultural science, we select the opening passage, page 1, which reads as follows:—"The science of agriculture. Definitions and terms. Its definitions. Scientific truths taught by the practice of agriculture." "The practice of the farm teaching the science. The laws of agricultural science best learnt when thus taught, and lead to improvements in the application of science to farm practice." If this is a definition, much has been written in vain as to the difficulty of defining. It not only fails in definiteness, but is curiously involved, as well as untrue, for "the practice of the farm teaching the science" is an impossible and impracticable idea.

The word "its" before each paragraph of definitions and terms appears to bear reference to the general heading, "The Science of Agriculture," and cannot be supposed to bear a grammatical relation to "definitions and terms." Taking this view of Mr. Taylor's "notes," we read as follows:—

"Its character in the soil, as temper, will, and disposition. These to be noted: success of farmer depending much on his knowledge of above (sister sciences). *Hungry, sick, grateful, obstinate, kindly, tender*, &c."

We defy any one to make any sense out of these utterances, whether taken with or without their context.

Next we have an attempt at further amplification. Thus "1 HUNGRY—constantly in want of food." Now, be it remarked that the subject is *soils*, and we are told that a soil is "hungry, constantly in want of food." Also that it is "sick." Here is indeed confusion of metaphor and blind guiding with a vengeance. Only let readers of NATURE endeavour to picture to their minds a hungry and sick soil! No wonder that Mr. Taylor in the richness of his fancy can further enlarge upon its gratitude, tenderness, and kindliness. Page 1 would itself furnish ample matter for review. It is as full of difficulties as the Moabitish stone, although it might not so well repay deciphering.

Again we read: "Short supply of organic matter improved by adding clay, where practicable, and vegetable matter." While concurring with the last simply-given advice as remedying the fault in question, we deny that any amount of clay can help towards this end.

Turning p. 1, we come to p. 2, where we begin at the top as follows:—"3. TENDER.—Hard and baked. Improved by rain, drags and harrows at right time." This tender soil is then hard and baked, and it appears also that it is improved by certain natural and artificial agencies which we thought were not only and solely unfit for the amelioration of such tender, albeit hard and baked soils.

On the same page we are thus enlightened as to the primitive rocks:—"The primitive rocks differ from materials yielded by decay, which is accomplished by oxygen (O) and carbonic acid (CO_2), gases invisible and transparent. Both attack rocks and metals, however hard; seen in the mould-board of the plough reducing it (?) to a powder without noise. *Temperature* and *water*, other two *agents* acting on the *Traitor's iron* and *potash*, loosening particles from the hard rock." . . . . These agents are the *friendly helpers* to the farmer. The italics are Mr. Taylor's own. We are irresistibly reminded of Mr. Weg and Mr. Venus, those two "friendly movers" in "Our Mutual Friend."

Passing onwards through the dreary succession of sentences devoid of subject, predicate, or copula, we arrive at p. 12, where instruction is given upon the various component parts of soils. Here we find the following information regarding alumina:—"Alumina. (1) Present in the soil, but not in plant food. (2) Double silicates are (1) silicate of alumina, (2) (*a*) lime, (*b*) potash, (*c*) or of soda, (*d*) or of ammonia. (3) Order of compounds, $H_3N_1K_2CO_3$, Na_2CO_3. The higher favourite puts out a lower and unites with the silicate of alumina. (4) The powers of vegetable life command an influence over each and all the second-rank partners. (5) Performs work of outdoor servant. (6) Reconstructs broken-up partnerships. (7) Amidst the faithless, constant only she. (8) Acts as purveyor of food for the plant."

We leave this extraordinary statement of the eight duties of alumina in the soil to the judgment of any sound scientific man or agriculturist, asking only why young people should be subjected to teaching so completely misleading, erroneous, and unintelligible, on the plea that they are obtaining insight into the principles of agricultural science?

THE PREVENTION OF BLINDNESS

The Causes and the Prevention of Blindness. By Dr. Ernst Fuchs, Professor of Ophthalmology in the University of Liége. Translated by Dr. R. E. Dudgeon. 8vo, pp. 230. (London: Baillière, Tindall, and Cox, 1885.)

UNDER the title of "The Causes and Prevention of Blindness," Dr. Dudgeon has translated an essay, written by Dr. Fuchs, of Liége, under the conditions of a competition announced by the "Society for the Prevention of Blindness in London," and to which the prize of 80*l.* offered by the Society was awarded. The book may be described as containing a succinct exposition of the chief causes of blindness, and an endeavour to render them intelligible to non-medical readers; the object being to obtain the cooperation of the public in the removal of these causes, in so far as that desirable end may be attained by improved hygiene, and by a better knowledge of the most favourable conditions of ocular work.

The causes of blindness which may fairly be said to be thus remediable, even including under blindness high degrees of defective vision, are two in number—namely, the purulent ophthalmia of new-born infants, and the progressive short-sight which is not uncommon in schools. The former is a disease which might frequently be prevented, which is always curable if treated in good time, but which, if neglected, is almost certain to destroy the sight; and to neglect of its early stages among the poor, and in remote country districts, probably four-fifths of the blindness which occurs among children in this country may be ascribed. Several months ago the Ophthalmological Society of the United Kingdom, moved thereto by Dr. McKeown of Belfast, sent a deputation to the Home Secretary to call the attention of the Government to the dangerous character and the easy curability of this affection, and to urge that steps should be taken, through the instrumentality of the Registrars of Births, to diffuse a more general knowledge of the importance of early treatment. Partly through the opposition of the Registrar-General, the deputation met with no encouragement; and the information given by Dr. Fuchs is therefore as opportune as it is valuable, and might with great advantage be communicated to the poor by clergymen, schoolmasters, and others. It may be said, however, that many of his recommendations apply chiefly to countries in which the employment of midwives is more general than in England.

The progressive short-sight of the educational period is a matter which has lately attracted much notice in all civilised countries, and Dr. Fuchs has nothing to say concerning it which is original. He presents, nevertheless, a brief and convenient summary of the facts, and a good description of the methods of school lighting and fitting which are most to be commended. This part of his volume may be studied with great advantage by any teachers and managers to whom the more systematic treatises upon the subject are either unknown or inaccessible. The book contains one serious error, which, in the English version, has been slightly modified by a mistranslation. Dr. Dudgeon writes, with reference to the provision for instruction about eye diseases in the medical schools of Great Britain and Ireland—"There are eye departments in all the large hospitals, but as a rule no regular lectures on ophthalmology are delivered." The word rendered "ophthalmology" is in the original not "*ophthalmologie*," but "*augenheilkunde*," and the correct translation would be "the treatment of diseases of the eyes." On this subject, that is to say, upon so much of ophthalmology as has any direct bearing upon the duties of the medical practitioner, systematic lectures are delivered in every medical school in the United Kingdom; and it is difficult to believe that the translator could have been unacquainted with the fact. "Ophthalmology," of course, takes a much wider range, and embraces branches of optics and of physiology with which the practitioner, unless a specialist in eye disease, has neither time nor reason to concern himself.

OUR BOOK SHELF

Among the Rocks round Glasgow: A Series of Excursion-Sketches and other Papers. By Dugald Bell. Second Edition. (Glasgow: Maclehose, 1885.)

THIS volume furnishes a good example of what a busy man can do in his few intervals of leisure. The volume is mainly based on notes of excursions kept by the author while acting as secretary to the Glasgow Geological Society. It affords a fairly accurate idea of the geological structure of the country round about Glasgow, and of the principal features of interest which the rocks of the district present. The excursions extend as far as Stirling, take in the course of the Clyde and not a few districts on its banks. Many of the papers are pleasant reading; and even geological specialists may find something in the pages to interest and inform.

Three Martyrs of Science of the Nineteenth Century. Studies from the Lives of Livingstone, Gordon, and Patterson. By the Author of "Chronicles of the Schönberg-Cotta Family." (London: S.P.C.K., 1885.)

THE author of this volume tells the story of these three remarkable lives very pleasantly and instructively, more, however, from the religious than the scientific standpoint. A very fair account is given of the work accomplished by Livingstone in Africa, though the author does not seem to be quite aware of the value of the geographical work accomplished by Gordon on the Upper Nile.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Upper Wind Currents over the Equator

THE importance of an accurate knowledge of the general circulation of the atmosphere over the equator is so obvious and so little known that the following observations, taken on a voyage from Aden to Australia in February, 1885, will be of interest:—

Over the north-east monsoon, north of the line, the surface wind was east-north-east, while the low clouds came from due east. No high cirrus was ever seen.

In 2° N. lat. the surface wind lowest clouds came from N.N.E., the next layer of cirro-stratus from E. rather fast, while the highest cirri drove very slowly from E.S.E.

In about 1° S. lat. the surface came from N.W. (the N.W. monsoon), small flecks of low cloud from N.E., while some high cirri moved from E. at a moderate rate.

In 5° S. lat. the surface wind still blew from N.W., the lowest cumulus moved from N.N.W., the next layer of cirro-stratus from N., while a still higher layer of cirrus came slowly from E. or E.S.E.

In 10° S. lat. the surface wind came still from N.W., and the clouds at moderate altitude from S.E.

In the "Doldrums," which we only reached in 13° S. lat., the surface wind was from S. and the clouds from S.E.

After we entered the S.E. trade, while the wind came from S.E., the clouds drove from S., and when about 25° S. lat. the trade drew into E.; the clouds came from S.E.

The relation of upper to surface winds in the N.E. monsoon is just what might have been expected; but the discovery of an easterly current over the N.W. monsoon and of an upper current over the S.E. trade, more southerly than the surface wind, is not only altogether new, but also quite anomalous.

In Australia, and the Southern Hemisphere generally, the upper current over a N.W. wind is from about W. and over a S.E. wind from about E.

On my way home I ran a section across the Atlantic from Rio to Teneriffe, but the absence of cirrus prevented any satisfactory determination of the upper winds in that region.

The matter is, however, so important that I start again in a few days for the hurricane region of Mauritius, where I hope to observe one of these exceptional cyclones. Then I hope to repeat a section of the Indian Ocean between Mauritius and Bombay, and afterwards, if all goes well, to get some sections in the Pacific to see what the meaning of this curious discovery may be. RALPH ABERCROMBY

21, Chapel Street, S.W., October 26

The Hellgate Explosion and Rackarock

THE statement in NATURE of the 15th inst. (p. 575) that rackarock is "blasting gelatine" or "nitroglycerine with compressed gun-cotton" is incorrect. Rackarock is simply powdered potassium chlorate, impregnated with an inexpensive oily combustible, such as coal-tar oil, and is one of my safety-explosives, which I discovered in 1870, patented in England, April 6 and October 5, 1871, and described more fully in the *Journal* of the Chemical Society for August, 1873, under the title: "On a New Class of Explosives, which are non-Explosive during their Manufacture, Storage, and Transport."

I am not responsible for the quaint name which the Americans have been pleased to give to my child.

As the so-called "rackarock" is not very sensitive or easy to explode, it requires a strong primer or detonator to set it off. This property, which I have fully discussed and particularly accentuated in my paper of 1873, explains why Gen. Newton, the Chief Engineer of the Hellgate mine, took the precaution of placing as a primer such a powerful charge (33 tons) of expensive dynamite on the cheaper charge of the potassium chlorate mixture (107 tons), a precaution carried here perhaps a little too far.

Still it is satisfactory to see that my safety-explosive performed the main part of the labour and rendered good service in the advancement of the works of peace. H. SPRENGEL

Savile Club, 107, Piccadilly

[We are very pleased to insert Dr. Sprengel's correction as to the composition of "rackarock." Up to the time of our notice about the explosion going to press the only information we could obtain was that it was the same substance as blasting gelatine, but with a less portentous name.—ED.]

An Earthquake Invention

IN your number for October 15 (p. 573) your numerous scientific readers will be interested to find a pretty long letter under the above heading from so able a seismologist as Prof. John Milne, of Tokio, Japan. Yet, his invitation notwithstanding, I must decline any discussion with *him*, either about my old letters which he refers to, or his own much changed opinion on their subject, since the occasion for my writing them occurred.

Those points, Mr. D. A. Stevenson, who is also invited, may, or may not, take up. My letters were impersonal, and dealt only with a British Association Report. I desire also to continue to keep them strictly to that, even to the very words of the particular Report as given forth to the world with all the usually unquestioned authority of that mighty Association, in their B.A. volume for 1884, p. 248, Section entitled "Experiments on a Building to resist Earthquake Motion."

C. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, October 16

On the Behaviour of Stretched Indiarubber when Heated

SOME time ago (NATURE, vol. xxv. p. 507) you permitted me to express a doubt as to the invariable success of an often-quoted experiment with cylinders of bismuth and iron, intended to illustrate some relations between specific heat and thermal conductivity.[1] I regret that I have made further progress along the evil road of scepticism. I should like, in fact, to ask whether it is absolutely true to say without qualification, as is done in many text-books, that india-rubber (when stretched) forms an exception to the general law that the volume of a body is increased when the temperature is increased. The usual form of the experiment supposed to prove this is well known: a piece of india-rubber tube or cord is stretched by a weight connected with a long light index-lever, and it is shown that when heat is applied the india-rubber gets decidedly shorter.

[1] Perhaps I may mention in passing that if lead is substituted for the bismuth the experiment succeeds perfectly, as theoretically it should do.

I have always had some hesitation in showing and explaining the result of the experiment in the above way, especially as I could not find any proof given that the contraction in length was not compensated, or more than compensated, by an expansion in other directions (like that of a worm in its creeping progress, or of a dry rope when wetted). I had, in fact, lately arranged an apparatus for determining the coefficient of expansion of india-rubber, whether positive or negative, when I found that the subject has been very fully investigated by Dr. J. Russner, of Chemnitz (see Carl's *Repertorium* for 1882, pp. 161 and 196).

