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THE

INTELLECTUAL OBSERVER:

REVIEW OF NATURAL HISTORY,

MICROSCOPIC RESEARCH,

AND

RECREATIVE SCIENCE.

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THE INTELLECTUAL OBSERVER.

FEBRUARY, 1862.

THE WORK OF THE YEAR.

The progress of science during a single year must depend, in some degree, on the recurrence of special phenomena in Nature to give occasion for inquiry, experiment, and speculation. The pure sciences are in so large a measure independent of phenomena, that their progress is at any time a fair criterion of the activity of thought; but in the various departments of physics, man has to wait upon Nature, to follow where she leads him; to encounter the difficulties of untrodden paths as she may point the way, and whisper of what is to be sought there. The history of science might be used as profitably, to illustrate the relations of human character and human knowledge to external circumstances, as the history of the nation or the individual in the development of successive phases of moral phenomena. In the analysis of cosmical laws, we must shape our courses as eclipses, and occultations, and transits may occur; the changes of the seasons give the proper subjects for the inquiries of the meteorologist; and in geology an earthquake, a volcanic eruption, or a landslip, may disclose facts that appear to nullify previous conclusions, so as to demand a reconsideration of points supposed to have been settled long ago. In these matters, for all the purposes of scientific inquiry, man is the creature of circumstances. But it is no less true that in the same pursuit he creates circumstances; and in geography, zoology, botany, chemistry, and other allied sciences, he is as often the inventor of methods of exploration, comparison, and experiment, as he is, on the other hand, incited to research by the varying aspects of the phenomenal. It has become a necessity of our civilization that events should be grouped and classified from week to week, from month to month, from year to year. But it must ever be borne in mind that no single week, month, year, or even cycle of years, will exhibit accurately the whole of the attainments of that one period, nor can it furnish every datum necessary to an estimate of the magnitude, and importance, and bearing, and scope of all the labours of the cultivators of physical science. The majority of results are like graftings upon old stocks; if every graft grows with vigour, they must be traced to the root that gives them life, ere we can determine the age and value of the tree. The latest improvement in telegraphs may be but a new graft upon the stock planted by Franklin; and in the improved chemical nomenclature on the basis of the theory of equivalents we must recur mentally to John Dalton, who believed he had attained to the ultimate atomic constitution of matter—doubly unconscious that as his first idea would in time begin to refute itself, yet in doing so it would acquire a practical value to which it is impossible to assign limits.

We must judge the year 1861 by what it has done to ripen into facts the suggestions of preceding years; we must judge it too by what it has actually added to the cumulative power of scientific thought; we must (if we can) judge it yet further by the nature of the work it has cut out for posterity. Divisions of time are altogether artificial, as compared with the activities of the human mind; and therefore, in sketching the history of science during the past year, we are, as it were, cutting out a portion from the woof of the continuous fabric which indicates only the nature of the pattern with out affording any very definite hints of either its beginning or its end.

Among the astronomical events of last year, the great comet of June and July must have first place. Unlike Donati's, which emerged from the depths of space as a mere speck, and rapidly expanded into vast proportions in its speed towards the sun, this, first seen by Mr. Burden, of Clifton, acquired almost immediately its full proportions as a phenomenon in its perihelion passage, and then dwindled away as it sped into the far and mysterious regions of its aphelion. This comet played the sphynx as imperturbably as its gigantic predecessor. Unlike Donati's, which was photographed in seven seconds, it refused to impress its image on the most sensitive plates, and its elements were not correctly determined until after it had vanished from our view. Then it was we found ourselves in possession of two items of possible knowledge in regard to it; first, that it was doubtless identical with the comet of 1684; second, that the earth had passed through its tail, experiencing no other effect than the auroral glare described by Mr. Lowe and Mr. Hind, as characteristic of the atmosphere on the 30th of June. The transit of Mercury on the 13th of November, and the eclipses of the sun and moon in December, were each, of necessity, so imperfectly seen in these islands, that the records of the occurrences have no conspicuous place in the annals of science. Though we must wait till 1865 for an eclipse which shall equal in interest that of July, 1860, there will be in the present year a sufficiency of special subjects to engage astronomers. Let it be an encouragement to amateurs to observe the aspects of the disc of the sun during March and September, that the supposed inter-Mercurial planet Vulcan was first discovered on March 26th, 1859, by Dr. Lescarbault, with means so simple that the discovery stands alone in this respect among the accomplishments of observation. There is the more encouragement, too, that M. Leverrier believes there are many planets circulating within the orbit of Mercury, so we may anticipate successive discoveries to prove the immediate region of the solar orb as thickly peopled as the interval between Mars and Jupiter. Here again is encouragement of the same kind, for of the planetoids, now seventy-one in number, the greater proportion have been discovered by amateurs. The new satellite of Saturn, and the new views obtained of the structure of the rings of that planet, will afford subjects of peculiar interest for observers during the present year.

From astronomical we turn to cosmical subjects; and prominent among the work of the past year we must place the researches of Dr. Thomson, on the age of the sun's heat, on which a paper was read before the British Association. Dr. Thomson endeavours to show that we have, in the present potential energy of the sun, a measure of its duration, past and present, and, strangely, the conclusions arrived at bear directly on the Darwinian hypothesis. Mechanical energy is indestructible, but there is ever a tendency to its dissipation, which produces gradual augmentation of heat, cessation of motion, and exhaustion of potential energy by which heat is produced. Some heat is probably produced in the sun by the influx of meteoric matter, and the amount thus generated may be sufficient to compensate the loss by radiation. Considerations derived from the disturbances of the inferior planets and the zodiacal light, show that the amount of meteoric matter cannot be enough to give a supply at the present rate, for 300,000 years, a conclusion ratified by Leverrier by his researches on the motions of the planet Mercury. Considerations of the motions of comets prove that the meteoric matter must be derived from spaces near the sun, the cooling of which, by radiation, cannot be more than 1°·4 centigrade annually. Adding chemical considerations to those of a strictly astronomical character, he concludes that the sun cannot have illuminated the earth for 100,000,000 years, and it is certain it has not done so for 500,000,000 years. Therefore the conditions under which life has passed through its successive phases on this planet, have not been in continuance long enough to insure the results demanded by prevalent theories of organic transmutation. In regard to Mr. Darwin, Dr. Thomson concludes that his geological estimates of time, necessary to the postulates on which he reasons, are entirely inconsistent with the chronology of the sun, to which cosmical laws induct us. No doubt, upon the basis thus hypothetically proposed, the researches now so ably carried on in photo-heliography will add many curious and important facts, and our new views of the spectrum may aid still further in revealing the chemical constitution of the luminous atmosphere as well as of the denser fabric of the solar body. The reduction of the phenomena of terrestrial magnetism to something like an order of periodicity, affords another connecting link between meteorology and the more strictly cosmical departments of physics. The tabulated observations of magnetic disturbances indicate a close relationship between these and the changes of weather on the earth's surface, both being apparently subject to cyclical revolutions, embracing periods of between ten and eleven years. There is now a stronger probability than ever that the magnetic needle will prove the true key to meteorological law, and the weather predictions of Admiral Fitzroy may be expected ere long to give place to bolder foreshadowings of atmospheric disturbance and alternations of solar heat. But while resting in these, and hesitating to draw the line between a *fait accompli* and a possibility of the future, what a daily witness has the world now of the direct value of researches and speculations in science! "Hoist drum," is the brief word by which the mariner is warned, and by obedience to which human lives and costly argosies are saved from the grasp of the approaching storm: a grand vindication of those forbidding statistics to which meteorology has been so long committed as a science of detail rather than of general principles applicable to purposes of the highest usefulness and mercy.

Chemistry is so little influenced in its progress by the changes of the seasons, and the varying aspects of the heavens, that its successive contributions to the stock of useful knowledge keep pace very closely with the march of time. Among its numerous accomplishments two distinct modes of analysis stand out conspicuously. Strictly speaking, the discovery of Bunsen and Kirchoff is not chemical, but actinic; but its applications will immediately interest and concern the chemist, who may now work conjointly with the astronomer, informing him what are the constituent elements of those planetary and solar masses, about the movements of which he is so ardently occupied. The immediate result of the application of spectrum bands to the identification of inorganic bodies, was the discovery of two new metals, *cæsium* and *rubidium;* then we were conducted by the same method to an analysis of the source of light, and the sun was shown to be a solid or liquid photosphere, bathed in an enveloping atmosphere containing iron, sodium, potassium, lithium, and other metals, in a state of permanent sublimation. Discovery, through the aid of the prism, will not stop here. Science promises that we shall soon know why the planet Venus is so pre-eminently lustrous, like a burnished silver mirror; why Mars has upon his homely visage the hue of a subdued fire; why Saturn looks so cold, and Uranus so peculiarly metallic. The mysteries of the spectrum conduct us beyond the boundaries of the solar system, and offer means of analyzing the constitution of the stellar masses; so that Procyon and Sirius, "red Orion, and Arcturus huge," may severally be made to describe, in the rays of light they flash on us from afar, the nature of their elementary structure, and their chemical relations to the earth we inhabit. Scarcely second in importance, perhaps practically of greater value, is the method of analysis by diffusion, on which the Master of the Mint communicated a paper to the Royal Society on the 6th of June last.