His results are briefly these:—

(1) That india-rubber (of which several kinds were examined) has without exception a definite coefficient of expansion which is always positive; experiments made at temperatures varying from 0° to 53°·4 gave, for its value at 10°, 0·000657; at 30°, 0·000670.

(2) That india-rubber in a stretched state expands to the same extent as when it is not stretched. No point of minimum density was observed, such as Puschl supposed to exist.

(3) That the apparently anomalous behaviour of stretched india-rubber when heated is simply a case analogous to those of anisotropic crystals, which expand to different extents in different directions. Iceland spar, for instance, as Mitscherlich showed, actually contracts in a direction at right angles to its principal axis when heated, although its volume is, on the whole, increased.

Although ordinary india-rubber is, of course, isotropic, yet when stretched it becomes anisotropic, as may easily be shown by stretching a piece until it is semi-transparent, and placing it between crossed Nicols; the direction of the strain lying at an angle of 45° with the plane of polarisation. Distinct colours, as with a selenite film, will be seen, varying from red to blue with the amount of strain.

The fact that india-rubber becomes hot when stretched, and especially if stretched and allowed to contract several times in succession, may perhaps be accounted for by molecular friction. It would almost seem, then, that in the account given in many books the truth, as well as the india-rubber, has been slightly "stretched." H. G. MADAN

Eton College, October 23

The Resting Position of Oysters

IN carrying out a series of experiments on the artificial breeding of oysters in my private aquaria, I noticed that the young oysters born in the tanks rested on the flatter shell when they obtained a flat surface, such as a tile, to adhere to, but when I so arranged that they had irregular surfaces to deal with, such as little bundles of twigs, some adhered one way, and some the other. But where young oysters, nearly two years old, were moved from their original supports, and were compelled to find new ones, they selected the flat shell to rest upon in every instance, except where they were placed on sand, in which case they rested on the convex shell, in order apparently to avoid clogging the mouth of the shell with sand. Is it not possible from these observations that adult oysters vary their position according to the nature of the ground they are on. I have seen adult oysters on muddy ground lying on the convex shell, while where adhesion to a flat surface could be obtained, they were all on the flat shell, and pectens are dredged with Balani and other growths on the flat shell in some instances, and on the convex shell in others, principally, however, on the latter.

H. STUART-WORTLEY

South Kensington Museum, October 23

The Value of the Testimony to the Aurora-Sound

I HAVE read with much interest the descriptions of this sound as given by Dr. Sophus Tromholt's correspondents in NATURE of September 24. I was, however, struck by the similarity of these descriptions to the well-known phenomena of *tinnitus* *aurium*, and it occurred to me that since a large number of persons have noises in the head—say one-half the entire adult population—it is probable that, when listening intently, a considerable number of observers heard the sounds of their own ears only. This is especially true of "sizzling," "hissing," and "buzzing" sounds.

If physicians affected with tinnitus are not careful to exclude the noises propagated in their own heads, they may discover many curious physical signs in the chests of their patients in making auscultatory examinations. SAMUEL SEXTON

12, West Thirty-fifth Street, New York, October 12

The Red Spot on Jupiter

ON October 24, at 17h. 32m., this object was estimated exactly central on the planet. As seen with my 10-inch reflector, power 252, the spot was very plain, though the low altitude of Jupiter rendered the telescopic image far from good.

My impression is that this red spot is now decidedly more conspicuous than it was when I last saw it on July 8, and that during the ensuing opposition it will again attract general observation as one of the most prominent features of Jovian detail. This well-known marking has now been watched for more than seven years, and its present aspect leads to the inference that its existence will be indefinitely prolonged. We may therefore justly regard it as a lineament of singular permanency. Though its motion and appearance (*i.e.* tint) have been subject to considerable variation, there has been little, if any change in either the shape or size of the spot. The mystery regarding its origin and real nature may perhaps ultimately be revealed on the basis of renewed and more exact observation in future years. W. F. DENNING

Bristol, October 25

A Remarkable Sunset

WHILE out for a walk this afternoon I was struck by a peculiarity in the sunset which I do not remember to have seen noticed before. The sun set about 4.43 p.m., and there was the usual "after-glow." I began to notice this first about five o'clock; there was then in the west a large bank of cumulus cloud rather low down, above this was a brilliant lemon-yellow, very bright, and this was bounded by a broad arc of a pale pink, the latter fading away into the light blue of the sky. Very soon afterwards I noticed that the pink arc, instead of being continuous, was really made up of a series of beams of bright light, which pointed to the position of the sun. I counted these, and made out five bright rays at unequal distances apart; behind this (as it seemed) there were a few yellow cirrus clouds. A sunset like this I have often noticed before, but what followed is, I think, novel. The bright rays were slowly turning round like the spokes of a huge wheel moving in a direction contrary to the hands of a watch. I noticed also that the breadth between the bright rays altered, two of them seeming to almost coalesce. In about ten minutes' time one ray turned approximately through 90°, and a new ray brighter than the other appeared on the right. The altitude of a ray when vertical was from 30° to 40°, I should say. By 5.15 the rays became very faint and soon vanished, though above the dark bank of cloud I could detect a faint crimson-lake glow.

The day had been fine on the whole, except that there had been a little rain early in the morning, and a very heavy rain shower between 12.30 and 1 o'clock. The air was extremely clear, and the wind was blowing freshly from the west, or perhaps it was a bit north of west. It was blowing slightly from right to left across the line joining me to the sun.

This phenomenon of the pink rays revolving seems to be explained by the dark spaces being due to clouds which were being hurried along by the strong west wind. I should like to know if any one living in a line W.S.W. of Cambridge noticed broken masses of cumulus clouds this afternoon *overhead* between 5.0 and 5.15 p.m. Greenwich time. PAUL A. COBBOLD

Caius College, Cambridge, October 26

A Tertiary Rainbow

THE supposed tertiary rainbow about which I sent a note a month ago must have been a halo formed by ice crystals, as readers of NATURE will perhaps have inferred merely from the recorded distinctness of the colours. It did not occur to me that ice crystals would be found in a horizontal direction from here, over the hot plains of the Punjab on the evening of an August day. But I have since calculated the size of the tertiary rainbow and the order of colours in it, and the calculation leaves no doubt that the phenomenon must have been a solar halo, caused perhaps by a hailstorm over the plains.

Thaudiani, Punjab, Sept. 25 T. C. LEWIS

The Sense of Colour

IN the early English "Lay of Havelok the Dane" the following words occur:—

> "Also he wolde with hem leyke
> That weren for hunger *grene* and bleike."

Mr. Allan Cunningham in his interesting paper (p. 604) does not allude to this old use of the word green. Is it a solitary case? MARGARET HEATON

Belvedere, October 24

Stone Axes, Perak

A CURIOUS Malay superstition has come to my knowledge concerning these implements. They appear to be very rare out here, and those found are treasured by Malays as lucky things to have about the house. I have as yet only been able to procure two specimens. One of these I have described in a paper on the Sakaies read before the Anthropological Society in June last. This nearly resembles Fig. 55 in Dr. Evans' "ancient Stone Implements of Great Britain," and is made of a soft description of slate which can be scratched with the thumb-nail. The other is of a much harder description of slate almost like greenstone; it much resembles Fig. 76 of the same work. It is 7¾ inches long, 1⅝ inches wide at the widest end, which is sharpened, and 1½ inches wide at the other end, which is not sharpened. The faces are flatter than those figured by Dr. Evans and the sides perfectly squared. It is beautifully polished, but several depressions are left all over it, showing that it had originally been chipped out. The Malays call them Bâtu-lintarh—*i.e.* thunderstones—and account for their presence by saying that they are the missiles used by angels and demons in their continual warfare.

But the peculiarity of the superstition is this: the Malays aver that the soft implement which I have described has been made by an angel or a demon and buried in the earth to become hard and fit for use, and support their argument by saying that these objects have been found freshly made of clay and quite soft, buried in the earth, where they have lately been deposited by some angel or demon for a future time of battle. The Malays say that the bâtu-lintarh is hard to procure in this state, as it almost invariably drops to pieces. For this reason they do not value it much, and more particularly because it has never inflicted a wound. The hard polished celt which I have just described, however, they value very highly, because they say it has been used in the aërial warfare and has inflicted a wound on one or more of the combatants. They adduce this supposition from the fact of the several depressions left by the chipping out of the implement, and say that these marks were caused by its contact with the body of one of the demon combatants. This last idea is very closely connected with another Malay belief, and most probably took its rise from it. This belief is that if the blade of a kriss or spear is bent or in any way damaged, it has most certainly wounded if not killed a man or some wild animal, and is therefore proportionately of much greater value. A Malay who professes to be a good judge of a kriss will, if asked to appraise the weapon, invariably first glance along the blade to see if it is bent ever so slightly, and if it is he will most certainly add two or three dollars to its value because it has "m'nikam orang" (struck a man). I have very little doubt that if some of the fine limestone caves of this district were thoroughly examined, they would yield a rich harvest of anthropological material. A. HALL

Batu Gaja, Kiuta, Perak, September 6

Photographic Action on Ebonite

AT the back of one of the cases of lecture apparatus facing a north window in this laboratory, there happens to have been standing for six months or more an ebonite plate with a framed glass plate in front of it, the glass having a star-pattern done in little spots of tinfoil all over it. The thickness of the frame, say an eighth of an inch, separated the two plates from each other.

On taking them out of the case the other day I noticed the pattern on the glass clearly and sharply imprinted on the ebonite; every little circle well marked. Dust had been plentifully deposited on all parts not screened by the tinfoil spots, and the striking clearness of the impression was mainly due to this local absence of dust; but even on wiping off some of the dust the pattern could still be detected, owing to some difference of surface between the exposed and the shaded portions.

It evidently is another illustration of Prof. McLeod's observation of the effect of light on ebonite, the modified surface affording an easy lodgment for dust. In case there be anything more in the matter it is proposed to replace the same or similar plates, and observe at intervals.

EDWARD E. ROBINSON
Lecture Assistant to the Professor of Physics in University College, Liverpool

THE SLIDE RULE

It is a perpetual source of amazement to those who are familiar with this instrument that its use is not almost universal. People of every class have to make simple calculations, while those engaged in scientific work, in designing apparatus, or in invention perpetually cover sheets of paper with figures, all of which trouble and the loss of time which it involves might be saved by the intelligent use of a good slide rule, and yet, for reasons difficult to find out, the habitual use of this instrument is limited to a very small proportion of the calculating community.

Most people know that the scales are logarithmically divided—that is, that the distance between the divisions marked 1 and 10 being in imagination divided into 10,000 parts, the division marked 2 is at the 3010th of these parts, the division marked 3 is at the 4771st of these parts, and so on, 3010 being the log. of 2, 4771 the log. of 3, and so on; and further, that the spaces between these whole numbers are similarly divided into fractional parts, thus 1·1 is at the 414th of the imaginary parts and 1·01 at the 43rd of these parts, 414 and 13 being the logs. of 1·1 and 1·01. This is very generally known, but it is more generally believed that to use the rule involves so much thought and anxiety that it is far simpler to work out results in the usual way, or at any rate that the rule can only be of any real assistance when a great number of similar calculations have to be made; and further that, as the results to be obtained are not absolutely correct, that as an extreme error of 1, 1-10th, or 1-100th per cent. is possible, according to the nature of the instrument, it is not really to be trusted. These objections are easily answered. As soon as the slight difficulty of reading the rule has been overcome—a difficulty due to the fact that in ascending the scale the divisions become closer, so that if there is room for ten subdivisions between 10 and 11, there are only five between 20 and 21, and two between 40 and 41—a difficulty which once overcome never recurs—then the simpler calculations, such as multiplication, division, and simple proportion, can at all times without an effort or a thought be instantly performed, while those involving proportions in which some of the terms are squares, cubes, roots, sines, or tangents can, after a moment's reflection, be as easily completed, so that even in the case of single operations time is saved. It is true when many calculations of the same kind present themselves, especially if some of the terms in the series are identical, that the use of the rule is specially advantageous; but in any case mental labour and time are saved.

As to the probable accuracy of results obtained by the use of the rule, they are in general superior to the accuracy with which the figures which require reduction have been determined, or, if this is not the case, they are in general so nearly correct that the error is of no consequence. For instance, if the marks obtained by several examinees are to be reduced to correspond to a total of 100, the commonest rule, which gives an accuracy of 1-300th part, is sufficiently good; for the nearest whole number only, and the right order are all that are needed. It would be absurd to doubt the accuracy of the instrument because it cannot be trusted to give figures correct to one part in a thousand. Or, again, if the weight of a piece of metal has to be determined from its dimensions, a good rule trustworthy to 1 part in 1000 will in almost every case be more than good enough; for, even if the specific gravity of the material be known so truly, it is not often that the piece can be made so near the specified size that the discrepancy which may ultimately be observed will be due more to the error of the rule than to the inaccuracy of construction. In such a case it would be as absurd to discard the rule as untrustworthy as it is to use 7-figure logarithms for the calculations of an ordinary chemical analysis. There are cases, of course, where observations can be made with a degree of accuracy beyond that which is obtainable by any rule—for instance, determinations of mass, length, angles, and time can all be made with extraordinary precision. Where, then, uncertainty is not introduced by observations of another kind, where the entire precision to be obtained in any such observations may be expected in the result, as, for instance, in the determination of the refractive index of the glass of a prism, in such cases the slide rule is unsuitable, and tables of logarithms furnish the most obvious means of making the calculations. Or, again, when pounds, shillings, and pence are involved, a result correct to the nearest farthing is generally desired to make accounts come right, and so, unless the sums dealt with are moderate, the slide rule is again unsuitable. However, the calculation of interest furnishes a good example of proper and improper use of the rule in making calculations. If it is required to find what a certain sum (s) will be worth at the end of a year at so much (r) per cent., the result might be found from the proportion $100 : 100 + r :: s : x$. Here the amount x would be determined with an accuracy of say 1-1000th part, so that if 1000*l.* were involved, an error of 1*l.* might arise. This is an improper use of the rule. A greater degree of accuracy would be obtained by the proportion $100 : r :: s :$ the increase of s. Here the interest is found to the same proportionate accuracy, and so in such a case the greatest possible error could only be one shilling, if the rate is 5 per cent. This example, though obvious, is given because it corresponds exactly with cases that arise in the laboratory, where the rule, if used properly, is of service, but, if improperly, is useless.

Calculations involving only the simple arithmetical rules, when extreme accuracy is required, are best performed by the help of a table of logarithms, or with an arithmometer; in fact with an arithmometer a far greater degree of accuracy can be reached than with ordinary 7-figure logarithms, and though they are also suitable for calculations in which only three or four significant figures are required, their great size and expense compare unfavourably with the portability and cheapness of the rule, and, moreover, trigonometrical and logarithmic functions cannot be found with them. These machines are shown at the Inventions Exhibition by Tate and Edmonson, and are worth examining. There is another calculating machine close to Tate's, by which the interest on any sum at any rate per cent. for any time may be found to the nearest halfpenny in an incredibly short space of time, worthy of the attention of those who have to calculate interest. But, to return to the slide-rule, it is astonishing that an instrument like Gravet's, 10 inches long only, with which all calculations, arithmetical, trigonometrical, and logarithmic, can be worked out so easily and with an accuracy of from 1-500 to 1-1000, according to the nature of the calculation, should be so little used.

This is not the place to give instructions for using the rule, but an outline of the method is necessary to make it possible to compare the different makes, many of which are shown at the Inventions Exhibition.

With two similar scales of equal parts, as inches divided into tenths or centimetres divided into millimetres, it is possible to add numbers, or, conversely, to subtract numbers; thus, if the zero of one scale is placed opposite, say, 6·5 of the other, opposite every number n on the first will be found $n + 6{\cdot}5$ on the second, and so addition or subtraction could be performed, but there would be no advantage in so adding or subtracting. In the same way the slide of the ordinary slide rule is employed to add distances, but these distances do not correspond to the figures attached, but to the logarithms of those figures, and so the sum which is found by such an addition is not the sum of the figures apparently added, but their product. If the slide is placed at random, all the pairs of figures which are opposite to one another are in the same proportion, and the multipliers which will change either series into the other will be found on each scale opposite the divisions marked 1 on the other. It requires no great amount of memory to bear this in mind: however the slide may be set, those numbers which are opposite to one another are in the same proportion, *i.e.* have a common quotient, which may be found opposite any of the divisions marked 1; and yet this is all that has to be remembered in multiplication, division, and simple proportion. The two top lines of a slide rule are generally identical, and they are used for these simple operations; they are generally distinguished by the letters A and B. In general the bottom line of the slide, that is, the third altogether, is identical with the first two, and is labelled C. This arrangement is convenient, for it is possible to insert the slide upside down, in which case all numbers which are opposite one another on A and C have a common product, which may be found opposite any of the divisions marked 1. This furnishes the most ready mode of finding actual or approximate factors of numbers, and is of great use to those who have to calculate wheelwork; further, by the use of the inverted C line under the A line any harmonical progression can at once be read, and any number of harmonic means can be inserted between two quantities. The fourth line is generally made different from the others in that it is on double the scale, and it is then distinguished by the letter D. If the units of the C and D line are placed opposite one another, a table of squares and roots is formed, or if in any other position the squares of the numbers on D vary in the same proportion as do the numbers that are opposite to them on C. It is in calculations made on the C and D lines that so much time is saved, for proportions in which some of the terms are squares or square roots can be worked out as quickly and as accurately as those in which simple numbers only are employed. If the slide is inverted so as to bring the B line opposite to the D line, then the square of any number on D × the number opposite to it on B is constant. This product may of course be found in B opposite 1 in D. Cube roots, among other things, may be found in this way.

These four lines are all that are generally found in a slide rule; occasionally others are added: thus a line on one third of the scale of the D line (sometimes called an E line) will, with the D line, enable one to directly work proportions in which some of the terms are cubes or cube roots, but this is not often required. With the usual four lines all arithmetical processes, except addition and subtraction, can be performed. There are, however, rules in which on the back of the slide are scales in which the distances are log. sines or log. tangents of the angles marked, then these lines being placed against an ordinary A line so that 90° on the line of sines or 45° on the line of tangents is opposite 1 on the A line, a table of sines or tangents will be formed; and if the slide is placed in any other position, the sines or tangents of the angles denoted by any divisions on either of these special lines will vary in the same proportion as do the numbers which are opposite them on the A line. In those rules in which lines of sines and tangents are given there is generally a scale of equal parts in which the length of the D line is divided into 500 or 1000 parts. If this is placed opposite the D line, with the ends of the two scales opposite one another, a table of logarithms will be seen; thus the logarithm of any number on the D line will be found opposite to it on the scale of equal parts.

Having pointed out the chief uses of a slide rule, it will be possible to describe the differences in construction in the several varieties. The most simple possible form is the original Gunter's scale to be found on any sector. With this and a pair of dividers calculations may be made, for if the dividors are set to the distance between any two numbers, any other pair of numbers which are found by the dividors to be the same distance apart will be in the same proportion, or have a common quotient, just as a common difference would be found if a scale of equal parts were used. This, however, is troublesome; but if the same principle is applied to a scale in the circular form the result is much more convenient. In this case angular distance takes the place of linear distance, and a pair of arms which can be opened to any angle can be moved round, and every pair of numbers covered will bear to one another a constant proportion depending on the extent of the angle. This is the principle of some of Dixon's rules shown at the Inventions Exhibition, near the arithmometers. In the well-known pocket instrument, the calculating circle of Boucher, an instrument like a watch, one hand is fixed and one is movable, and the face is also movable. There is another instrument of the same kind, in which the scale is drawn on a helical line. Here the scale and one hand are movable, and there is one fixed hand. This, which is Prof. Fuller's spiral rule, is made and exhibited by Stanley. Circular instruments are also made, in which scales slide over one another, which are in this respect like the straight rules. There is more advantage in the circular form than appears at first. In the straight rules the A and B lines are each double, the first and second halves are identical; this repetition of the scale is required in order that, however the slide may be placed, the part of each opposite to the other may contain at least a complete scale of numbers. In the circular form, however, the beginning and end of a single logarithmic scale meet, and so the scale itself is its own repetition both above and below. For this reason the openness of the divisors in a circular instrument is the same as in a straight rule, of which the length is six times, instead of three times, the diameter of the circular line.

Of the two types of instrument—one in which one slide works against another, generally straight, sometimes circular, and the other in which there is no slide but only a line divided logarithmically with a pair of hands, which type is always circular—which may be called respectively the slide and the index types, each has certain advantages. The slide form is preferable, in that each setting of the slide furnishes a complete table of pairs of related numbers, as, for instance, of any English and foreign measure, of squares and roots on any scale, such as diameters and areas of circles, or of sines or tangents on any scale, so that, without moving the slide, any number of results may be read off, whereas with instruments of the index type the scale must be moved under the hands, or the hands over the scale, for each result. On the other hand, index instruments are more convenient than the usual slide rules in working out long expressions of the form $\frac{a \times b \times c \times d}{e \times f \times g}$, in which any of the terms may be squares, cubes, sines, or tangents, for the terms are taken alternately from the numerator and denominator and set in order with the fixed and movable hand until all are worked off, when the answer is found under the fixed hand. There is no necessity to observe any result till the process is complete; on the other hand, with slide instruments, each result of the form $\frac{a \times b}{e}$, $\frac{a \times b \times c}{e \times f}$, &c., must be read and set before it can be operated upon by the next pair of factors. In Gravet's rules, however, this disadvantage of the straight form is removed by the addition of a cursor or sliding index, which in other ways is a great comfort.

All instruments of the index type suffer terribly from parallax, owing to the hands being above the face, so that they do not in practice give the accuracy that from the length of scale upon them might be expected.

This is especially the case in small instruments: for instance, Boucher's calculating circle, made in the form of a watch, is probably divided so accurately that on that score an error of one part in a thousand does not exist; yet, owing to parallax, the practical limit is about 1-300. This instrument has, besides the ordinary line, one on a double and one on a treble scale for squares and cubes, a line of sines, and another of equal parts for logarithms.

The possible accuracy of any instrument depends upon the length of the scale included between 1 and 10, called the radius, and also upon the linear accuracy with which a setting or reading can be made; this is at least twice as great in slide as in index instruments. In order to obtain great accuracy various means have been adopted whereby a great length of scale is brought within a small compass. Among slide instruments are Prof. Everett's "Universal Proportion Table," published by Longmans, Green, and Co., and General Hannyngton's slide rule, made and exhibited at the Inventions Exhibition by Aston and Mauder. In these the slide is made in the gridiron form. In Everett's instrument there are twenty bars, the total length of which is about 13 feet; a scale of equal parts is also printed, so that logarithms can be read with it. In both of these instruments only simple proportions can be effected, unless special grids, divided on a double scale or trigonometrically, are provided. Far the most ingenious of all devices for obtaining a great length of radius in a comparatively short space is due to Mr. Beauchamp Tower, whose name is well known in connection with the spherical engine. His instrument is a slide instrument consisting of two tapes running side by side over equal and independent rollers, but the tapes have a half twist in them, so that they have each only one surface and one edge. In this instrument, made privately for his own use, each tape is about 12½ feet long, and as both sides of the tape are used the radius is about 25 feet, and therefore, as far as openness of scale is concerned, it is equivalent to a straight rule 50 feet long, while the instrument itself is only just over 6 feet in length.

Slide rules of the index class can have a great length of scale more readily employed than others. Thus Prof. Fuller's helical instrument has its radius equal to 42¼ feet, and is in openness of scale equivalent to a straight rule 85 feet long, while the box which contains it is only 17×3¾×3¾ inches inside measure. Dixon exhibits a special rule with the scale extending over 10 concentric circles, but with this form a less degree of accuracy is attainable when using the inner than when using the outer circle. Thus the inner circle is equivalent to a straight rule 30 feet long and the outer to one 60 feet long. There is an outer circle equally and logarithmically divided to find logarithms. In another of Dixon's instruments, similar in size and form, there is the same outer circle for proportions and logarithms, and a series of inner circles divided so as to give sines, cosines, tangents, cotangents, secants, and cosecants. Each of these is on a board 14 inches square. Rules with very extended scales do not in practice give results with an accuracy which is proportional to their length, though the working accuracy is very much increased. They have this advantage, that they can be worked to their limit with ease, while with a well-divided pocket rule the errors of construction are beyond the limits of vision, and so the calculator is apt to strain his eyes to get results as accurate as possible. For instance, results obtained by a good pocket-rule one foot long can be trusted to a thousandth part; at the same rate Prof. Everett's should be accurate to a thirteen-thousandth part, and Prof. Fuller's to an eighty-five thousandth part. In practice a four and a ten-thousandth part are their limits. Again, instruments with very extended scales have only room for one line, so that simple proportions only and logarithms are all that can be directly obtained from them. For general use in the laboratory or elsewhere where calculations of every kind have to be made, the straight form, on the whole, seems most convenient, because of its portability, the quickness with which it can be worked, the diversity of operations that it will directly accomplish, and the extraordinary accuracy in comparison with other forms of the results to be obtained. Far the best instruments of this type that the writer has yet seen are those made by Tavernier-Gravet, of Paris, already alluded to. They are different to those generally used in England in that the line in the slide which works against the D line is itself a D line, so that squared proportions have to be performed by the aid of the cursor. This form has the further disadvantage that the inverted slide cannot be used for finding factors, which is a great loss; on the other hand, the two lower lines may be used for simple proportions, and they will give a double accuracy. On the whole, the original pattern with an A, B, C and D line seems preferable. Of the straight rules shown at the Inventions Exhibition those made by Stanley exceed all the others in workmanship and they are equal in this respect to the Gravet rule. Among them are rules for special purposes, as Hudson's scales and Ganga Ram's rules. Hudson's scales, which are made in card, each having two slides, are a marvel of constructive skill. Dixon shows his "triple radius double slide rule," with which very complex operations may be readily performed. Heath shows a slide rule for converting sidereal to mean solar time, or the reverse, correct to about ·02 of a second, but this is not a slide rule proper, as the scales are not logarithmic.

There is entirely a different class of slide rule shown by Lieut. Thomson. In this there is, as usual, an A, B, and C line, but instead of the D line there is a "P" line, in which the distances, instead of being logarithmic, are logarithms of logarithms. By this instrument fractional powers may be found as readily as simple products or quotients. It has, however, this defect, that the scale converges so rapidly as the numbers ascend that high numbers can only be obtained with a proportionate accuracy far less than is possible with low numbers. It is one feature in the slide rule of ordinary construction that an error of reading of, say, 1-100th of an inch will produce the same proportionate error in any part of the scale. This rule for involution is shown in the straight and circular form. It is right to mention that the same thing exactly was invented by the late Dr. Roget and published by him in the *Phil. Trans.* of 1815.

No attempt has been made to give an account of every special form of rule that is made; those shown at the Exhibition and some other well-known forms, which well illustrate the different kinds of development, have been imperfectly described and the general principles on which all depend sufficiently explained to make evident the advantages of each type of instrument.

C. V. Boys

HOMING FACULTY OF HYMENOPTERA

IN connection with Sir John Lubbock's paper at the British Association, in which this subject is treated, it is perhaps worth while to describe some experiments which I made last year. The question to be answered is whether bees find their way home merely by their knowledge of landmarks or by means of some mysterious faculty usually termed a sense of direction. The ordinary impression appears to have been that they do so in virtue of some such sense, and are therefore independent of any special knowledge of the district in which they may be suddenly liberated; and, as Sir John Lubbock observes, this impression was corroborated by the experiments of M. Fabre. The conclusions drawn from these experiments, however, appeared to me, as they appeared to Sir John, unwarranted by the facts; and therefore, like him, I repeated them with certain variations. In the result I satisfied myself that the bees depend entirely upon their special knowledge of district or land-marks, and it is because my experiments thus fully corroborate those which were made by Sir John that it now occurs to me to publish them.