For the purpose of propounding this method, Professor Graham divides bodies into two classes,—crystalloids, those which exhibit a tendency to crystallize, and which are of high diffusibility; and colloids, which are of low diffusibility, affect a vitreous structure, and have little effect on the volatility of the solvent. Examples of crystalloids will occur to the mind of the reader in plenty, and it may therefore suffice to state that animal gelatine is the type of the colloids. The peculiar fitness of gelatine and cognate organic compounds for the purposes of animal organization arise from their plastic nature, and the facility with which they become media for liquid diffusion while still retaining their identity. Passing by the suggestion thus offered us, of new modes of investigating the chemistry of life, we will be content here to indicate the process by which the analysis by diffusion is conducted. A septum of membrane is provided, it may be a sheet of gutta-percha paper, or vegetable parchment, eight or ten inches in diameter, by three inches in depth, formed on a hoop in the fashion of a sieve. A mixed solution, which may be supposed to contain sugar and gum, is placed upon the septum to a depth of half an inch, and the instrument is floated upon a considerable quantity of water. In the course of time, the sugar—a crystalloid—by its high diffusibility, separates from the gum, leaving the gum in an undiffused state remaining on the septum. In another experiment, defibrinated blood charged with a few millegrammes of arsenious acid was found to impart the greater part of the arsenious acid to the water in the course of twenty-four hours. The diffusate was so free from organic matter, that the metal could be readily precipitated by sulphuretted hydrogen and the quantity weighed. The separating action of the septum by this process is called *dialysis,* under which designation a great revolution will doubtless be effected in the processes of proximate resolution. The applications of this method in judicial investigations, in the detection of adulterations, and in researches into the subtle phenomena of animal and vegetable life, will be of immense value, because simple beyond all precedent in the history of chemical practice. Other, and apparently remote departments of science will be aided by the discovery of dialysis; and we shall not be long in learning that we have in it a talisman to unlock some of the secrets of the molecular structure of bodies.

The conquest of the earth is a work shared pretty equally by the active spirits of every class of action and thought. The explorer and the colonist move in the van, but their efforts are aided by every practical application of scientific theory; and even the recluse lends his aid when deducing from human history and natural phenomena the conditions on which life is possible, and civilization good. But to exploration we look for the preparatory steps, and in 1861 there was much added to our previous stock of knowledge of the physical aspects of the globe. The hills and valleys of Japan have yielded treasures of animal and vegetable life; we know somewhat more of China, much more of Australia, and the African mystery takes precedence of the Asian in modern annals.

At the commencement of the year, we had full particulars of the results of the survey of the North Atlantic, by the party under Captain Young, in the steam yacht "Fox," for the purposes of ocean telegraphy. There was little added thereby to our stock of geographical knowledge, but the soundings brought to light the fact, that at a depth of 7000 feet, and about 500 miles from Greenland, the sea abounds with life, not only of the low order of globigerina, but starfishes and annelids, and boring creatures capable of doing mischief to submerged cables. The like results have followed the investigations of Mr. Gwyn Jeffereys and others, proving how confined have been our views hitherto of the distribution of life on the globe. The Swedish polar expedition, under Mr. Torell, who is accompanied by the veteran Peterman, has attracted considerable attention, owing to its exploration of portions of the Spitzbergen coast not touched by any of the numerous polar expeditions of the last half century. We may expect shortly an account of the researches of the Expediçao Scientifica of the Brazilian Government in the Amazon district—a region of wonders—so far as that can be rendered in the absence of the notes and photographs of S. de Capanema, the geologist to the expedition; Professor Allemão, the leader of the enterprise, having abundant material for a representation of the botany and geology of the country. Dr. Livingstone continues his labours with unabated ardour; Sir Robert Schomburgk is gathering information on the products of Siam; Captain Blakiston, who explored the Kootanie Pass, through the Rocky Mountains, three years since, is now penetrating untrodden regions of Central Asia, and will be able to add much to our knowledge of the geography of China; the French expedition to Southern Siberia is at work on the regions bordering the Amoor; and Dr. Beke is on his way to determine the true site of the Biblical Haran, a point considered so far settled already, that there is but small prospect of any important consequences.

Conspicuous among the items of information on the subject of physical geography, are the two recent explorations of the interior of Australia; the one by Mr. Stuart, which was well conducted, and came to a happy end; the other, by Mr. Robert O'Hara Burke, which was wofully mismanaged, and terminated disastrously. We now know satisfactorily that the predictions of the geologists respecting the interior of that vast continent were founded in error. Instead of interminable wastes of sterile rock, broken only by lakes of brine, there are immense tracts of fertile country; mountain chains, whence issue streams that water flowery valleys, and extensive tracts of metalliferous soil. We are only beginning to understand the extent of the resources of the prosperous colonies of Australia, to which we may turn with renewed hope during the present American crisis, believing in the possibility of an abundant supply from thence, of every product for which hitherto we have been so largely dependent on the other side of the Atlantic. The explorations of Captain Sturt comprised, perhaps, the gloomiest and most forbidding regions of the interior; those of Mr. Stuart were from Chambers' Creek to within 250 miles south-west of the Gulf of Carpentaria, from which point he retraced his steps. In the centre of Australia he planted the British flag on a pile of stones, within which was inclosed a bottle, containing a statement of his progress up to that point. The configuration of the surface, and the vegetation during the greater part of the toilsome journey, indicate that there is an almost inexhaustible extent of country fitted for the diffusion inland of the civilization which now prospers on the coast. The expedition under Mr. Burke left Melbourne on the 20th of August, 1860, crossed the continent, and reached the tidal waters of the Albert River, which flow into the Gulf of Carpentaria, and returning to their depôt at Cooper's Creek. The party consisted of Mr. Burke, commander, Mr. G. Landells, second in command, Mr. W. J. Wills, astronomer, Herman Beckler, surgeon and geologist, Ludwig Becker, artist and naturalist, ten men, and three sepoys. They had camels, horses, waggons, and an abundant outfit. At Menindie a dispute arose, and Mr. Landells left the expedition with Dr. Beckler. Burke then divided the expedition into three parties; and himself, Wills, and six others proceeded to Cooper's Creek, leaving the rest to bring up the stores to the depôt. At Cooper's Creek, Burke again divided his party, leaving three or four to keep charge of the depôt till his return, but about the time they were to wait there was evidently a misunderstanding. Burke then started for Eyre's Creek, 300 miles distant. From this point they proceeded eastward, till they struck the 140th meridian, travelling thence due north, till they reached 17° 53′ S., and 139° 49′ E. They next pushed on to the Gulf of Carpentaria. On the 19th of February last, they began to retrace their steps, and on this journey Gray died, after indescribable sufferings. On the 21st of April they reached Cooper's Creek, alas! just seven hours after the party in charge had quitted the depôt on their way to fall back on Menindie. They were now in a helpless condition, and subsisted for a while on the seeds of a plant called nardoo. Burke sank from exhaustion, and died; Wills died next, and King was left alone in the wilderness. He crawled in search of the blacks, and found them; and at last reached Melbourne, the bearer of melancholy tidings. Five others died of scurvy and want, including Dr. Beckler, who is believed to have added to the misfortunes of the party by his adherence to the indefensible cause of Landells. Miserably as this affair ended, such of the journals as have been preserved confirm the statements of Mr. Stuart, that the interior of the continent is diversified with fertile tracts of vast extent, navigable rivers and lakes, and rocky ranges rife with metallic treasures.