The house where I conducted the observations is situated several hundred yards from the coast, with flower gardens on each side and lawns between the house and the sea. Therefore bees starting from the house would find their honey on either side of it, while the lawns in front would be rarely or never visited—being themselves barren of honey and leading only to the sea. Such being the geographical conditions, I placed a hive of bees in one of the front rooms on the basement of the house. When the bees became thoroughly well acquainted with their new quarters by flying in and out of the open window for a fortnight, I began the experiments. The *modus operandi* consisted in closing the window after dark when all the bees were in their hive, and also slipping a glass shutter in front of the hive door, so that all the bees were doubly imprisoned. Next morning I slightly raised the glass shutter, thus enabling any desired number of bees to escape. When the desired number had escaped, the glass shutter was again closed, and all the liberated bees were caught as they buzzed about the inside of the shut window. These bees were then counted into a box, the window of the room opened, and a card well smeared over with birdlime placed upon the threshold of the bee-hive, or just in front of the closed glass shutter. The object of all these arrangements was to obviate the necessity of marking the bees, and so to enable me not merely to experiment with ease upon any number of individuals that I might desire, but also to feel confident that no one individual could return to the hive unnoticed. For whenever a bee returned it was certain to become entangled in the bird-lime, and whenever I found a bee so entangled, I was certain that it was one which I had taken from the hive, as there were no other hives in the neighbourhood.

Such being the method, I began by taking a score of bees in the box out to sea, where there could be no landmarks to guide the insects home. Had any of these insects returned, I should next have taken another score out to sea (after an interval of several days, so as to be sure that the first lot had become permanently lost), and then, before liberating them, have rotated the box in a sling for a considerable time, in order to see whether this would have confused their sense of direction. But, as none of the bees returned after the first experiment, it was clearly needless to proceed to the second. Accordingly I liberated the next lot of bees on the sea-shore, and, as none of these returned, I liberated another lot on the lawn between the shore and the house. I was somewhat surprised to find that neither did any of these return, although the distance from the lawn to the hive was not above 200 yards. Lastly, I liberated bees in different parts of the flower garden, and these I always found stuck upon the bird-lime within a few minutes of their liberation. Indeed, they often arrived before I had had time to run from the place where I had liberated them to the hive. Now, as the garden was a large one, many of these bees had to fly a greater distance, in order to reach the hive, than was the case with their lost sisters upon the lawn, and therefore I could have no doubt that their uniform success in finding their way home so immediately was due to their special knowledge of the flower garden, and not to any general sense of direction.

I may add that, while in Germany a few weeks ago, I tried on several species of ant the same experiments as Sir John Lubbock describes in his paper as having been tried by him upon English species, and here also I obtained identical results: in all cases the ants were hopelessly lost if liberated more than a moderate distance from their nest. GEORGE J. ROMANES

THE HEIGHTS OF CLOUDS

FROM the Upsala Observatory comes an account of fairly exact measurements of the heights of clouds during the summer of last year, and a very interesting publication it is. It appears that when the circumpolar expeditions were planned the Swedish Meteorological Observatory furnished their station at Spitzbergen with three theodolites, of a somewhat novel though simple construction, for the double purpose of observing the altitude of the aurora and that of clouds. The difficulty that has always been felt in such observations has been that of easy intercommunication between the different observers, so as to fix on the particular part of the cloud of which the height was to be measured. Thanks to modern invention this difficulty was got over by connecting each station with a telephone. The reported good results obtained at the circumpolar station—the publication of which, by the by, has not been done as yet—induced Herr Hildebrandsson, the director of the meteorological observatory at Upsala, to commence a set of similar observations there. On a couple of pillars, about 450 yards apart, and placed on an approximately north and south line, a couple of theodolites were erected, the stations being connected by telephones. The theodolites employed may be described as ordinary theodolites, the object glass of the telescope being replaced by a large open ring, across which were stretched a couple of cross wires, whilst the eye-piece consisted of a simple hole of 3mm. in diameter. When observing near the sun dark glasses would be placed in front of this orifice. As might be expected, there are several unavoidable errors in using these instruments, the principal of which are the uncertainty of an identical point in a cloud being measured at each station, and the want of synchronism of the observation—a very important point when clouds are travelling with any speed. The method of observation was somewhat laborious, and was as follows. The two observers, each at a theodolite, agreed as well as they could on the point in the cloud to be observed, and at a particular time, fixed upon in advance, brought the cross wires on this somewhat indefinite spot, and then read their instruments, noted the time of observation, described the cloud, and if possible sketched it. A second observation of the same point gave the direction and rate of motion of the cloud. Perhaps one of the most easily observed clouds is the cumulus, and we find from a table given that the probable error of observation is very considerable. Thus, in one whose height was calculated to be 1,639 metres, the probable error of one observation was 748 metres, and of the mean of 16 observations 187. Out of 101 observations the mean height of a cumulus was 1,690 metres, and the probable error of the mean 40

"Mesures des Hauteurs et des Mouvements des Nuages." Par N. Ekholm et K. L. Hagström.

metres. The labour to attain even such accuracy is very great. The surprise is that at Upsala they did not adopt a photographic theodolite such as is now, we believe, in daily use at Kew. In the Kew "nephographs," as they are called, the telescope is replaced by a camera, and the observations do not involve half the labour of eye-observations. For instance, when the two nephographs are in a fixed position the manipulations are simplicity itself. One observer telephones to the other the cloud whose height it is desired to ascertain. By means of a very simple pointer both direct their cameras to the cloud, having inserted a dry plate in position. The lenses are closed by shutters, both of which can be opened and then closed with any desired rapidity by an electrical arrangement from one station. The exposures are thus made simultaneously, and the photograph must include every point in the cloud. The position of the cloud is fixed by crossed lines etched on a glass plate which is in contact with the dry plate, and which always occupies the same position, and from these cross lines, which are impressed on the two negatives, any desired point is measured. The readings of the graduated circles of the nephoscope having been taken the height and distance of the cloud is readily calculated. It might be supposed that considerable errors might be made even with this arrangement as the solid angular distance included is somewhere about 55°, and the objects within this are impressed on a plate less than six inches square. As a matter of fact, such is not the case. Measurements of objects a couple of miles off, and at known distances from the observer, have been observed with an error of less than 1 per cent., a base of 250 yards having been used—an accuracy which is far greater than could be obtained by eye-observations when the object to be observed is uncertain in outline, and when there is no definitely fixed point to observe. It must not, however, be supposed that there are no difficulties in photographing clouds of every description. It requires, for instance, a keen judgment to hit off the exposure necessary to differentiate between the white clouds in the higher regions the pale blue sky against which they are projected. All such difficulties are to be overcome with practice. It is to be hoped that before long the Upsala Observatory will adopt such a plan as we have indicated, when the results they obtain will be even more valuable and be less laboriously attained than they are at present.

The following table gives the height of the different characters of clouds at Upsala :—

Stratus		625 metres.
Nimbus (lower)		1,115 „
„ higher		2,185 „
Cumulus and cumulo-stratus	top	1,690
	base	1,307
	mean	1,498
Lower alto-cumulus		1,988
Higher „ „		4,242
Cirro-cumulus		5,513
Cirrus		6,823

The authors point out that, according to their observations, apparently there are seven levels, each one occupied by a different species of cloud, viz. : 600, 1,100, 1,500, 2,000, 42-4,600, 58-6,600, and 80-8,600 metres ; and these levels agree with those deduced by M. Vettin of Berlin, who deduced them from a different mode of observation. There are several remarkable tables, some of which give the diurnal variation in the height of clouds, others the diurnal variation of the frequency of high clouds at Upsala during the summer, others again which discuss the question of the effect of the height of the barometer on the cloud masses. One of the most interesting sections of the memoir is that on the calculation of the velocity of wind at different heights from the movements of clouds.

On the whole, the Observatory at Upsala is to be congratulated on the step it has taken in making systematic observations of cloud heights and velocities. It is a matter of capital importance to meteorology that such should be undertaken in various localities, not only at or near the sea level, but also at as high altitudes as possible. Were the cloud levels, for instance, the same at all places, mountainous districts would be very much more cloud bound than we know is the case. Observations of clouds in the Alps show that the levels at which the different classes are to be found exceed the heights which are shown in the table above ; and it remains to ascertain not only the effect of barometic pressure on the levels, but also the disturbing effect caused by the elevations in the land. Such observations might well be added to the observatory at Ben Nevis, and no doubt some enthusiastic meteorologist would be willing to spend a summer in the Alps to make observations at a still higher station. Until work such as this is undertaken the subject can only be partially discussed on scientific grounds.

W. DE W. A.

THE RECENT TOTAL ECLIPSE OF THE SUN

WE have received the following communications :—

THE news that bad weather seriously interfered with the work of the Government Survey parties, sent to observe the eclipse of the 9th inst. from points on the centre line of totality, induces me to send you the accompanying incomplete sketch and hasty account by to-day's mail :—

I observed the eclipse from Tahoraite, the present southern terminus of the Napier-Wellington Railway, a point well within the belt of totality, but some forty miles north of the centre line.

I went, determined to concentrate my whole attention on the corona, and the corona alone—I did not even take my watch. My eclipse observations are therefore necessarily very incomplete.

After a stormy night (alternate showers of rain and hail, with a bitterly cold wind), day-dawn brought a clear sky ; but a heavy bank of clouds far away to the south boded no good to observers in that direction. The cold was bitter, and fresh snow lay very low down on the neighbouring hills.

The first contact occurred not long after sunrise, the atmosphere in the east being rather hazy, and the light *pale* (other observers say *ruddy*). At first the temperature of the air seemed to rise steadily, but when the sun's disk was a quarter obscured, it began to fall again, and as totality approached the cold became severe.

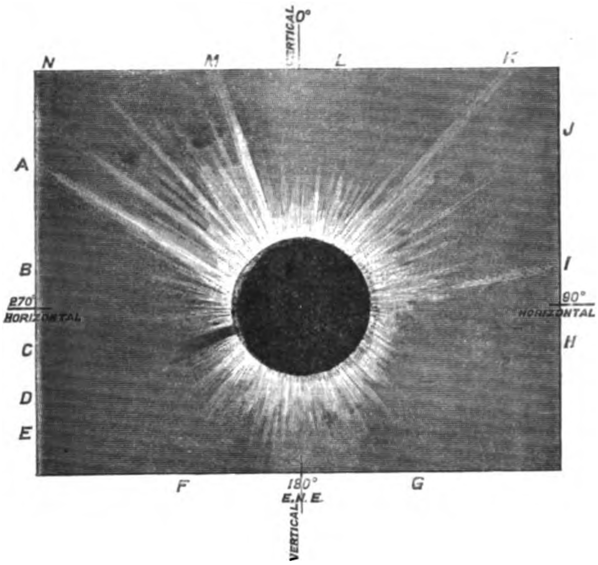
When the occultation of the sun had reached three-quarters, the so-called "livid" character of the light became very marked, and about ten minutes before totality a curious and tremulous play of light on the ground—like dark ripples or moving "marblings," if I may use the word, became apparent.

In order to keep my eyes as sensitive as possible to the faint light of the corona when it should become visible, I only watched the sun (through a telescope) for a few minutes after first contact, I then averted my gaze, and fixed it persistently on the dark-green bush surrounding the Tahoraite clearing. All I noticed during my hasty survey of the disk was two small and one large spot, the latter close to the limb at about 90° (see sketch), and surrounded by faculæ.

The moment "totality" occurred I turned my gaze towards the sun, and having previously, to save time, drawn disks on several pages of my pocket-book, I hurriedly took sketch after sketch of the shape of the corona, the rays of which were much better marked than I had been led to expect. My object in taking several sketches was to record any change in the position of the rays. I took five during the short time of totality, and their agreement is so clear as regards the number and relative position and length of the main rays, that it fully confirms the general impression left on my mind as to the fixity of this phenomenon.

I was just engaged in making a last estimate of the extent of the corona between 35° and 90°, when a cry arose from the bystanders, "Look at the red flame shooting out to the left!" I withstood the temptation, and observed the almost sudden disappearance of the corona on the reappearance of the sun. All I can therefore say of the red protuberance which attracted so much notice is that the emergence of the sun is blended in my mind with a vague and fleeting impression of a narrow streak of red light with a broad streak of white light outside it, between 200° and 290°, and almost symmetrically divided by the position of the dark rift in the corona.

An acquaintance who noticed the rift in the corona told me that the red flame shot out close to it. He described the shape of the flame as *ragged;* other intelligent observers compared it to a *sugarloaf;* the most intelligent



Corona as observed during solar eclipse of September 9, 1885, as seen from Tahoraite, North Island, New Zealand, about 40 miles north of centre line of totality:—A, 320°; longest ray, 2-3 diams. B, first contact about 285° (vague). C, Sun apparently reappears about 260° (vague). D, 250°; dark rift in corona. E, approximate position of large red protuberance which shot out just before close of totality. F, corona, ¾ diam., rather ragged. G, corona, ½ diam., regular. H, large sun-spot with faculæ close to the limb at time of first contact. I, 80°; 3rd longest ray, 1½ diam. J, between these two long rays corona extends nearly ¾ diam., with some longer rays. K, longest ray, 1¼ diam. L, corona, hardly ½ diam. M, 2nd longest ray, 1½-2 diams. N, between longest rays corona extends ¾ to 1 diam.; 2 long rays 1¼ diam. (N.B.—Corona alone was observed: relative position and lengths of rays reliable; absolute lengths to be taken with caution.)

of those I heard, to a *drop of water* hanging from an object. Other observers, again, stationed two miles off, saw, *not a red* but a brilliant *white* flame shoot out.