The conquest of the earth calls forth the energies of the engineer, the miner, the surveyor, and the merchant, as the proper coadjutors of the astronomer, geologist, and naturalist. Submarine cables have failed in so many instances, that we must hope for an entire remodelling of the system under which they have been laid and lost hitherto. The jobbery of dishonoured contracts has brought discredit on the science out of which they originated; interrupted communications by the delusion of supposed improvements in the transmission of intelligence; and caused the hopeless consignment to the sea-bottom of thousands of pounds contributed by too confiding shareholders. It may be a long while yet ere the message of "peace and good-will" shall be again conveyed from these islands to the remoter shores of the Atlantic, but it will be done, and we have but to wait. Ocean telegraphy is in its infancy, and has been fruitful in infant follies of waste, and error, and perversion; but the sacrifice has not been all in vain, and the promoters of such enterprises are brought back to the old vantage ground of fact, for the necessary basis of their theories. That in other departments science assiduously seconds individual energy, we had a grand example in the transmission of the intelligence from America, of the concession to the demands of Britain in the matter of the "Trent" and "San Jacinto." To such agencies commerce adds her numerous means of help. The closing of the ports of the Southern States of North America has recalled attention to the capabilities of soils and climates where the abuse of slavery is unknown. Now to bridge torrents, establish iron roads through ghauts and marshes, there is opportunity for the engineer to aid, at last, in doing justice to India; and Britain may discover the value of the Oriental gem which has hitherto but faintly sparkled in her diadem of empire. We are promised ships that cannot sink; boats are made in a few hours by machinery; rifled ordnance and plated frigates promise to give the command of the seas to the masters of the forge; and the blasting system of Bessemer is overpassed by the discovery of the part which nitrogen plays in the composition of steel. To bring up the rear in this system of engineering applications, Bonelli's telegraph writes down with equal rapidity the messages that by older systems were only spelt out in arbitrary signs, liable to error and occasional delay. Looking to the gleam of the morning for the promise of the coming day, the prospect brightens and fills us with heart and hope. The learned societies are generally in a prosperous condition. The arts flourish. The means of life abound. Naturalists' clubs and scientific books are on the increase; a higher standard of mental and moral culture is the desire of the English people, and the progress of education among the masses tends to refine popular intelligence and encourage prudence and thrift, and inculcate that wholesome doctrine that God helps those who help themselves. The statistics of health and mortality increase the force of the conclusions drawn from the last census, that human life has a higher average duration, and is less embittered by avoidable ills; while the resources of Britain expand, and peace is crowned with prosperity. In the forward glance rises, to the broadening sunlight, the grotesque yet dignified façade of the new International Exhibition, where, during 1862, science, and art, and plodding industry will hold peaceful conference on their several abilities to bless the world. While other plans are immature that will be the monument—of which he was himself the founder—to that noble Prince whose blameless life was endowed with the genius of active goodness; as it will vindicate, in the face of the world, the famous motto of Lord Bacon, "The true end of science is to enrich human life with useful arts and inventions."

SHIRLEY HIBBERD.

PRIME MOVERS.

BY J. W. M'GAULEY,

Author of "Lectures on Natural Philosophy," etc.

WE shall briefly examine the most important of those sources of motion which have been either adopted or proposed, and shall compare their respective advantages and defects. The subject is one of great interest; since the cost of every industrial product is affected by the expense of the power which is employed in obtaining it. And, within the memory of many of us, the prices of nearly all the articles in general consumption have been greatly diminished, because the prime movers used in their manufacture have been either changed or improved. Some consequences, which are both interesting and instructive, will follow from our reflections on the subject; ingenuity will be prevented from wasting its energy on contrivances that have been already tried, and have been proved either impracticable or worthless; and the capitalist may decide for himself as to the feasibility of any invention designed to generate motion, so that neither shall his liberality be abused, nor he himself be deterred from lending his aid to the progress of science, through an indiscriminating dread of all new discoveries.

At first, every laborious process was performed by man himself. In the infancy of society, when his wants were few, his subsistence easily obtained, and the calls on his exertions not very numerous, this was attended with but little inconvenience. But, as civilization progressed, he called to his aid the horse, the ox, and other animals; next, he used water-power, afterwards the wind, and finally steam: until at length his occupation was reduced to little more than the superintendence of those gigantic powers which he had pressed into his service. But man is never content with what he *has* done—and it is well that he is not; for this is the source of progress, the origin of every improvement. As long as the human race shall exist on earth, it shall advance in knowledge, and therefore in *power;* and each succeeding age shall unfold wonders that were not even dreamed of in the preceding. Constant efforts, therefore, have been made to supersede the steam-engine, by some motive power still more convenient or economical. What will be the result of similar attempts hereafter, none can say; for it would be rashness to place a limit to the discoveries of science; but, hitherto, as we shall presently perceive, success has not attended these efforts. On the contrary, time, labour, and ingenuity have been wasted on projects which, being opposed, in many instances, even by physical laws, were utterly impracticable. We shall consider, in succession, the various sources of motive power; directing our attention principally to those contrivances which have been intended, either seriously to modify the present mode of applying steam, or altogether to set it aside.

Although the *strength* of *animals* has been used from the earliest times, we have arrived at but little accuracy, and no uniformity, in our modes of determining even its average amount for any species; and the estimates which have been made regarding it vary considerably. This, however, should cause no surprise; since not only do animals of the same species differ in their capabilities, but the very same animal gives different results, according to the nature of its employment, its intervals of rest, the kind and quantity of its food, and a number of other circumstances. The strength of an animal is equal to "the product of its effort, its velocity, and that part of the twenty-four hours during which the effort is continued." And there is, for each individual, some set of values of these quantities which gives its maximum amount of work. An animal may move so fast, as to be able to move only itself; or, from being overburdened, so slowly, as to produce no useful effect. The proper speed and burden lie between these extremes. An animal may be employed either in carrying, in pushing, or in drawing. A man will carry, on a horizontal plane, eighty-five and a-half pounds, for seven hours a day, two feet and four-tenths per second; which is equivalent to 5,171,000 pounds carried one foot. He will draw with a force of from seventy to eighty pounds on the level ground; but will push at the height of his shoulders with a force of only about twenty-seven or thirty pounds. He can ascend a flight of steps, unburdened, at the rate of twelve twenty-fifths of a foot per second, which—supposing him to be of average weight—is equivalent to 1,935,000 pounds lifted one foot, or only two twenty-fifths of what he could do, moving horizontally.

Of all animals, the horse is best adapted for labour. And, since he uses his weight to overcome resistance, his efforts are most effectively exerted in drawing a load on a horizontal surface. Watt considered that a horse could raise only 33,000 lbs. one foot high, per minute; and this is the standard which has been adopted in estimating the power of steam-engines. It is equivalent to 15,840,000 lbs. raised one foot high in a working day of eight hours. According to Gerstner, the following represents the work done by the different animals :—

Animals.	Pounds Weight.	Mean Effort in Pounds.	Mean Speed per Second.	Hours per Day.	Pounds per Second.	Effect per Day.
Man	150	30	2·5	8	75	2,160,000
Draught-horse ...	600	120	4·0	8	480	13,824,000
Ox	600	120	2·5	8	180	8,640,000
Mule	500	100	3·5	8	350	10,080,000
Ass	360	72	2·5	8	180	5,184,000

A horse, on the authority of Desaguliers and Smeaton, is usually considered as equivalent to five men. Bossut reckoned an ass as equivalent to two men.

The power of animals is derived from the combustion which is carried on in their bodies; and the heat derived from this source was originally absorbed from the sun's rays during the growth of those plants which, mediately or immediately, form their food. And hence, in reality, their force is derived from the SUN.

Having availed himself of the strength of animals, man was a long time before he perceived that he might obtain a motive power from water. Hand-mills, termed *querns,* were used for grinding corn long after the still ruder method of pounding it had been wholly, or in part, discontinued; subsequently these were fitted with shafts, and cattle were attached to them; but, as Strabo informs us, water-mills were not introduced at Rome until about seventy years before the Christian Era. It has been estimated that a ton and a-half of water per minute, falling one foot, will grind and dress a bushel of wheat per hour. The cost of putting up any hydraulic machine is nearly the same as that of a steam-engine of the same power; but the force derived from it is less expensive.—The power obtained from rivers and streams, also, is derived from the SUN. For the water is raised, during evaporation, by the sun's rays; and produces its effect, while falling back to its original position.

A vast force is generated by the rising and falling of the water which constitutes the tide; and it has, in a few instances, been turned to a practical use, by means of *tide-mills.*—The motion obtained in this way, however, forms an exception, not being derived from *heat,* but from the attractive action of the sun and moon.

The force of the *wind* was applied very early to the propulsion of ships; but it was not employed to drive machinery until a comparatively recent period. Wind-mills are said, by some, to have been invented in France, in the sixth century; it has been asserted by others that they were known in Greece and Arabia in the seventh century, but were first introduced into these countries during the Crusades. They have been very commonly used, particularly in Holland, for drainage; but their frequent stoppage for want of wind, and the difficulty of regulating their speed, has been a serious obstacle to their adoption in most manufactures.—The force obtained from the wind, also, is derived from the SUN: which, by rarefying the air in distant regions, cause atmospheric currents to be produced.

Before entering on the subject of steam-engines, and their proposed substitutes, it will be useful to glance at a few of the properties of Heat, which, with the one exception we have mentioned, is probably the source of all our motive power. Heat is employed either to cause an increase of temperature, in which case it is said to be *sensible;* or to produce mechanical changes, in which case it is termed *latent.* The work which is lost by friction is always expended in the development of heat; and hence it is supposed, that the friction of a piston against the sides of a steam cylinder causes no diminution in the power of the engine, since the heat which is set free raises the temperature of the steam, and therefore augments its pressure. The effect producible by 772 pounds falling one foot, is considered to be the quantity of work, corresponding with the heat, which would raise a pound of water, at the ordinary temperatures, through one degree Fahrenheit; and this quantity has been termed "Joule's unit." When a body returns to its original condition—steam, for example, to water—heat disappears, and to an extent equal to that which would be generated by employing the force thus produced in overcoming friction. This is called "the conversion of heat into mechanical energy." And the efficiency of the heat, in a heat-engine, depends on the relation between the heat converted into mechanical energy, and the whole heat applied. It is probable that the efficacy of all prime movers, without exception, is proportional to the heat so converted. The efficiency of a steam-engine depends on that of the furnace, or the effect of the steam upon the piston, and on the power communicated by the piston, through the crank shaft, to the machinery; but nearly one-fifth of the heat is expended in causing a draught in the chimney, and a large quantity besides is lost by radiation from the various parts.