I leave these discordant statements and comparisons to be reconciled by other men.

During totality there was a considerable amount of diffused light around the sun. I am unable to state its extent or colour from personal estimate. Some of the bystanders called the colour pearl-grey; others, reddish; others, again, pale blue and white.

The colour of the corona itself seemed to me very pale bluish green.

The sketch I send you should explain itself. I will only mention that the angles are, of course, only estimated, the zero direction being the upper end of the vertical through the centre of disk.

The rift in the corona was very marked, and extended right down to the disk; it was very near to by far the longest of the rays. In conclusion there is nothing that the coronal rays remind me of so much as an auroral display.

N. A. Graydon

Hastings, Hawkesbay, N.Z., September 11

Mr. Henry Bedford, of All Hallow's College, Dublin, sends us a copy of the *Marlborough Express*, New Zealand, of Wednesday, September 9, 1885, giving an account of the eclipse as observed at Blenheim and other places in New Zealand.

The eclipse at Blenheim began at 6.30 a.m., and totality occurred at 7.25.

"The totality—if totality it was—could have lasted but a bare moment: for, to the untrained observer, it seemed that a patch of bright sunlight on the upper edge of it was never absent. It must, however, be remembered that Blenheim is on the very outer edge of the belt, and that the apparent duration of totality was so extremely short that, by an optical illusion, it might seem that sunlight was never totally obscured. The corona and sun's flames were plainly visible, and formed a spectacle which no mechanical contrivance can imitate, and no art can reproduce. Several stars in different quarters of the heavens—and particularly one about four sun's diameters below the eclipse—were seen, and the general appearance of the sky and of the shadows on the hill sides and in the water was that of early dawn. The eclipse was certainly a wonderful phenomenon, and almost as interesting to the non-scientific observer as to the man of science who viewed it in his observatory.

"Observations of the eclipse were taken in the cricket ground at Blenheim by Mr. Dobson, C.E., and ten instantaneous photographs were secured by Mr. W. H. Macey, the two gentlemen acting in conjunction. Mr. Dobson's observations were made by the telescope and theodolite, the powerful telescope belonging to Mr. Cullen of Mahikipawa having been erected in the cricket ground for the purpose."

At Wellington, by the time the total phase was reached the sun was sufficiently clear of clouds to give an uninterrupted view. As totality was reached the scene was most impressive, and as the darkness increased the western heavens became illuminated with a deep orange colour, shading off into the most delicate of yellows. A number of stars were plainly seen during the darkness. After about a minute and a half the sun again shone out, and gradually increased. Pigeons and birds began to fly about in a helpless fashion, and sought their roosts.

Dr. Hector reports:—"Heavy southerly squalls, with hail, spoiled the observations. We were at Dryertown, on the centre of the line, but got only partial glimpses. A pink patch surrounded the sun, and extended 15° from it, probably due to the same dust film in a high atmosphere that caused the sun-glows last year."

At Mastertton a heavy south-west gale with rain set in on the 8th, and the morning broke without any signs of clearing. Messrs. M'Kerrow and party, who had camped at the foot of Otahuao, proceeded to the top and fixed their instruments amid driving snow and hail. Just before totality the sky cleared, and all the phenomena were fairly visible. One photograph was taken before totality, three during, and one after. The corona was visible for fully a minute, encircling a ring of light radiating to a distance of about half a diameter of the sun. It was of a pale white colour, like the electric light; of uniform width, except at the sun's equator, where it slightly protruded, and was evidently of greater extent.

We have just received, by the dilatory method of a letter by post, an account of the preparations making and made for the due observation of the Total Solar Eclipse in September, up to within a fortnight of the event coming off; but no more. Our informant, the Venerable the Archdeacon Stock, of Wellington, New Zealand, was momentarily expecting two large auxiliary expeditions, one from Sydney, the other from Melbourne; and had been himself told off for corona work. But though brimming full of fine enthusiasm to do all that man could do in that department, he yet characteristically adds, "but how can we expect to see any of the more refined and minute features through all this Krakatão haze which the sun has still to shine through? In 1882, before that great volcanic eruption, we could see the comet of that year close up to the sun's limb; but now I am certain that nothing of the kind could be visible." C. P. S.

15, Royal Terrace, Edinburgh, October 21

NOTES

PROF. PASTEUR read on Monday evening to the Paris Academy of Sciences a statement, of which the following is the substance as telegraphed to the *Standard*:—M. Pasteur some time ago succeeded in rendering proof against rabies some sixteen out of every twenty dogs experimented upon. But to ascertain that immunity had really been given, he had to wait four months after the inoculation had taken effect. He therefore set himself to obtain virus of different degrees of strength, with the object of obtaining prompter and more certain results. This was effected by the following means:—A rabbit was inoculated with a fragment of tissue taken from the spine of a rabid dog. The incubation of the poison occupied fifteen days. As soon as the rabbit was dead a portion of its spinal marrow was in turn inoculated into a second rabbit, and so on until sixty rabbits had been inoculated. At each successive inoculation the virus became of increased potency, and the last period was not more than seven days. Having ascertained that exposure to dried air diminishes the virus, and consequently reduces its force, M. Pasteur supplied himself with a series of bottles containing dried air. In these bottles were placed portions of the inoculated spinal marrow of successive dates, the oldest being the least virulent, and the latest the most so. For an operation M. Pasteur begins by inoculating his subject with the oldest tissue, and finishes by injecting a piece dating from two days only, whose period of incubation would not exceed one week. The subject is then found to be absolutely proof against the disease. At the beginning of July a young Alsatian, named Joseph Meister, who had been severely bitten in several places by an undoubtedly rabid dog, presented himself at the laboratory. His case, left to itself, being considered hopeless by M. Pasteur, Prof. Vulpian, and other high authorities, the patient was submitted to the same series of inoculations that had been so successful on dogs. As a proof a series of rabbits were simultaneously subjected to the identical processes. In ten days thirteen inoculations were made with pieces of spinal marrow containing virus of constantly-increasing strength, the last being from the spine of a rabbit which had died only the day before. The youth thus operated upon by the successive administrations of weaker virus was made proof against the virus of the intensest strength. It is now 100 days since he underwent the last inoculation, and he is in perfect health. Those rabbits, on the contrary, which were at once inoculated with the strong virus, without first being rendered fit to receive it, became affected within the proper incubation period, and died with the usual symptoms. The first inoculation practised upon Meister was sixty hours after he had been bitten. M. Pasteur has, at the present moment, another human patient under treatment who was bitten a few days ago by a mad dog. M. Pasteur said it would now be necessary to provide an establishment where rabbits might always be kept inoculated with the disease. In this way there would constantly be a supply of spinal tissues, of both old and recent inoculation, ready for use. Before the sitting was adjourned M. Pasteur received an enthusiastic ovation from both the Academy and the public present.

THE annual meeting of the five academies forming the French Institute took place at two o'clock on October 24 in the large hall of the Institut; M. Bouguereau, President of the Academy of Beaux Arts was in the chair. The great prize delivered once every two years was awarded to Dr. Brown-Sequard, the well-known physiologist. M. Paul Bert had written a paper "On Vivisection," which was expected as a sequel to the delivery of the prize to Dr. Brown-Sequard, but it was not read for want of time. The annual banquet took place in the evening for the second time.

IT is rumoured that M. Goblet, the Minister of Public Instruction, proposes to return to the former organisation of the Institut, which was regarded as a universal self-electing body. Each class or special academy had not the privilege of choosing its own members as now, but of proposing a list of candidates to the whole Institut. The increased solemnity given to the annual and quarterly meetings, and the institution of banquets, are considered as preparatory to this important change.

M. BERTRAND, who was nominated member of the French Academy some months ago, will be received on December 10 next, at a solemn sitting, when he will read his inaugural address. It will be answered by M. Pasteur.

A VERY valuable addition has recently been made to the Science Collections now displayed in the Western Galleries at the South Kensington Museum of Science and Art. Mr. Rochfort Connor, of the Inland Revenue Department, has prepared a number of exquisitely finished pen-and-ink drawings of objects viewed with the microscope, often by the aid of very high powers. The collection, which covers two large screens in the rooms devoted to biology and geology, include drawings of insects and other minute forms of animals, and of various anatomical preparations from them, of curiosities of pond-life, and of the skeletons of many organisms, both recent and fossil. Among these last Mr. Connor's highly-finished representation of some of the more complicated forms of the Diatomaceæ, such as *Heliopelta* and *Coscinodiscus*, are especially worthy of admiration, though some of his drawings of Foraminifera, Bryozoa, and Sponge-spicules are scarcely inferior to these in delicacy of execution. These drawings represent, we understand, the leisure hours of a busy life-time, and their author is now engaged in a series of microscopic drawings illustrating the characters of food-products and their adulterants. A few of these are now exhibited as samples, and the series when complete cannot fail to be of great use to public analysts and others.

AT a meeting of the Brookville (U.S.) Society of Natural History, September 22 (according to *Science*), a committee was appointed to confer with the scientific associations, educational institutions, and with individuals throughout the State of Indiana, concerning the advisability of the formation of a State Academy of Science, and if thought advisable, to co-operate with such persons in favour of the formation of such an association. Free expression of opinion is called for by the committee, both as to the need of such an organisation and as to the best plan for its composition. It is now the plan to hold a meeting at Indianapolis between Christmas and New Year's day. It proposed that the organisation shall enable the citizens of Indiana who are engaged in scientific work to meet at certain times "for social intercourse, for the exchange of ideas, and the comparison of results of scientific studies." It would appear from the prospectus that the Academy would be a State society similar to the American Association.

SOME theoretical views on the detonation of meteorites have been recently offered by Signor Bombicci in the Royal Accademia dei Lincei. He supposes the detonation to be that of an explosive gas mixture, formed during the surface-heating of the mass in the atmosphere, and accumulating chiefly in the vacuous space left behind the mass in its very swift flight. The gas mixture is probably of oxygen and hydrogen, and it becomes detonant when the proportions are near those in which the gases form water. The oxygen may be supplied from the air; the hydrogen may come from the meteorite itself, which, having like porous bodies and fused metals, taken it up and condensed it in some region of space, sets it free again as it becomes very hot by friction of the air, and as an enormous difference of pressure arises between the front and the back part. But a portion (and perhaps the larger) of the detonating mixture may come from dissociation of the aqueous vapour in contact with the glowing and fused surface of the meteor. To the idea of an actual explosion of the meteorite by internal energy, Signor Bombicci objects that the ball must be shattered to the finest dust, and that fragments would not be coated with a crust. Sometimes meteorite stones remain quite whole in spite of the detonation. Haidinger's idea of the sound being due to air rushing into the vacuum behind the meteorite is thought improbable because the detonation takes place in very high layers of the atmosphere, where the air is much too rare; moreover the movement of the meteorite until detonation is a quite steady one. The character of the noise, and its repetition at intervals, also the shattering of the mass into fragments forming a cone of dispersion towards the earth all agree, in the author's opinion, with an explosion of gas behind the meteorite. Referring to another point, Signor Bombicci thinks that the earth has by virtue of its magnetism a selective action on cosmic masses; hence the universal presence of iron in meteorites.

MESSRS. A. AND C. BLACK will publish immediately a volume by Dr. Croll, F.R.S., entitled "Discussions on Climate and Cosmology," and also a new edition of "Climate and Time."

ACCORDING to the *Journal of Indian Art* the Government of India has decided to combine the duties of the Archæological Survey and those hitherto performed by the curator of Ancient Monuments. For this purpose India, exclusive of the Madras and Bombay presidencies, has been partitioned into three divisions, one of which has been placed under the control of Major Keith, who superintended the construction of the magnificent Gwalior gate which H.H. Maharajah Scindia has presented to the South Kensington Museum, and which will be a prominent ornament of next year's exhibition.

WE have received from Mr. Saville Kent, Superintendent and Inspector of Fisheries in Tasmania, a very encouraging report of operations for the year ending July 31, 1885. Much of the report is devoted to oyster fisheries, which Mr. Kent is endeavouring to develop on scientific principles. He has established hatcheries at various points, and a laboratory for experiments, and under his care the oyster ought to become an important industrial product in Tasmania. He also advises the encouragement of sponge fisheries. With regard to Salmonidæ, Mr. Kent concludes that no true salmon have yet been established in the lakes and rivers of Tasmania. The fish of large size which abound in the great lakes and other large sheets of water are really essentially the same as the Great Lake Trout or *Salmo ferox* of Great Britain.

IN the Report by the Board of Trade on their proceedings and business under the Weights and Measures Act for the past year, it is stated that the attention of the department has been called by the Corporation of Dublin to the necessity of providing a legal standard measure for testing steam pressure-gauges. In reference thereto regret has been expressed that at present the Standards Department has no power to do this. The question appears to be whether a pressure-gauge is a "measure" within the meaning of the Act. The testing apparatus proposed by the Corporation is a measurer of pressure applicable only for special use, and it belongs to a class of measuring instruments, as barometers, thermometers, &c., not directly provided for by the Act. In the report of last year an opinion was expressed that the time had now arrived when this country might, under proper conditions, join the International Convention on Metric Standards, and in September last Her Majesty's Government made known to the Comité International des Poids et Mesures at Paris that England was willing to join the Convention. This has now been done; and the Comité accepts the reservations of Her Majesty's Government as to the introduction of the metric system into this country, affirming that there is nothing in the articles of the Convention which implies any obligation on the part of a contracting State to attempt to modify the system of weights and measures legalised at the time in that State. The adhesion of England, therefore, is not to be regarded as any expression of opinion that the adoption of the metric system in this country would be desirable. A copy is attached to the Report of a Memorandum on Metric Standards intended for laboratory use; and also a copy of a scale of errors to be permitted on ordinary metric standards used in testing manufacturers' weights. Metric weights from 20 kilograms to 0·001 gram. to be used for the purposes of science and manufacture, or for any lawful purpose not being for the purpose of trade, have been verified for the local authority of Birmingham.