There is great reason to believe, that all sources of power yield the same amount of it, with the same quantity of heat; and that the only thing we can do is to discover in what machine the amount of heat expended in work approaches the nearest to equality with the entire quantity.

The same substance, in the solid state, has less capacity for heat than in the liquid state; and, in the liquid, less than in the vaporous state; but combustion may change a solid, or a liquid, into a gas which has a less capacity for heat; and the heat given out by fuel, is the difference between its specific heat and that of the products of its combustion. Charcoal, when burned, takes oxygen from the atmospheric air: and, as that gas is rendered more dense, without alteration of its volume or elastic force, it loses the difference between its specific heat in its former and its latter state. It was found, as the mean of several experiments, that one pound of hydrogen, combining with oxygen, is capable of raising 51,146 pounds of water, one degree Fahrenheit; one pound of carbon, 14,500 pounds of water; one pound of phosphorus, 11,900 pounds of water; and one pound of sulphur, 2800 pounds of water. But hydrogen, during combustion, combines with *eight* times its weight of oxygen; carbon, with only *twice and two-thirds* of its weight; phosphorus, with only about *once and a quarter* its weight; and sulphur, with only *an equal* weight. The heat evolved has, therefore, a very close relation to the amount of oxygen which enters into combination. We may deduce the heating power of any kind of fuel from these quantities, if we know the nature and relative amounts of its constituents; since all fuel consists chiefly, or altogether, of carbon, of carbon and hydrogen, or of carbon, hydrogen, and oxygen. There is a loss of heat, by vaporization of water, whenever that fluid is formed during combustion; and this loss is estimated at one-fifth of the power of the hydrogen—any water, mechanically present in the fuel, would, of course, be a cause of further diminution. The heating powers above mentioned suppose the combustion to be complete; but if, from any cause, it is imperfect, the carbon may be only partially consumed—dense smoke being generated; or it may combine with only half the quantity of oxygen; in which case the thermal unit falls from 14,500 to 4400 pounds of water. Hydrogen unites with pure oxygen at 800°, and burns in the atmosphere at 950°; carbon unites with pure oxygen at 700°, and burns in the atmosphere at 800°; but when the fuel contains incombustible gases, higher heats are required; and if the temperature should exceed 1200°, particularly if it approach 1500°, carbon, combining with the earthy matters found in ordinary coal, will form clinkers, and fuel will be wasted.

The heat of all fuel is that which has been received from the SUN, during the chemical changes which take place in the growth of those plants that constitute not only the forests at present in existence, but those forests also belonging to a remote period, to which our coal-fields owe their origin. There is no fuel which is not derived from one of the organic kingdoms—none, indeed, which has not had its origin in plants, at least preparatory to its having entered into animal organizations. It is probable that, during combustion, the *supporter* takes the place of combined caloric, which therefore is evolved. Hence, when carbon becomes carbonic acid, heat is set free; but when carbonic acid is decomposed in any way, heat is absorbed.

We have reason to believe that the ancients knew more about steam than is usually supposed; and the mistake on this point may have arisen from their terming steam "air." There is no doubt that steam, and air expanded by heat, were used by them for producing motive power. Hero, of Alexandria, who flourished about B.C. 120, discusses the properties of *air*, as a medium for communicating pressure and motion; and enters into the nature of a vacuum—subjects which comprehend the whole theory of the steam-engine. But, long as the properties of steam have been known, and much as they have been studied, the greatest actual efficiency of the steam-engine is still but about one-sixth of its theoretical; that is, but one-sixth of what its efficiency ought to be, taking into account the heat which is expended in working it. Besides other sources of loss, steam is wasted, in heating the cylinder, during the first part of the stroke; which is necessary, from the cooling of the cylinder, during the expansion effected in the latter portion of the preceding stroke. And not only is the steam, which has been condensed from this cause, only partially revived afterwards, but its revival becomes, in some degree, mischievous; since it continues, while the exhaust steam is passing into the atmosphere, on the condenser; and thus, by increasing the "back pressure," it lessens the power of the engine. The loss, from this cause, particularly with high velocities, and great expansion, is so serious, that it very much diminishes and sometimes altogether destroys the advantage derived from using the steam expansively. Some steam, also, is condensed behind the piston, owing to the conversion of part of the heat into work, and the consequent precipitation of water. This, in itself, is not a loss; but, during the latter part of the stroke, it robs the cylinder of heat, and the steam, thus condensed, and afterwards revived, being formed too late, increases the *back pressure.*

It was supposed that a large quantity of the heat, which is carried off by the waste steam, might be retained; and the *Regenerative steam-engine* was designed to effect this object.—A furnace, placed under the cylinder, heated the steam to a temperature higher than the boiling-point corresponding with its pressure; and a *respirator,* or apparatus capable of rapidly absorbing or imparting heat, was employed. The steam, in passing off to the atmosphere, through the respirator, left a large quantity of heat behind; and this was taken up by the steam, which next entered the cylinder. It was asserted that, with this engine, only one-twentieth of the effect was lost; but it is nearly the same in principle, and is open to almost the same objections, as the *caloric* engine, which we shall notice presently.

A belief that the *crank* destroys power, has caused many efforts to construct *rotary steam-engines;* that is, such as would produce a rotary motion, by the *direct* action of the steam, and without the medium of reciprocation, which is unavoidable in ordinary engines. This belief, however, is shown, by the properties of the lever, to have no foundation: a certain amount of force is, no doubt, lost on account of obliquity of the connecting-rod; but this loss is far more than counterbalanced by the advantages of the crank, which gradually brings the heavy masses of matter to a state of rest, or motion; and, by the diminished speed it causes, towards the end of the stroke, gives time for the waste steam to escape before the piston returns upon it.—The first rotary steam-engine, of which we have any account, was that invented, or at least described, by Hero, of Alexandria, in the second century before the Christian era. The steam was made to escape from apertures, near the ends, and at opposite sides, of a hollow arm which turned about its centre; the reaction against the interior of the tube, opposite to the apertures, caused a rotary motion. Its principle has been applied in engines constructed by Avery, in America, and by Ruthven, in Edinburgh; and it is one of those contrivances, which have often been reinvented; but it is less efficient than the common engine, since the steam leaves the revolving-arm with a higher velocity than that of rotation.

In other forms of rotary engine, the steam produces a continuous motion, by causing vanes, etc., to revolve within a drum; but it has been found impossible to keep such surfaces steam-tight.

The attempts made to obtain a more economical, or, at least, a more convenient prime mover than steam, have given rise to many proposed substitutes for it; but none of them have been successful. If any machine shall supersede the steam-engine, it must be "cheaper and as good," or "better and as cheap." However ingenious it may be, unless it fulfills one, at least, of these conditions, it has no chance of being adopted.—We shall first direct attention to what has been proposed, rather as improvements of the ordinary engine, than as different sources of motive power.

The *steam and ether engine*, was intended to economize the heat which is wasted in the condenser, when the steam is changed into water. Few attempts to improve the steam-engine have excited such sanguine expectations; and the invention was actually purchased by the French Government, on the recommendation of eminent French engineers, who estimated the saving it was supposed to effect at seventy-four per cent.; even Rennie, who seems to have examined it carefully, considered it to save seventy per cent.—Ether was evaporated, by the heat given out in condensing the steam of an ordinary low-pressure engine; and the resulting ether vapour was employed to move a piston. It was assumed, that all the work done by the ether was so much gained; but, among other inconveniences, the evaporation of the ether was found incompatible with condensation of the steam, at a sufficiently low temperature; and the effect derived from the steam was, therefore, less than it should be. Without great care, also, there was danger of ignition or explosion, with the ether vapour; and ether was unavoidably wasted.