MR. CLEMENT L. WRAGGE, of the Torrens Observatory, near Adelaide, late of Ben Nevis, has been instructed by the Queensland Government to "visit and report as to the best means of establishing meteorological stations in Queensland, including the Cape York Peninsula and Torres Straits." Mr. Wragge, who lately returned to Brisbane from Northern Queensland, will commence his duties early this month, and proceeds shortly to Normanton in the Gulf of Carpentaria.

THE Institution of Mechanical Engineers met at Coventry yesterday, when the following papers were read:—On the construction of modern cycles, by Mr. Robert Edward Phillips, of London; on the distribution of the wheel load in cycles, by Mr. J. Alfred Griffiths, of Coventry; description of a hydraulic buffer-stop for railways, by Mr. Alfred A. Langley, of Derby.

THE aquarium at the Inventions Exhibition has lately received some valuable additions in the form of golden tench, American salmonidæ, and Italian carp, notwithstanding the fact that the Exhibition will shortly close. It is to be hoped that the exhibits from the Buckland Museum collection will be allowed to remain in the aquarium, where they appear to far better advantage than in their previous *locale*.

THE Ichthyological Museum now in course of formation at South Kensington has been lately enriched with further valuable specimens of fish. Amongst them are some prawns unique in size, measuring *twelve* inches long, which were presented by Mr. John S. Charles, of Lower Grosvenor Square.

THE *Scientific American*, in a recent issue, describes the tangent galvanometer constructed at Cornell University, from the designs of Mr. Anthony, the Professor of Physics, to meet the want of a standard instrument for the measurement of heavy currents, and for the direct calibration of the commercial instruments in use for measuring the currents employed in electric lighting, &c. For the measurement of heavy currents there are four circles, two 2 metres in diameter, and two 1·6 metres, mounted, according to Helmholtz's plan, at distances apart equal to their radii. The conductors forming these circles are copper rods, three-fourths of an inch in diameter. The needle is suspended by a silk fibre in a mass of copper, which serves as an effectual damper, and makes it possible to take readings very rapidly. By a peculiar arrangement of mirrors and telescope the deflections are read directly in angular measure on a circle 50 inches in diameter, to within three-tenths of a minute of arc. The copper conductors are mounted on a brass framework accurately turned and adjusted, and the dimensions are all known within one five-thousandth. For the measurement of small currents there are two circles, about 1·5 metres diameter, each having two conductors, and comprising altogether 72 turns of No. 12 copper wire.

THE indications of such an instrument of course depend upon the value of the horizontal intensity of the earth's magnetism, and without some means of determining this quantity in the place where the instrument stands, and at the time when a measurement is being made, no great accuracy is attainable. For making this determination, a coil a metre in diameter, consisting of 100 turns of No. 18 wire, is suspended, so that its centre coincides with the centre of the instrument by means of a single phosphor-bronze wire, which is itself attached to a torsion-head reading to ten seconds of arc. By the aid of this coil, observations may be taken at any moment for the determination of H by the method proposed by Sir William Thomson. The instrument is mounted in a copper building, from the construction of which all iron has been rigidly excluded. Several conducting wires connect the building with the dynamo and other rooms of the physical laboratory, 550 feet distant, and switches in the building serve to send the currents through the several coils of the galvanometer singly, in series, or in multiple arc, direct or reversed. By this means currents from 1 milliampere to 250 amperes can be accurately measured.

THE last number (Heft 33) of the *Mittheilungen der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens* contains a paper by Herr Hütterott on the Japanese sword, with numerous illustrations of the various forms. It describes the manner in which it is forged, how it reaches the extraordinary degree of excellence for which it is celebrated, in short the *technique* of the making of a Japanese sword in the feudal days. Herr Mayet concludes his account of a visit to Corea, the first part of which we have already noticed. Dr. Naumann, the director of the Geological Survey of Japan, and Japanese representative at the late Geological Congress at Berlin, communicated an extract from a report of his on the geological structure of the Japanese islands.

ONE-TENTH of the "Studentenschaft" at the Zurich University is now female. Twenty-nine young ladies study medicine, fourteen philosophy, and two political economy. Of the forty-five female students, fifteen are Swiss, and ten Russian.

THE after-sunglow has again at times been visible in Stockholm, from the middle of August to the middle of September, being distinct from the ordinary evening aurora.

A FURTHER telegram has just been received by the Russian Minister of War from Col. Prjevalsky, dated Osh, September 30—that is, the 12th inst., new style. Only the concluding passage has as yet been published by the Russian papers:—"August 14 (new style, August 26), Oasis of Tchira.—I have explored the Keria Mountains. We are now proceeding *viâ* Khoten and Aksu, and we shall arrive in Semiretchia towards the end of October. All is well."

THE spheroidal state of liquids has recently been made an object of study by Signor Luvini (*Il Nuovo Cimento*). A curious phenomenon was noticed when air was blown into the drop (to test the view that liquids in that state do not boil because they have lost their dissolved air). There arose bubbles often larger than the mass of liquid, and very persistent; they shared the movements of the drop and sometimes moved independently. Such bubbles were had in pure water, soapy water, alcohol, and ether, and would probably arise in all liquids. Sometimes they appeared only after the tube was withdrawn. Signor Luvini infers that liquids in the spheroidal state do not lose their dissolved air, or lose it very little. The author made arrangements for observing the spheroidal state under different air pressures, and he came to the conclusion that the temperature of each liquid in that state, under a given pressure, is very nearly equal to the least boiling temperature of the liquid under the same pressure.

WE have just received from the secretary, Mr. Charles Bailey, F.L.S., of Manchester, the reports of the Botanical Exchange Club for the years 1883 and 1884. For 1883 Mr. G. Nicholson acted as distributor, and 3735 specimens were received and divided out again amongst the members. In 1884 Mr. Arthur Bennett undertook the labour of distribution, and the number of specimens placed in circulation was 4371. The two reports contain a series of annotations by the distributors upon the more interesting plants which passed through their hands. For a considerable number of species new counties are registered. The most interesting additions to the British flora, of which they make mention, are a *Scutellaria*, intermediate between *minor* and *galericulata*, perhaps a hybrid, found by Mr. Nicholson in a place one would have thought likely to be thoroughly explored long ago—the shores of Virginia Water; *Potamogeton fluitans*, a pond-weed very difficult to recognise, found by Mr. A. Fryer in Huntingdonshire; and *Carex salina*, a boreal species known already in Scandinavia, Iceland, the Faroes, Nova Zembla, and North America, which has lately been discovered by Mr. Grant in Caithness. The Rubi of Britain want carefully comparing with those of the Continent, and Mr Arthur Bennett has done well to send the Club specimens to be verified by Dr. Foche, of Bremen, whose synopsis of the German Rubi has been taken lately by Hyman as a basis for his enumeration of the European forms in his most useful geographical conspectus of the European flora.

A CURIOUS calculation has been recently made by Signor Bartoli regarding the mean density of a body which should contain all the known elements in a solid state, either uncombined, or, if partly combined, each retaining the density belonging to it in the solid state. The author makes three suppositions—(1) the masses of all the substances equal; (2) masses such that the corresponding volumes are equal; (3) masses in ratio of the atomic weights. The corresponding mean densities he arrives at are 2·698, 7·027, and 5·776, and it is pointed out that the last value comes very near that got by Cavendish for the mean density of the earth, viz. 5·67; possibly an accidental agreement, yet interesting.

WE have received from Mr. Francis Day copies of two papers, on a subject on which he also read a paper at the Aberdeen meeting of the British Association. One is entitled "Notes on the Breeding of Salmonidæ," being observations on the fish cultural experiments being carried on at Howietown, and on experiments by the author himself at Cheltenham. The second, from the *Transactions* of the Linnean Society, is on the breeding of salmon from parents which have never visited the sea. This also describes the results of experiments at Howietown.

WE have received the report of the Council of the Leicester Literary and Philosophical Society for the past year. Various important additions have been made to the town museum; the work on the flora of Leicestershire, undertaken and edited by a botanical sub-committee, is now in the press, and will shortly be published; the resolution, adopted at the last general meeting of the society, for the promotion of science classes in the town has, owing to various circumstances, only been partially carried out. Two experimental classes, one for pure mathematics, the other for physiology, have been commenced, and have been attended with fair results. The reports of the various sections show a considerable amount of work done during the year.

Short abstracts of various papers read before the society are given in the *Transactions*.

A MISSION of thirteen youths, belonging to the best families in Cambodia, has arrived in Paris for the purpose of study. They have been placed under the care of M. Pavie, who has constructed a line of telegraphs between Siam and Cambodia. This is the first time since 1864 that Cambodians have come abroad for purposes of education.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mr. George E. Crisp; a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, presented by Miss Ethel O'Donoghue; a Kinkajou (*Cercoleptes caudivolvulus*) from Demerara, presented by Mr. John Carder; four Common Squirrels (*Sciurus vulgaris*), six Common Dormice (*Muscardinus avellanarius*), British, presented by Mr. Thomas Weddle; a Tennant's Squirrel (*Sciurus tennanti*) from Ceylon, presented by Miss Maude Bovill; two Vulpine Squirrels (*Sciurus vulpinus*) from North America, presented by Capt. E. E. Vaill; a Coypu (*Myopotamus coypus*) from South America, presented by Mrs. Amelia Appleton; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Sly Silurus (*Silurus glanis*), European, presented by the Marquis of Bath, F.Z.S.; a Red Lory (*Eos rubra*) from Moluccas, an Alexandrine Parrakeet (*Palæornis alexandri*) from India, deposited.

OUR ASTRONOMICAL COLUMN

PERIODICAL COMETS IN 1886.—Of the now somewhat numerous list of comets of short period, two will be due at perihelion in the ensuing year:—(1) The comet Tempel-Swift, or 1869 III. and 1880 IV., which is likely to return under circumstances that will render observations impracticable, so far at least as a judgment can be formed without actual calculation of the perturbations. (2) Winnecke's comet, last observed in 1875, its track in the heavens near the perihelion passage in December 1880 not allowing of the comet being seen at that return; the perturbations may be very sensible during the present revolution: neglecting their effect, the mean motion determined by Prof. Oppolzer, for 1880, would bring the comet to perihelion again about August 24·5, under which condition its path would be as follows:—

	R.A. °	Decl. °	Distance from Earth
July 25·5	177·5	+10·2	1·17
Sept. 13·5	241·7	−24·9	0·98
23·5	246·1	−30·2	0·64
Oct. 3·5	264·8	−35·6	0·64
23·5	305·0	−36·0	0·77

The actual orbit of Winnecke's comet approaches very near to that of the planet Jupiter in heliocentric longitude 110°, at which point the comet arrives 720 days or 1·97 years before perihelion passage, the distance between the two orbits is then less than 0·06 of the earth's mean distance from the sun.

It is very possible, however, that the comet which may most interest astronomers in 1886 will be that observed in 1815, and known as Olbers' comet, which, according to the elaborate calculations of Dr. Ginzel, will again arrive at perihelion in December 1886. The most probable date that can be inferred from the observations of 1815, and the computation of planetary perturbations in the interval is December 16, but unfortunately the observations did not suffice to determine the mean motion in 1815 with precision, and consequently Ginzel found for the limits of the period of revolution 72·33 and 75·68 years, hence the comet may reach its perihelion many months earlier or later than the date given by calculation. Extensive sweeping ephemerides have been published, and it may not be too soon to direct attention to a search for the comet at the beginning of the next year, or as soon as the region in which its orbit is projected at the time can be advantageously examined.

A CATALOGUE OF 1000 SOUTHERN STARS.—Vol. iii. of "Publications of the Washburn Observatory" is to contain a catalogue of 1000 stars between 18° and 30° of south declination, formed by Rev. Father Hagen and Prof. Holden from the observations of Prof. Tacchini at Palermo during the years 1867–69, which were printed in the *Bulletino* of that observatory between April, 1867, and July, 1869, and with which Prof. Holden says he became acquainted through M. Houzeau's Vade-Mecum. The stars observed are from the 6th to the 9th magnitudes, and the magnitudes appear to have been very carefully noted, while it is remarked that the positions are excellent. They are reduced to the year 1850, but the mean epoch of observation of each star is appended. The copy before us is a reprint from the above-named volume. Tacchini's observations were made with the Palermo meridian circle fully described in the *Bulletino*.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, NOVEMBER 1–7

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 1

Sun rises, 6h. 56m.; souths, 11h. 43m. 40·9s.; sets, 16h. 31m.; decl. on meridian, 14° 35′ S.: Sidereal Time at Sunset, 19h. 15m.

Moon (two days after Last Quarter) rises, 0h. 13m.; souths, 7h. 20m.; sets, 14h. 14m.; decl. on meridian, 9° 37′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 57	12 22	16 47	18 25 S.
Venus	11 11	14 46	18 21	25 50 S.
Mars	23 54*	7 13	14 32	14 20 N.
Jupiter	2 55	9 9	15 23	2 2 N.
Saturn	19 45*	3 53	12 1	22 18 N.

* Indicates that the rising is that of the preceding day.

Phenomena of Jupiter's Satellites

Nov.	h. m.		Nov.	h. m.	
1	6 48	II. occ. reap.	6	5 18	I. tr. egr.
5	5 1	I. ecl. disap.	7	2 39	I. occ. reap.
6	3 0	I. tr. ing.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, Nov. 1.—Outer major axis of outer ring = 44″·0; outer minor axis of outer ring = 18″·9; southern surface visible.