It was supposed, from the very low temperature at which certain fluids boil, that they might be used, with the steam-engine, more advantageously than water. Thus, while the latter, under ordinary pressure, boils at 212°, alcohol boils at 276°, and ether at 98°. And, as the elastic force of the vapour produced is, in each case, the same, it was considered that the vapour of alcohol, ether, and other fluids which boil at compararatively low temperatures, might be used in producing motive power, more economically than that obtained from water. Their boiling points being lower, they can be evaporated with less expenditure of fuel; and from this it was assumed that, at a given cost, they would do much more work. This reasoning was extremely plausible; nevertheless it was found that the vapour of water, though produced at a higher temperature, is more economical than that of any other fluid. The reason is a very simple one: the mechanical effect of a vapour depends, not only on its pressure, but also on the distance through which that pressure is exerted. Now, as a cubic inch of water, at 212°, produces one thousand six hundred and ninety-six cubic inches of vapour: while a cubic inch of alcohol produces only six hundred and sixty, and a cubic inch of ether, only four hundred and forty-three: it follows that, to fill as much space as is occupied by the vapour obtained from *one* cubic inch of water, nearly *three* cubic inches of alcohol, or *four* of ether, must be evaporated. And hence, the motion of a piston through a given distance is produced far more cheaply by the evaporation of water, than by the evaporation of alcohol, or ether. The same is true with regard to every other liquid that has been tried—and, we may reasonably suppose, with regard to any whatever: much more being lost, by the additional quantity required to be evaporated, than is gained by the lower temperature at which the evaporation takes place. In reality, the effect produced by any vapour depends on the amount of heat which is necessary for its production: and this, for water, alcohol, and ether, are as follows:—

	Specific Gravity.	Boiling Point.	Heat of Conversion into Vapour.
Water	1·000	212°	942°
Alcohol	0·825	175°	425·5°
Ether	0·700	112°	302·6°

Cagniard de la Tour reduced alcohol, spec. grav. 0·837 at a temperature of 497°, to a vapour having a calculated pressure of one hundred and nineteen atmospheres; but it occupied a space not quite *three* times its original volume. He converted sulphuric ether, at 392°, into a vapour having a pressure of nearly thirty-eight atmospheres; but it occupied a space not *twice* its original volume. At 497°, water exerts a pressure of about forty-four atmospheres; and occupies a space about *ninety-nine* times its original volume. At 392°, it exerts a pressure of about fifteen atmospheres; and occupies a space about *one hundred and forty-one* times its original volume. Sulphuret of carbon has an elastic force equal to about four atmospheres, at 212°; and to nearly twenty-nine atmospheres, at 392°; but it is liable to the same objections as alcohol and ether. Oil gas vapour, which is produced from the liquid that is separated from oil gas by the pressure used to render it portable, was suggested, by Tredgold, as perhaps very suitable to supply the place of the vapour of water in a steam-engine; it boils at 170°, and remains liquid at common temperatures. But there can be no doubt that the mechanical effect of its vapour, also, is dependent on the quantity of heat absorbed in passing from the liquid to the vaporous state—this being most probably a general law.

The remarkable expansion of carbonic acid and other gases, when liquified, very soon attracted notice. Sir H. Davy expected that it would afford a mechanical agent, on account of the immense difference between the increase of elastic force in gases under high and low temperatures, by similar increments of temperature. The force of carbonic acid at 12°, was found equal to that of air compressed to one-twentieth of its bulk; and at 32°, to that of air compressed to one thirty-sixth; making an increase of pressure equal to thirteen atmospheres. It was ascertained by Thilorier, that the pressure of the vapour formed by liquified carbonic acid from 32° to 86° Fahrenheit, amounts to from thirty-six to seventy-three atmospheres; and the volume from twenty to twenty-nine—the expansion being four times that of atmospheric air. But Davy did not remark that the space through which the pressure is exerted is inconsiderable. The less the specific gravity of a vapour, compared with that of the fluid from which it is produced, the more effective it will be as a mechanical agent; but the specific gravity of steam is less than that of any vapour which has been tried, not only when compared with liquids, such as alcohol, etc., but with liquified gases also; as will appear from the following:—

Liquids.	Spec. Grav. of Vapour.	Spec. Grav. of Liquid.	Temperature	Mechanical Effect.
Sulphurous Acid................	2·777	1·42	45°	426
Sulphuretted Hydrogen......	1·192	0·9	50°	630
Cyanogen	1·818	0·9	45°	395
Ammonia	0·5962	0·76	50°	1057
Chlorine	2·496	1·33	50°	440
Water	0·48	1·000	212°	1711

The *gas engine* was intended, by Brunel, to apply to practical purposes the power expected from the expansion of liquified gases; and it must be a source of wonder and regret, that so enlightened a man should have wasted his ingenuity on so hopeless a project. He placed liquified carbonic acid in two receivers; and when these were heated and cooled alternately, the resulting expansions and contractions were made to communicate motion to a piston, working in a cylinder, which was placed in an intermediate position. A rise of 180° gave a pressure of ninety atmospheres; which, having no resistance to overcome, except that of the vapour in the other receiver, at a lower temperature, tended to move the piston with a force estimated at sixty atmospheres. The pressure was undoubtedly very great; but the distance through which it acted was trifling. Brunel constructed an eight-horse engine on this principle.

It was hoped that a boiler, furnace, and all their attendant inconveniences would be rendered unnecessary, by using explosive gases instead of steam, for the production of a vacuum; and the *gas vacuum* engine was patented for this purpose in 1824. The air was rarefied alternately in two chambers, by burning coal gas within them; water, which was then forced up by atmospheric pressure, was used to turn an overshot wheel. The inventor proposed applying this principle to the movement of a piston in a cylinder; but the contrivance would then be liable to the objections which are fatal to that we shall consider next.

It was expected, that not only might a vacuum be produced by explosive gases, but that a motive power also might be directly obtained from it. The *ignition-gas engine,* which was intended to carry out this object, was invented many years since, and was reinvented about five years ago in America. It is at present being tried as a new invention in France, by M. Lenoir.—An explosive mixture, consisting of hydrogen, or some of its compounds, and common air, is ignited by electricity or other means, in a cylinder, the piston of which is impelled by the expansion and subsequent contraction produced by combustion. One measure of hydrogen and two and a-half of common air expand, during explosion, to *three* times, and then collapse to *one-half,* of their original bulk. Several years since, this engine was characterized as "violent, vacillating, and noisy," and it must necessarily be so. Such a principle cannot be successfully applied; the *inertia* of matter renders it impossible for machinery to be effectually moved by sudden and transient impulses, such as those which are the result of explosions. To move a material substance, particularly if it is of considerable weight, the power must *continue* to act upon it for some appreciable time. Even gunpowder may be so manufactured as to explode too rapidly for the production of a proper effect on the ball. A door, which may be easily closed by gently pushing it with the finger, will move very little, or not at all, when struck suddenly or violently with the hand; and, the more violent the blow, the less it will move. Other explosive mixtures, including gunpowder, have been tried, with similar results.

The substitution of heated air for steam was proposed, in 1816, by Stirling; and, about twenty-five or thirty years ago, air, expanded in an iron cylinder, which was kept at a red heat, was used for giving motion to a piston. But, as in all the experiments of this kind which have been made, it was found that the cylinder was soon destroyed by the high temperature. In *Ericsson's caloric engine,* which was constructed on this principle, and caused so much excitement some time ago, in America, there were two larger and two smaller cylinders—a smaller being placed above a larger, and the pistons of both being made to move together. The air passed from the smaller or *supply* cylinder, through a *regenerator,* where it was heated to about 450°, to the larger or *working* cylinder, where its temperature was raised to 480°, by a fire placed underneath. The regenerator—to which the name of *respirator* was given, in the *regenerative steam-engine,* mentioned above—was a vessel, in which sheets of wire gauze were placed side by side, so as to form innumerable cells, through which the air was made to pass. The air which left the working cylinder at a high temperature, imparted to the wire gauze most of its heat: and this was taken up by the air passing through it to the working cylinder: that side of the regenerator which was next the latter being always very hot; and that, at which the cold air entered, being always comparatively cool. The excess of pressure on the piston in the working cylinder, above that on the piston in the supply cylinder, constituted the power. When the air was heated to 480°, its volume was doubled, so that the pressure, per inch, on each piston was the same; but as one of them had twice the surface of the other, it was acted on by a double pressure. It was asserted that, with this arrangement, only one-tenth of the entire heat was wasted. But any apparatus, capable of depriving steam, or air, of its heat, *in transitu*, must retard its progress, and, therefore, must diminish its effect. The bad conducting power of air must cause it to absorb or relinquish heat slowly, and with difficulty. And the cylinders required are enormous: in Ericsson's sixty-horse engine, the larger were *six* feet in diameter; and in his marine engine, *fourteen*.

The extraordinary force exerted by *electro-magnets*, suggested electro-magnetism as a moving power. The writer of this article, some years ago, made a great number of experiments on this subject,* and he was led to the conclusion that certain properties, which he had found in combinations of electro-magnets, would always prevent their application in any useful way. All the experiments that have since been made with them, have established the soundness of the reasons on account of which he abandoned the attempt. A superficial view of the matter would lead to the impression that an electro-magnetic engine must be more efficient than a steam-engine of equal cost. But the expensive nature of the material it consumes; the complication of its machinery; the diminution of its power, by circumstances which cannot be avoided; and in many cases the uncertainty—we might almost say the capriciousness—of its action, must ever leave it very inferior to the steam-engine. And its warmest advocates have long since acknowledged† that, on the score of economy, electro-magnetism can never compete with steam. Indeed, the French Government, when it offered a prize of £2000 for a successful electro-magnetic engine, required only that it should not consume more than half a kilogramme, or about seventeen and a-half ounces, of zinc per horse-power per hour: in France this would cost tenpence, in England less, but much more than the same amount of steam-power. It is not difficult to show

* See Reports of the British Association for 1835, 1836, etc.

† Page's Letter to the Government of the United States in 1850.

that it *must* be more expensive to maintain an electro-magnetic engine in action, than a steam-engine capable of doing the same work. One grain of zinc was found to raise only *eighty pounds* one foot high; but one grain of coal, in the furnace of a Cornish engine, will raise *one hundred and forty-three pounds*, through the same distance. The cost of one hundred-weight of coal is *nine* pence, that of one hundred-weight of zinc about *two hundred and sixteen* pence. Hence, electro-magnetic power is nearly *fifty times* as expensive as that obtained from steam. It has been asserted by Liebig, that the zinc of the battery cannot give out more power than the coal required to smelt it; and that the *heating* power of a galvanic battery is the equivalent of its *mechanical* power; so that, if applied to the vaporization of water, the steam produced by the heating power would do as much work as can be expected from its application to an electro-magnetic machine. Favre has shown that the heat liberated from a galvanic battery is proportional to its chemical action; and that the mechanical work performed by the current always incurs an expense of the heat, borrowed from that which is evolved by the battery. It is worthy of notice that when an effect opposite to the magnetic attraction is produced —as, for instance, when magnetized bodies are forcibly drawn asunder—the heat is augmented. It has been ascertained that, using "Joule's unit," one pound of zinc consumed in a Grove's battery would, if the heat were utilized, raise 1,698,000 pounds one foot high; and one pound consumed in a Daniell's battery, 1,019,000 pounds. But 1,698,000 pounds raised one foot high, are equivalent to only one horse-power, during fifty-one minutes. These, besides, are the maximum *theoretical* effects; but, from the imperfect nature of the electro-magnetic machine, nothing like them are really attainable. If, as Joule supposes, heat is changed into mechanical effect during the action of the engine, the maximum power of even a perfect electro-magnetic machine must be far less than is produced with the same expenditure, by steam. Liebig observes that, according to the experiments of Despretz, six pounds of zinc combining with oxygen give no more heat than one pound of coal, and that, therefore, the coal should produce six times as much power as the zinc.—We may remark, that the heat given out by the zinc was that with which it combined during smelting, and was obtained from the fuel. It would follow, that the power of the electro-magnetic machine is derived from the same source as that of the steam-engine, but is not obtained so directly.

It has been replied to some of these facts, that electricity, and not heat, is required for electro-magnetism. But that galvanic battery which produces most heat—a single cell of large size—produces also most electro-magnetism. And intensity is required, only because of the resistance which a great length of wire offers to the current. If heat and electricity are not merely modifications of the same element, they are certainly most intimately connected, and are always found associated.

Besides all this, the force of electro-magnets diminishes rapidly through space. One which retained two hundred pounds in contact at one-fiftieth of an inch, lifted only forty pounds and a-half, or about one-fifth. Also, the disturbance caused by the motion of the electro-magnet, or of its sub-magnet, greatly diminishes the power. A magnet which, when free from disturbance, possessed a force of one hundred and fifty pounds, fell to one-half when the sub-magnet, or armature, was made to revolve near its poles. Moreover, the very change of the electric current causes a diminution of its effect: since the secondary current is generated, moves in a direction opposite to that which produces the required motion. Time also is necessary for magnetization; and on account of the secondary current, for de-magnetization also.

Experiments in electro-magnetism as a motive power, have been made on a scale large enough to leave little uncertainty regarding it; governments and public bodies having, in some instances, granted liberal aid to the experimentalist. Page received twenty thousand dollars, or about four thousand pounds sterling, towards the expenses of his experiments. The most sanguine hopes of a successful result have been frequently entertained.—Jacobi, in 1839, propelled a boat on the Neva; but he obtained only one horse-power from *twenty square feet* of platina battery surface. Davidson, in 1842, ran a locomotive, weighing five tons, on a railway near Glasgow: but with a speed of only five miles an hour, which was equivalent to one horse-power; yet he required *seventy-eight pairs* of thirteen-inch plates of iron and amalgamated zinc. Page, in 1850, reported to the United States Government that he had then succeeded in obtaining, at the rate of one horse-power, during twenty-four hours, for twenty cents, or about tenpence British; and he stated, in a subsequent letter, that he had constructed a ten-horse engine. Nevertheless, it was announced some time after, by one of his friends, that he had given up the experiment, as the twenty thousand dollars, and a large sum besides, had been expended on it. His engine was an ingenious and powerful development of De la Rive's ring; and when one of his large helices was magnetized, three hundred pounds, weight of iron, which had been placed within it, was lifted up by the magnetic power, and as long as the electric current was transmitted, remained suspended in the centre—realizing the fabled suspension of Mahomet's coffin. Allen's electro-magnetic engine was inspected by the present Emperor Napoleon, and was exhibited, by his desire, at the *Conservatoire des Arts et Métiers;* he even appointed a commission of scientific men to examine and report upon it, being, as was stated, so pleased with it that he intended to purchase the invention. But, like every preceding attempt, it ended in nothing.

We have now, as far as our limits would permit, noticed the various sources from which motive power has been, or was expected to be, derived. Every experiment that bears on the subject seems to indicate that all motive power is ultimately reducible to *heat*, or at least is proportional to it. And, if such be the case, the only useful object for which our experiments can be made, would be to discover the most economical means of obtaining, and the most effectual mode of applying, heat. One important conclusion follows from what has been said, that if it is not absolutely impossible to discover a prime mover which shall supersede steam, success is so difficult, and beset with so many obstacles, that prudence suggests great caution, both in contriving and adopting any principle or machine having this for its object. On the other hand, it is clear that excellent as the steam-engine undoubtedly is, only a small portion of the heat required by it is effective in producing motion; and, therefore, it affords abundant opportunities for ingenuity to distinguish itself, and for enterprise to secure profit, in further perfecting its details.

ON FLUKES.

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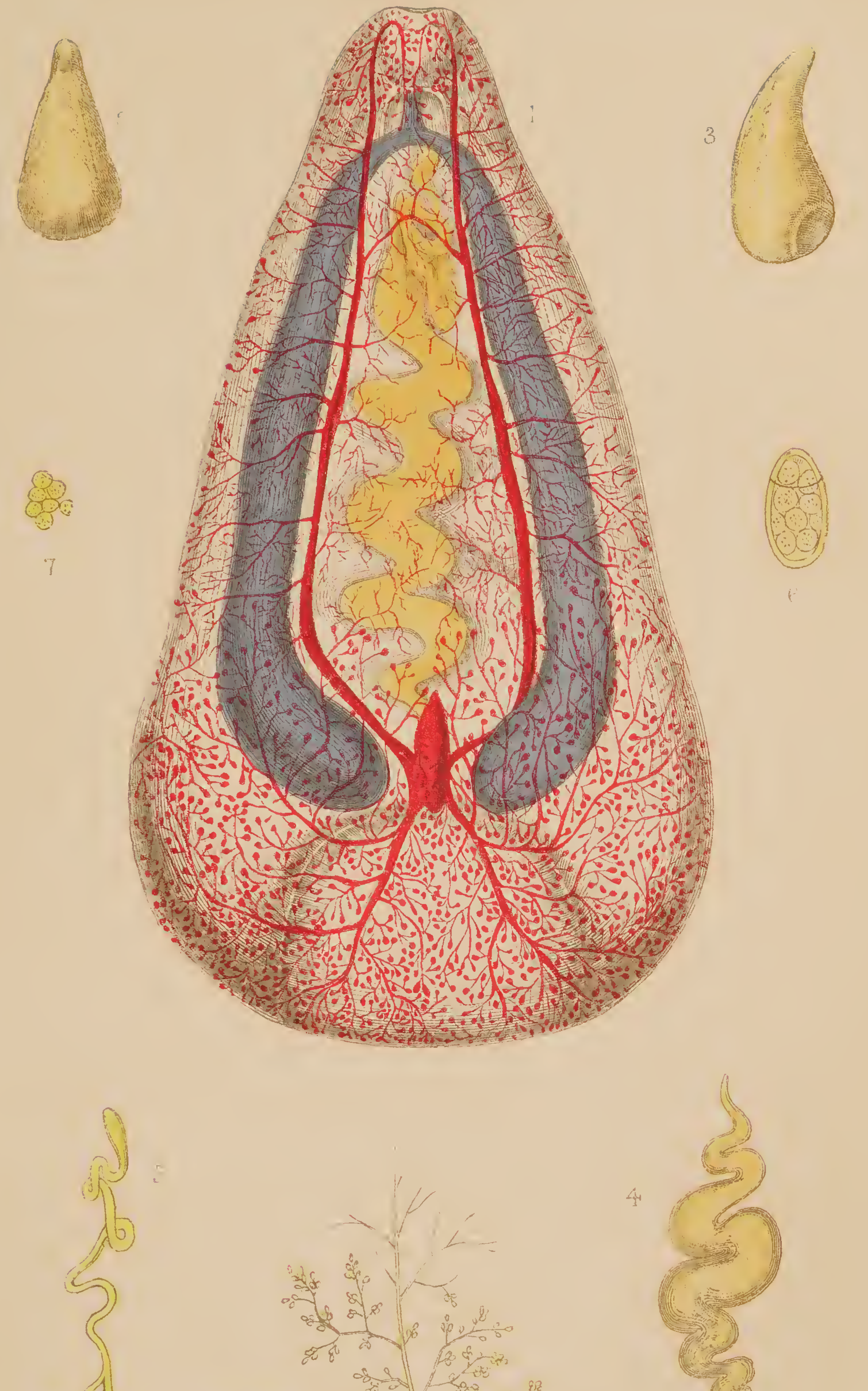
Flukes constitute a numerous group of diminutive beings who enjoy the privilege of snugly ensconcing themselves within the interior of other living animals. That eminent parasitologist, Alexander von Nordmann, well expressed the unpleasing sensations which pervade the human mind when first induced to contemplate the curious variety of creatures destined to inhabit so strange a dwelling. "Who," he exclaims, in the opening section of his valuable *Mikrographische Beitrage*, "who that did not witness the fact, could possibly have believed that Nature had formed living animals to grope for their existence in the interior of other beings so advanced in the scale of organization, not only, indeed, in the higher, but even in the highest! Nevertheless, such is the case. Man shrinks when he first hears of it; he stands aghast



Amphistoma conicum

when he first beholds it; and words fail to express the peculiar feeling of awe and aversion of Nature which creeps over him when he discovers the thing, that appeared to him incredible, to be a simple matter of fact."