Nov.	h.	
1	4	Mars in conjunction with and 4° 16′ north of the Moon.
3	7	Mercury at greatest distance from the Sun.
3	9	Jupiter in conjunction with and 0° 52′ north of the Moon.
7	21	Mercury in conjunction with and 6° 16′ south of the Moon.

THE SCOTTISH METEOROLOGICAL SOCIETY

AT the annual meeting of this Society the Report of the Council stated that thirty-eight new members had been added to the Society during the year, and the membership now numbered 698. A new station had been established on the island of Fidra, at the mouth of the Firth of Forth, and that observations had been made for the Society at San Gorge, Central Uruguay. A large number of naturalists and others had availed themselves of the facilities for research offered by the Scottish Marine Station during the summer, there being thirteen working at the laboratories at the present time. Communications were now going on between the Council and several influential gentlemen in Glasgow, which it was hoped would result in the establishment of a permanent station for marine research on the Clyde. Mr. H. N. Dickson, of the Marine Station, communicated the results of experiments and observations which, during the past two months, he had been conducting at Granton, with the view of collecting data from which to determine the corrections to be applied to the readings of thermometers exposed in the ordinary Stevenson screen, in use in many places over the world. Having referred to the errors to which the ordinary screen gives rise, consequent on the varying atmospheric motion and radiation, he proceeded to say that his investigation was carried on chiefly by means of improved screens designed by Mr. John Aitken of Darroch, and that the dew points from the dry and wet bulbs by Glaisher's tables had been compared with those given by a new form of hygrometer designed by Prof. Chrystal of Edinburgh University. As regards Mr. Aitken's screen, in some a fan was introduced in order to secure a proper and uniform circulation of air for the thermometers in all weathers; others were simply sunshades; one consisted of two thermometers, one of which was partially blackened; and another of a thermometer having its bulb inclosed in a tight-fitting silver sheath, highly polished. The construction of Prof. Chrystal's hygrometer was explained and a brief account given of the results either already arrived at or suggested during the investigation, and it was intimated the inquiry was to be resumed at the Ben Nevis Observatory during August and September. At this Observatory, the climate of which offers unique facilities for the prosecution of such inquiries, an instrument of novel construction would be added, which had been designed by Prof. Tait for hygrometric research. Prof. Ewing, of Dundee, then described the arrangements which had been made for commencing the proposed earthquake observations on Ben Nevis this summer. The investigation was to include earthquakes proper; earth movements of so very delicate a kind as to be totally indistinguishable without some form of instrumental assistance, which are conveniently called earth tremors; and there were what might be named changes of the vertical, or those tiltings which the earth's surface seemed to be constantly undergoing. The different seismometers to be employed at the Observatory were then described, and in illustration some of the more striking peculiarities of the earthquakes of Japan were referred to.

PROF. KIESSLING'S INVESTIGATIONS INTO THE ORIGIN OF THE LATE SUNSET GLOWS[1]

THE interesting and important experimental demonstrations lately made by Prof. Kiessling of Hamburg to illustrate the artificial formation of all manner of sunset effects are probably well known to meteorologists in general. The September number of *Das Wetter* contains a valuable series of comparisons tending to show that the conditions under which artificial glows were produced have actually existed whenever the remarkable sunset effects have made themselves prominent. The following abstract may prove of interest to those who do not receive the paper itself.

With regard to the "after-glow," or re-illumination, he suggests two explanations as possible:—(*a*) Simple reflection of the refracted rays essential to the formation of the ordinary sunset-glow (the *first* glow); or (*b*) direct diffraction by a second homogeneous haze at much greater elevation. He considers, however, that the calculated heights of the latter place it out of the question. To the former there are only two important objections, the chief one being the slight polarisation, so far as the very scanty records indicate. The observations are, however, exceedingly deficient. Still, Prof. Kiessling has to allow that they do not tell in favour of the proposed explanation. The other difficulty is the *position* of the glow. It presupposes a mirror-like surface, parallel to the earth, with the intermediate space unusually transparent, conditions at first sight very improbable at the altitudes under consideration. But Prof. Kiessling's own experiments, detailed at the end of his paper on "Die Dämmerungserscheinungen im Jahre 1883," have shown the possibility. In these he obtained results most remarkably similar to those requiring explanation, and by methods reproducing in a striking manner the conditions considered actually to exist in the atmosphere.

A warm, moist stratum of air being produced in contact with a cold stratum the resulting haze along the contact surface formed the site of diffraction phenomena, approaching those actually observed in ordinary brilliant sunsets according to the fineness of the haze particles, and also reflections reproducing the "after-glow."

The almost constant saturation of the cold upper strata in winter is indicated by observations at high-level stations and the persistent upper haze. Let a warm [cyclonic] current come beneath such a layer, then the fine haze at the surface of contact will have beneath it the peculiarly transparent atmosphere common to such conditions and requisite for the transmission of the resulting diffraction (and reflection) phenomena. This should be found to exist in *all* brilliant sunsets, Prof. Kiessling stating the following law:—*An intense purple glow, visible over a considerable area, may occur when, in close proximity beneath a lofty and highly-attenuated haze, there is formed an extensive stratum of air at considerably higher temperature.*

Date of Sunset	Date of Observation (Roman Figures) and Difference of Temperature						
January 30, 1883	XXVIII. − 3·6	XXIX. + 2·7	XXX. + 4·3	XXXI. − 2·6			
February 11	X. − 2·0	XI. + 3·2	XII. + 0·1	XIII. + 6·1	XIV. + 0·5		
April 27 (at Grächen) and 28 ...	XXV. − 4·9	XXVI. − 2·1	XXVII. + 1·2	XXVIII. + 2·9	XXIX. + 0·7		
May 5 (warmer season)	III. − 3·4	IV. − 1·7	V. − 4·5	VI. − 4·1	VII. − 2·5		
But on Rigi (1790 metres)... ...	− 10·4	− 8·8	− 7·7	− 8·5	− 8·6		
Säntis (2467 metres)	− 14·1	− 13·4	− 13·1	− 11·3	− 12·1		
St. Bernard (2400 metres, about)	− 14·7	− 14·4	− 13·6	− 13·6	− 11·4		
September 20	XVIII. − 3·8	XIX. − 0·9	XX. + 5·5	XXI. − 2·0	XXII. − 0·2		
Rigi Culm	− 7·6	− 5·7	+ 1·2	− 6·5	− 7·0		
October 9 (Grächen) and 11	VII. − 1·9	VIII. + 1·4	IX. + 0·3	X. + 1·7	XI. + 6·5	XII. + 2·0	XIII. − 1·5
November 22 and 23	XXI. + 0·6	XXII. + 1·6	XXIII. + 4·4	XXIV. − 2·5			
November 29 and 30	XXVII. + 0·8	XXVIII. − 2·6	XXIX. − 1·6	XXX. + 2·6	I. + 5·2	II. − 2·4	
Rigi } glows generally over }	− 4·5	− 6·9	− 0·8	+ 3·7	+ 3·5	− 6·3	
Säntis } Europe. }	− 7·5	− 9·9	− 4·2	+ 2·3	− 0·7	− 9·7	
Pic du Midi (2859 metres)... ...	− 13·3	− 7·2	+ 0·8	+ 3·8	− 2·8	− 13·3	

Although we cannot ever expect direct observations of temperature at the common surface producing the sunset glows, yet, as Prof. Kiessling shows, if we can prove that the warm undercurrent always accompanies sunset glows, the proof is practically complete. Such indications may be expected during the colder seasons in the form of abnormal vertical distribution of tempera-

[1] Ueber die Entstehung des zweiten Purpurlichtes und die Abhängigkeit der Dämmerungsfarben von Druck, Temperatur, und Feuchtigkeit der Luft *Das Wetter*, vol. ii. No. 9. p. 161.

ture, an *increase* instead of decrease at higher stations. He brings forward a long array of figures supporting this conclusion, especially for sunrise effects in 1883, as seen from Säntis (2467 metres), in North-East Switzerland, in the bend of the Rhine. Stations to the east—Munich (528 metres) and Hohen Peissenberg (994 metres) are taken for observations on temperature and relative humidity. The last place is about 35 miles south-west of Munich; both may be considered as beneath the sky region producing glows at Säntis. As *difference of temperature* is the most decisive comparison, his tables are here reduced to a series showing the difference of Hohen Peissenberg returns from Munich, in degrees Centigrade. In some cases one or two other returns are also added, reduced in like manner. *Normally*, allowing for difference of height, Hohen Peissenberg should register 2°·5 below Munich.

The final set of observations refer to some of the earlier afterglows. The greater anomaly with greater elevation (increases of 5°·2, 10°·6, 12°·2, and 17°·1 respectively in the figures given) is very suggestive. The reason of the non-agreement in May has already been stated.

Except the last, these observations refer to ordinary sunrise effects, but the only difference between them and the recent glows is considered to be that the latter occur by reflection at a higher level and in a more finely attenuated haze, thus giving the richer effects. The presence of such a haze with the glows was a matter of very common observation.

The question, of course, requires further consideration, especially with respect to observations of the recent glows. Besides this connection with a warm stratum of air, Prof. Kiessling finds another, almost as general, with barometric maxima, as was noticed with the similar phenomena in 1881.

Referring, in his concluding paragraph, to the connection of the glows with the Krakatoa eruption, Prof. Kiessling writes that the thousand or so records of their geographical distribution, now in his hands, "show a perfectly continuous spread of the anomalous glows, and of the diffraction phenomena of Bishop's Ring dating from August 26, 1883, and spreading from the Straits of Sunda as a centre over the tropical and temperate zones."

J. EDMUND CLARK

A CENTURY OF SCIENCE IN BENGAL

IT was a happy idea of the Council of the Asiatic Society of Bengal to commemorate the completion of a century of the Society's existence by publishing a review of the progress made and the services rendered to knowledge by the institution.[1] The idea of a learned society composed of Europeans in India studying the country and communicating to each other at periodical meetings the results of their researches, arose first in the fertile brain of Sir William Jones, who was judge in the Supreme Court at Fort William, and who delivered, on January 15, 1784, to about thirty members of the European community of Calcutta, a "Discourse on the Institution of a Society for Inquiring into the History, Civil and Natural, the Antiquities, Arts, Sciences, and Literature of Asia." As a result of this discourse, the "Asiatick Society," the parent of all such societies, was founded. Its motto, which is taken from Sir William Jones's discourse here referred to, is this: "The bounds of its investigations will be the geographical limits of Asia, and within these limits its inquiries will be extended to whatever is performed by man or produced by nature." After many vicissitudes it has just completed its hundredth year, and the record of its work forms the large volume just mentioned. This is divided into three parts: first, a history of the Society, by Dr. Mitra; its work in archæology, history, and literature, by Dr. Hœrnle; and the work in natural science, by Baboo P. N. Bose. The change which has come over the face of India in the course of a century could hardly be better marked than by the fact that two out of the three parts into which the volume is divided—one of these being on natural science—are written by native gentlemen. In the history of the Society we notice that in 1808 a resolution was proposed by Dr. Hare and seconded by Dr. Leyden (frequently referred to in Lockhart's "Life of Scott"), "that a Committee be appointed for the purpose of physical investigations, the collection of facts, specimens, and correspondence with individuals whose situations in this country may be favourable for such discussions and investigations." It was then agreed to provide two committees—one for science, the other for literature; twenty years later, in 1828, a committee was appointed "to promote geological researches, working under the rules then in force for the Physical Committee," and at the same time the published *Transactions* of the Society were divided into two parts, one devoted to physical, the other to literary subjects. Nearly twenty years later the whole of the work of the Society was delegated to six committees, one having charge of zoology and natural history, another of geology and mineralogy, and a third of meteorology and physics. The establishment of a museum did not occur to the founder, but curiosities were constantly coming in from members, and in 1796 it was proposed to give these a suitable house. In 1814 Dr. Wallich proposed the formation of a museum, and offered duplicates from his own collections, as well as his services in arranging it, and a museum was accordingly started. The story of the growth of the various sections of the Natural History Museum is told by Dr. Mitra. On the whole it is one of great progress, although financial difficulties beset the museum at first. But as soon as the Society became able to pay for scientific curators all went well. In 1865 the Society's zoological, geological, and archæological collections were made over to the Government of India for the public museum in Calcutta. A writer in the *Calcutta Review*, speaking of the Society's exertions for the establishment of the national museum, said: "Had it done nothing else to promote science during the last ten years, it would have entitled itself to the gratitude of posterity for the vigour with which it has prosecuted to success a project fraught with so much public usefulness." The earlier volumes of the Society's *Transactions*, published under the title "Asiatick Researches," created a sensation in the literary and scientific world in Europe. A French translation was speedily published, with notes on the scientific portions by no lesser hands than Cuvier, Lamarck, Delambre, and Olivier. Of the work of the Society in preserving Sanskrit MSS., in translating and publishing various works from the native languages, and other valuable services to literature, Dr. Mitra speaks at length. Amongst the publications, apart from the papers, we notice many of scientific interest, such as catalogues of various sections of the museum, of the mammals and birds of Burmah, of Indian lepidoptera, besides translations of numerous works of Hindoo science. In summing up at the conclusion of his historical sketch the benefits conferred on India and the world by the Society during its hundred years of existence, Dr. Mitra sums up its scientific work (apart from papers, and published volumes above referred to) thus: "It got up an archæological and ethnological museum of considerable extent, a geological museum rich in meteorites and Indian fossils, and a zoological museum all but complete as regards the avifauna of India."