Nearly thirty years have elapsed since the Russian professor penned this prologue, and it must be conceded that our recent helminthological discoveries have, as yet, done little calculated to chase away such prejudice from the public mind. Perhaps, of all the paradoxes enunciated by creative wisdom—in so far as they affect the economy of organic being—none are more likely to excite astonishment than the truths which demonstrate the curious phenomena of parasitic life; yet, we make bold to number ourselves with those who believe in "necessary evils," and in the following pages undertake to show how a nearer acquaintance with the objects of our study can impart that "enchantment to the view" which is commonly regarded as an effect of distance.

The first group of parasites to which we invite attention are the "flukes," as they are popularly termed; but not unfrequently we shall speak of them as trematodes, or *Entozoa* of the order *Trematoda*, which signifies that they are *internal* parasites, suctorial worms, or helminths, generally characterized by the possession of certain pores or openings. The Greek word, τρηματωδης, from which the ordinal title is derived, means *perforate.* Other parasites, it is true, display a variety of openings and sucking disks, but we shall find them associated with several distinctive peculiarities, into the consideration of which it were now a loss of time to enter.

Flukes are not parasitic during the entire period of their existence, for whilst passing through the cycle of their life-development, they frequently change their residence, at times inhabiting either open waters or the dewy moisture of low pasture grounds. Their strange migrations, active and passive, from parasitic to non-parasitic abodes, will be discussed hereafter. In the adult condition flukes abound in all classes of vertebrated animals; that is to say, in fishes, reptiles, birds, and mammals.

To convey a more precise idea of their distribution, we may observe that flukes are sparingly found in man and monkeys. They are still less frequent in the higher carnivora; none, to our knowledge, having hitherto been detected either in the lion or the tiger. In the common cat, however, two species are known, one proper to its wild, and the other to its domesticated state. Only a few infest the dog and fox, and they are almost entirely absent from the civets and ichneumons; the exception to the rule occurring in the Indian Viverra, in the lungs of which the writer has discovered a small species.

Flukes are abundant in the nocturnal bats; they are scarcely less so in the insectivorous moles and shrews, whilst at least three distinct forms traverse the body of the unfortunate hedgehog. As yet, none have been descried in the bears, properly so called, but a single species is known to infest the closely allied badger. Weasels and others are peculiarly liable to invasion, and the same may be said of the amphibious seals. Among the herbage-loving rodents the squirrels and marmots are not usually subjected to their attacks; but an Italian, named Targione Tozzetti, is said to have detected the common liver-fluke in our familiar *Sciurus vulgaris*. Even rats and mice are tolerably free from trematodes, yet they harbour an immense variety of other helminths. Flukes, like ourselves, rejoice in the flavour of hares and rabbits, but they utterly repudiate a residence within the body of the uninviting sloth. Our domesticated quadrupeds, such as the horse and ass, are seldom troubled with their presence; but swine, on the other hand, are peculiarly annoyed in this respect. Speaking generally, they are prevalent in all ruminating herbivores, being grievously numerous in sheep and cattle.

Turning our attention to the feathered tribes, on the whole it may be said that flukes are scarcely less abundant in birds than in mammals. Hitherto we have not met with them either in the flesh or viscera of pigeons, parrots, or even in the insect-eating woodpeckers; but, as might be expected, they are of remarkably frequent occurrence in the alimentary canal of gulls, herons, storks, cranes, plovers, ducks, and other water birds.

Flukes readily gain admission within the bodies of the cold-blooded reptiles, and display an abiding partiality for the batrachian frogs and toads. In the water-loving salamanders they occur less numerously; and in the saurian, chelonian, and ophidian orders they are comparatively unknown. In members of the piscine class they are almost always present, being markedly plentiful in the stickleback, minnow, tench, perch, pope, bull-head, mackerel, trout, salmon, ling, burbot, turbot, flounder, lump-fish, sander, and dorado; and still more so in the perch, pike, barbel, bream, eel, sole, sun-fish, and sturgeon.

A contemplation of these cursorily recorded facts can scarcely fail to suggest several peculiarities respecting the distribution of these creatures. That worthy helminthologist, Carolus Asmund Rudolphi, to whose investigations we owe so much, long ago remarked that the entozoa constituted a distinct *fauna*, or, in other words, a special collection of animals whose country is the circumscribed region of the interior of living beings. We may carry the simile further, and compare each creature thus infested to an island home, whose parasitic inhabitants having a tendency to roam, not unfrequently visit adjacent isles, that is, the bodies of other animals. Taking a wider view in the matter, it is obvious that the distribution of internal parasites, throughout *space*, must be co-equal and co-extensive with the geographical range of the animals in which they dwell; and it also follows that they will have acquired a corresponding distribution in *time*. Their bathymetric position or distribution in height and depth in relation to our planet, will also accord with that of the infested creatures; in short, the length, breadth, and area of their geological and geographical range will be identical with that of the vertebrate groups whose individual members they inhabit.

This subject becomes yet more strikingly suggestive when we take into consideration the complicated facts and phenomena which the various phases of parasite development unfold; for during their larval wanderings in search of a final resting-place which shall prove suitable to their adult condition, they provisionally occupy the bodies of different kinds of evertebrata; and in order to complete the genetic cycle of the parasite's life, there must needs be, of course, a contemporary existence of both vertebrate and evertebrate types, a concurrence which surely no reasonable person would ascribe to fortuitous circumstances. Further into this speculative inquiry we do not now enter, having purposely suspended our record of the origin, growth, and migration of the young flukes, until we have discussed the features of their adult structure. Meanwhile, however, it is but fair to acknowledge that we have diligently sought for a more practical evidence of the existence of internal parasites in ancient times. This we have done by scraping down portions of fossil excrement, and submitting them to microscopic observation, in the hope of possibly stumbling upon a parasite's hook or spine. Success in this experiment would have enabled us triumphantly to vindicate the force of our persuasion as to their pre-adamite creation; but as the question now stands, few naturalists can doubt their former prevalence. Of course, a searching like the above, can hardly ever prove effective, for the delicacy of their tissues, the minuteness of their bulk, and more particularly, the extreme rarity of their being mixed up with the eliminated products of the alimentary canal, are considerations which almost warn us of the hopelessness of such investigation. If, however, real colo-lites, or fossil sections of the digestive tube of any of the larger extinct vertebrates could be obtained, then we should not entirely despair of recording ocular proof of the occurrence of Entozoa in the secondary and tertiary epochs.

In regard to the number of existing species of Trematoda, no very accurate estimate can be formed. The writer of this article, not very long ago, made a special investigation, partly with the view of determining this point, and the results of this inquiry are embodied in a lengthened "Synopsis of the Distomidæ," published in the fifth volume of the "Journal of the Proceedings of the Linnæan Society." In that communication 344 different species of flukes were recognized; and of these, 126 are proper to fishes, 47 to reptiles, 108 to birds, 58 to mammalia, and 5 to non-vertebrated animals. This list, however, does not include certain leech-like forms of fluke (such as are described by parasitologists, under the generic titles of *Tristoma*, *Polystoma*, *Gyrodactylus*, and the like), the greater part of which ought rather to be considered Ectozoa than Entozoa, inasmuch as their habit is to attach themselves to the external surface of the bodies of the creatures they attack. No doubt, in the above record, many immature forms have been regarded in the light of distinct species by the older authors; but when, on the other hand, we take into consideration the additions which have been recently made—especially by Professor Molin of the University of Padua and by the writer himself—and also the probably much larger number of forms which remain undiscovered, it becomes evident that, at the very lowest estimate, we may assume the order Trematoda to comprise five hundred species.