The long review of the work of the Society in natural science is, as already mentioned, written by Baboo Bose. His method is to take the various branches of science in succession, such as mathematical and physical science, geology, zoology, botany, geography, ethnology, and chemistry, and to describe under sub-heads the papers on these subjects contributed to the *Transactions* of the Society, together with a brief biographical sketch of the more celebrated or prolific authors. At the end we get a classified index of all the scientific papers, an alphabetical list according to the author's names being given at the conclusion of the first part. Amongst the latter we notice many whose names are familiar as contributors to NATURE. In the early years of the Society, and down to 1828, the scientific contributions to the Society's *Proceedings* were almost wholly connected with some branch of pure or mixed mathematics, for most of the men who went out to India, especially in the scientific branches of the military service, had been well grounded in this subject. The section on the investigations into the mathematical science of the Hindoos is of great interest. Sir William Jones put before the Society from the outset the object of studying these sciences, and he set the example himself, but the initial difficulty was to find any native capable of assisting him. Baboo Bose records that, although ample stipends were offered by Sir William Jones to any Hindoo astronomer who could name in Sanskrit all the constellations which he would point out, and to any Hindoo physician who could bring him all the plants mentioned in Sanskrit books, he was assured by the Brahmans whom he had commissioned to search for such instructors, that no Pundit in Bengal even pretended to possess the knowledge he required. Geology and mineralogy flourished in the Society from the commencement, while zoology was at first unduly depressed and discouraged owing

[1] "Centenary Review of the Asiatic Society of Bengal, 1784 to 1883." Published by the Society, Calcutta. Thacker, Spink, and Co., 1885.

to the aversion of Sir William Jones to zoological studies, and it was only about 1828 that the papers of Dr. Falconer, Col. Tickell, and others began to occupy an important position on behalf of zoology in the Society's transactions. With Indian botany, geography, and ethnology are connected many names of world-wide fame. With regard to chemistry, it may be said practically there is no chemical research in the Society's publications. Chemistry, as Baboo Bose explains, can only be studied in the laboratory, and until recently India had but few laboratories, and few competent men with leisure to devote to the subject. A curious statement, by the way, creeps into the account of Mr. Piddington, who studied Indian storms, and gave an account of every cyclone in the East between 1839 and 1851. Baboo Bose says his experience was most varied, and then quotes the following from some unnamed source :—"He was one of the few who escaped from the massacre of Amboyna." Now, as the massacre of Englishmen by the Dutch Governor of Amboyna took place in 1622, Mr. Piddington, if he was observing storms in India in 1850, could hardly have been in the Eastern Archipelago two centuries and a quarter previously. Many other portions of this volume, such as the chapters on coins, on ancient Indian alphabets, on the study of the languages and literature of India, and on the study of Indian antiquities, are of deep interest, but we have confined ourselves to the chapters on natural science.

The dominant feeling produced by an examination of this volume is one of satisfaction that so much has been done by this single society towards investigating the past and the present of (or, in the words of Sir William Jones, "man and nature in") our great dependency. For the most part this has been done by private individuals, but on more than one critical occasion the directors of the East India Company, in accordance with their generous traditions, came to the aid of the Society with large contributions; otherwise there appeared no way out of the difficulty except the dissolution of the Society and the abandonment of the works in which they were engaged. If this were the place it would be interesting to compare this method of practically leaving everything to private initiative, with that adopted by the French in Indo-China, of the Government undertaking a series of literary, artistic, and scientific investigations through competent specialists into a new possession. Notwithstanding the great and marked success of the Asiatic Society of Bengal, the French plan has advantages which cannot be overlooked.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Among the more noticeable Natural Science Courses this term are Prof. Dewar's on Dissociation and Thermal Chemistry; Prof. Newton's, on Evolution in the Animal Kingdom; Dr. Gadow's on Human Embryology; Dr. Vines's, on the Physiology of Plants; and Prof. Macalister's, on the Peripheral Nervous System.

Prof. Hughes is lecturing on Methods of Geological Surveying; Dr. R. D. Roberts, on Principles of Geology; Mr. Marr, on Elementary Stratigraphy; Mr. T. Roberts, on Palæontology; and Mr. Hawker, on Elementary Petrology; all at the Woodwardian Museum.

Prof. Roy is lecturing on General Pathology, and also conducting a Practical Course in Morbid Anatomy and Histology.

Prof. Stokes is lecturing on Hydrodynamics; Prof. Cayley, on Higher Algebra; Prof. Darwin, on Orbits and Perturbations; Mr. Glazebrook, on Waves and Sound; Mr. Hobson, on Planetary Theory; Mr. Macaulay, on Theory of Structures; and Mr. Forsyth on Abel's Theorem. Numerous other courses on higher mathematics, open to the University, are being given by college lecturers.

We are glad to notice that Mr. A. Sheridan Lea, M.A., Lecturer on Physiology, and formerly Scholar, of Trinity College, has been elected to a Fellowship at Gonville and Caius College. Mr. Lea's work in connection with Prof. Michael Foster's "Text-Book of Physiology" is well known. Mr. Lea was placed in the First Class in the Natural Science Tripos in 1875, and has since been continuously engaged in the University teaching of Physiology.

Dr. S. Richemann has been appointed assistant to Prof. Dewar, Jacksonian Professor.

Messrs. E. W. Hobson and A. R. Forsyth are appointed Moderators, and Mr. C. H. Prior Examiner, for the next Mathematical Tripos.

King's College offers a Vintner Exhibition of 70*l.* per annum for Natural Science. The examination begins on December 10.

St. John's College offers several scholarships, exhibitions, and sizarships for competition on December 10. Candidates may offer any of the subjects of the Natural Sciences Tripos except Mineralogy, and may be elected on the ground of special proficiency in one only. Particulars will be furnished by the tutors.

A joint examination for Natural Science Scholarships at Emmanuel, Christ's, and Sidney Sussex Colleges will be held on January 5, 1886, and following days. The subjects are Chemistry, Physics, Elementary Biology, Geology, and Mineralogy. Further particulars will be given by the tutors of either college.

Out of the 875 freshmen whose names have appeared in the preliminary lists, about 104 have announced their intention of studying medicine in the University. A few more may be added when the results of the October Previous Examination are known. The Anatomy School is attended by over 130 students, for whom an exceptionally abundant supply of dissecting material is in hand. The Demonstration Lectures have to be repeated from lack of room; indeed, the necessity for increased accommodation in this department is becoming extremely urgent.

LONDON.—We have received a circular stating that "In view of the adjourned extraordinary meeting of Convocation (of London University) to be held on Tuesday, November 3, a number of graduates met on Wednesday last to consider the proposed scheme for the establishment of a Teaching University for London. As the result of their deliberations it was thought desirable that attention should be called to some of the more striking objections to the proposed scheme; and that, having regard to the grave importance of the questions to be submitted to the members of Convocation affecting the very existence of the University as at present constituted, they should be especially requested to attend on Tuesday next, and to give their support to Mr. Bone's amendment, to *receive* the report submitted by Lord Justice Fry, without *adopting it* '*in bloc*.' Should this amendment be carried, the following resolutions, expressing what is believed to be the feeling of the majority of the graduates, will be moved:—(1) 'That Convocation, whilst affirming the general principles of the desirableness of bringing the teachers and the examiners of the University into closer relationship with one another and with the Senate, and of modifying the constitution of the Senate in accordance with the previous recommendations of Convocation, and without giving to the teachers an undue share of representation on the governing body of the University, refers back the scheme to the Special Committee for further consideration.' (2) 'That the number of members on the Special Committee be increased by one-half.'"

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, July 29.—The following papers were read:—A monograph of the Australian sponges, part 5, the Auleninæ, by R. von Lendenfeld, Ph.D. Several sponges from various localities in the Australian region have been included by the author in this new sub-family, the members of which are characterised by a very peculiar structure not met with in any other sponges. The new sub-family *Auleninæ* is placed in the family Spongidæ, and consists of the two new genera Aulena and Halme, with three species in all. The anatomy and histology of these is accurately described and illustrated by numerous plates. The Auleninæ form honeycombed or complicated reticulate structures; the cavities form a kind of vestibule and are simple in Halme, where an outer lamella surrounds the whole sponge, or subdivided into numerous small compartments, as in Aulena, where no outer lamella exists. Into the system of Vestibule-Lacunæ both the inhalent and the exhalent canals of the sponge open. The skeleton of Halme is composed of thick main fibres rich in sand, thin, simple and clean connecting fibres, and a hard cortex of sand cemented with spongiolin. The skeleton of Aulena is very peculiar. It consists of a regular network of fine horny threads in the joining points of which large sand grains are found. In the membranes of the Vestibule-Lacunæ of this genus nervous elements, sensitive and ganglia cells have been discovered by the author. These and many other histological details are described in the paper, which dwells also on the morphological significance of these interesting new sponges.—On a sponge destructive to oyster-culture in the Clarence River, by R. von Lendenfeld, Ph.D. In this paper the author describes a new sponge, *Chalinula coxii*, which appeared some years ago on certain oyster beds in the Clarence River, and destroyed some of them completely.—Note on the Glacial period in Australia, by R. von Lendenfeld, Ph.D. The author draws attention to some further evidence of ice action in the Mount Lofty group near Adelaide, where some glacier-polished Siluro-Devonian rocks, with very well preserved striæ, have been discovered and photographed.—Jottings from the biological laboratory of Sydney University, by William A. Haswell, M.A., B.Sc., F.L.S., &c., Lecturer on Zoology and Comparative Anatomy. This paper contains (1) some notes on an Australian species of Bonellia, which seems scarcely to differ from the European species, *Bonellia viridis;* and (2) some observations on aquatic respiration in fresh-water turtles.—On the supposed Glacial epoch in Australia, by Capt. F. W. Hutton, F.G.S., &c. The author discusses the phenomena which have been adduced as evidence for the former existence of a Glacial epoch in Australia, and shows that they are susceptible of a different interpretation. He distinguishes between a Glacier epoch, such as has occurred in New Zealand, in which, owing to various local, but only local, causes, ice-fields prevailed over much larger districts than at present, and a Glacial epoch, such as has been demonstrated in the Northern Hemisphere, which is the result not of variations caused and limited by local circumstances, but of alterations universal or cosmical in character. The Glacier epoch in New Zealand is regarded as anterior to the Glacial epoch of the North.

Paris

Academy of Sciences, October 19.—M. Bouley, President, in the chair.—Remarks on the 209th volume of the "Connaissance des Temps" for the year 1881, presented to the Academy on behalf of the Bureau des Longitudes, by M. Faye.—Note on the establishment of a laboratory in the Institute for the measurement of the photographic plates obtained during the transit of Venus in 1882, by M. Bouquet de la Grye. Arrangements have been made, by means of which it is hoped that the calculations and measurements relating to 700 plates will be completed in fifteen months.—Note on the Dinoceratidæ discovered by Mr. Marsh in the Eocene formations of Wyoming, United States, by M. Albert Gaudry. These huge pachyderms, which seem most to resemble the European Coryphodon described by M. Hébert, are specially remarkable for the characteristic horny protuberances on the frontal region, whence their name (δεινός, terrible, and κέρας, horn). The skull is also distinguished by its small size, in this respect resembling that of a reptile, as well as of several other mammals of the Lower Tertiary epoch.—On the birational geometrical transformations of the *n* order, by M. de Jonquières.—Note on the fifth part of the topographical map of Algeria, presented to the Academy on behalf of the Minister of War, by Col. Perrier. This part comprises the six divisions of Jebel-Filfila, Bone, Wed-Guergur with Cape Rosa, Menerville, Medeah and Mostaganem to the scale of 1 : 50,000.—Note on the sub-lacustrine ravines of glacial streams, by M. F. A. Forel. During his recent surveys of Lakes Constance and Geneva, M. Hörnlimann has discovered that both the Rhine and the Rhone continue their course under the lacustrine waters through deep ravines excavated beneath the respective submerged deltas. That of the Rhine has been traced for a distance of four kilometres and to a depth of 125 metres below the lake, while that of the Rhone may be followed for over six kilometres from the mouth of the river with a depth varying from 200 to 230 metres.—On the origin and classification of meteorites, by M. Stanislas Meunier. The author discusses the objections urged against his views on the nature and classification of meteoric bodies, by M. Brezina in the "Meteoritensammlung des Mineralogischen Hofkabinets in Wien," Vienna, 1885.—On the latitude of the observatory of Bordeaux, by M. G. Rayet. The mean latitude of this establishment, whose longitude was determined in 1881 at 11m. 26·444s. W., is found to be 44° 50′ 77″·23.—On the integrals of total differentials of the second species, by M. E. Picard.—Questions relating to a bundle of plane cubic figures, by M. P. H. Schoute.—On the torsion of prisms, by M. Marcel Brillouin.—Description of a new apparatus for measuring electric currents (one illustration), by M. F. de Lalande. This apparatus, for which the name of "electric areometer" is proposed, dispenses with a permanent magnet, the source of so much error in other appliances, is highly sensitive and practically unaffected by changes of temperature, while its readings are unmodified by the neighbourhood of metallic bodies or even of powerful magnets.—On the theory of the transmitting electromagnetic telephone, by M. E. Mercadier.—Note on the electrolysis of the salts, by M. Ad. Renard.—Combination of the neutral carbonate of magnesia with the bicarbonate of potassa, by M. R. Engel.—On the adulteration of olive oil intended for consumption by the addition of sesame cotton and other oils extracted from seeds, by M. A. Audoynaud. The bichromate of potassa and nitro-sulphuric acid are proposed as reagents for determining the presence of these substances.—On certain peculiarities in the development of the teeth of the cachalot (spermaceti whale), by M. G. Pouchet.—On the process of development of *Epicauta verticalis*, by M. H. Beauregard.—On the part supposed to be played by the living tissues of wood in the ascension of the sap in large plants, by M. J. Vesque. The author contests the opinion of those physiologists who hold that it is impossible to explain by the aid of purely physical forces the ascension of water in plants over 10 metres high.—On a waterspout observed at Shanghai on August 21, by M. Martial.—Account of the same waterspout, by M. Marc Dechevrens.—Description of M. Buisson's new rifle, by Gen. Favé. For this weapon it is claimed that it can be fired from five to ten times in a minute by troops charging the enemy without stopping an instant to re-load. As many as a hundred rounds may be fired off in this way.

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