Flukes are small animals, usually visible to the naked eye, but seldom attaining any very significant bulk, some of the minutest forms scarcely exceeding the $\frac{1}{100}$ of an inch in longitudinal diameter. The species most commonly known (*Fasciola hepatica*) is capable of attaining a length of rather more than an inch, and there are four other flukes whose measurement is considerably beyond this. These four notables, deserving special mention, are the following:—

1. The *Distoma crassum*, fourteen of which were discovered by George Busk, Esq., F.R.S., in the alimentary canal of a Lascar. The original description states that "these flukes were much thicker and larger than those of the sheep, being from an inch and a half to near three inches in length." One example may be seen in the Museum of the Royal College of Surgeons, Lincoln's Inn; and a second in the Museum of the Middlesex Hospital Medical College.

2. The *Distoma veliporum*, procured by Professor Otto, of Breslau, from the stomach of a large Mediterranean shark (*Squalus griseus*). This fluke acquires a length of fully three inches.

3. The *Fasciola gigantea*, a trematode of equal longitude, and rather broader than the last named. Forty specimens were found by the writer in the liver of a young giraffe, which died in Wombwell's travelling menagerie, at Edinburgh, during the severe winter of 1854-55.

4. The *Distoma gigas*, discovered and described by the

Italian naturalist Nardo. This is the longest fluke-worm known; it attains a length of no less than five inches, and has hitherto been found only within the stomach of a large fish (*Luvarus imperialis*), which frequents the Adriatic Gulf and the coasts of Sicily.

The ordinary aspect of these creatures is not such as would, at first sight, recommend itself to the attention of the general observer; yet those who will take the trouble to submit them to microscopic examination will find their senses gratified, not only by the evidence of a fair exterior, but by the exhibition of elegantly-grouped internal organs. If, further, a satisfactory attempt be made to inject some of the larger species, the beauty of the specimens will be thereby increased tenfold. To be completely successful, however, finely-pointed syringes must be employed, aided by the most careful and delicate manipulations. Up to the present time, indeed, we believe that the so-called vascular system of the trematoda has been efficiently injected only by M. Emile Blanchard, of Paris, and by the author of this communication.

The introduction of pigments not only renders the objects more attractive in appearance, but, at the same time, facilitates our comprehension of their anatomical peculiarities. In the illustrations, therefore, here or in future selected, to render this subject clear, we shall employ colouring as follows:—

Blue for the digestive system. Hitherto we have found artificially prepared ultramarine to answer the purpose admirably. Specimens of flukes from the giraffe, thus injected by the writer, may be seen in the Anatomical Museum of the University of Edinburgh, and in the author's private collection of Entozoa.

Red for the water-vascular system. The distinguished disciple of Baron Georges Cuvier, above-mentioned, has here employed vermilion, and we have adopted the same plan. The principal figures in the accompanying plates will be, in part, taken from the inimitable drawings of Blanchard, as given by him in Victor Masson's imperial-octavo edition of "Le Règne Animal," and in the eighth volume of the Zoological division of the third series of the "Annales des Sciences Naturelles." From the extreme beauty of the representations just referred to, some parasitologists have been led to question their accuracy. Recently, however, the writer had the satisfaction of convincing an eminent German naturalist that his surmises in this respect were fallacious; for, on exhibiting to him two similarly injected flukes from the author's own collection, he credited the French helminthologist with the highest manual skill, to which we believe him to be justly entitled.

Yellow for the reproductive system. This colour is usually more or less present in the organs included under this group of structures, owing particularly to the presence of multitudes of minute eggs, whose shells are highly tinged. Two shades will be introduced; namely, *orange-yellow* to characterize the female tissues, and *pale yellow* to represent those of the opposite sex.

Other pigments may be occasionally employed, where the natural colouring of the skin, or other special circumstances, seem to render their exhibition suitable.

The fluke which we have first selected for description and illustration is the cone-shaped amphistome, or *Amphistoma conicum* of Rudolphi. This parasite is common in oxen, sheep, and deer, and it has also been found in the Dorcas antelope. This amphistome almost invariably takes up its abode in the first stomach, or rumen, attaching itself to the walls of the interior. In the full-grown state it never exceeds half an inch in length; but in the accompanying plate we have purposely given a large central figure (1), representing the fluke magnified ten diameters linear, whilst the upper figures (2 and 3) respectively afford an anterior and lateral view of the same individual. If closer inspection be made, it will be seen that the animal is furnished with two pores or suckers, one at either extremity of the body, the lower being by far the larger of the two. By means of the latter the amphistome anchors itself to the papillated folds of the paunch, or first stomach, as this organ is improperly called.

In the central figure the following structures may be remarked. The oral sucker at the anterior end, or head, as it is termed, leads into a narrow tube forming the throat or œsophagus, and this speedily divides, or rather widens out, into a pair of capacious canals. These cavities are correctly regarded as together constituting the stomach; but they are cæcal, that is, closed below, having no other outlet than the entrance above mentioned. Hence we justly infer that nearly all the materials or juices received into the body of the fluke are in a fit state to be at once absorbed into the system; yet it is not at all improbable that indigestible particles are occasionally expelled from the mouth, when the cæca are overdistended by their accumulation. On examining flukes it is very common to observe this engorgement of the alimentary canals, and, taken in connection with other characters, it affords the parasitologist a ready mode of ascertaining to what *genus* the Entozoon belongs. In most flukes the digestive canal is thus simple and divided; but in Fascioles, as we shall subsequently illustrate when describing the common liver fluke, it is strikingly dendritic or regularly branched.

The water-vascular system next demands our attention.

The vessels thus named vary greatly in disposition, not only among the flukes, but also in other orders of parasites. This circumstance, along with other considerations, has given rise to much discussion as to their nature and function. Into the debate we do not now propose to enter, but may remark in passing, that there do not appear any very good grounds for considering them equivalent to the true blood-vessels of other invertebrated animals. In the present example, however, it will not be denied that the vascular arrangements bear a very striking resemblance to that of arteries or veins; and the centrally-placed pouch (as shown in Fig. 1 of the accompanying plate) might very easily be taken to represent the heart. This large cavity gives origin to two primary trunks, which pass forward along the inner sides of the digestive cæca; in their passage they send off secondary branches which divide and subdivide until we arrive at a series of minute capillary ramifications, the latter, according to Blanchard, terminating in small oval-shaped sacs or lacunæ. The last-named organs are placed immediately beneath the skin, and appear to have a special connection with that structure, the nature of which will be subsequently considered. Whatever may be the significance of these lacunæ—and on this point much might be said—all will agree that the arrangement of the vessels in connection with them is extremely beautiful. Hitherto no one has discovered any external outlet to the central pouch; yet, in all probability, such an opening exists. Several observers have considered this water-vascular system as directly connected with the organs of digestion; but, in maintaining this opinion, they are clearly erroneous.

In an anatomical and physiological point of view, the study of the reproductive system possesses high interest. Nearly all the flukes are hermaphroditic, that is to say, each individual is at one and the same time both male and female. In the large Figure (1) the essential organs connected with this system are only partially indicated. The central tortuous canal is the so-called uterus; this, as shown in the dissection below (Fig. 4), communicates with two rounded sacs, one in front of the other; in this situation it also subsequently divides into two tubular branches; these tubes pass right and left, one to either side of the body, and curving upwards, after the fashion displayed in the drawing, they branch out into exquisitely delicate ramifications which terminate in little grape-like bunches. In different kinds of flukes these botryoidal structures display a variety of appearance, and are collectively denominated the yelk-forming organs. The germs of the future eggs are developed in a separate glandular body called the ovary, which latter, in the present species, is probably represented by the larger of the two vesicles seen at the junction of the lateral ducts leading from the branched organs above described. The smaller sac lying in front is, in all likelihood, an accessory pouch in which the germs become surrounded by the yelk-particles or granules; the essential act of fertilization is, likewise, herein effected at the same time, by the presence of Spermatozoa which have succeeded in gaining access to the pouch. After a while, the perfectly developed eggs descend into the broad uterine tube, and by their numerous presence impart a deep yellowish or orange-brown colour to this organ. The ova themselves are very small, the largest being about the $\frac{1}{150}$ of an inch long, and $\frac{1}{250}$ of an inch broad. The example here drawn (Fig. 6), was taken from an Amphistoma, which, with many others, the writer obtained from the paunch of a Zebu, formerly living in the Zoological Society's Gardens, Regent's Park. The illustrations on the opposite side of the plate represent the male reproductive elements, the lower one (Fig. 5) showing the two largely developed testes, which are irregularly divided into five or six lobes; the latter consisting of numerous smaller lobules. From each of these glands there passes off a duct or *vas deferens*, the two afterwards combining to form a single channel; this becomes enlarged towards the end, where it constitutes a sheath for the lodgment and protection of the intromittent organ. The small pencillings higher up (Fig. 7) represent the sperm-cells, containing extremely minute Spermatozoa. In the Amphistome, as in most flukes, the external reproductive orifices terminate separately, and near each other, at the anterior third of the body, their position being generally indicated by a smooth, oval-shaped, papillary eminence.

A nervous system has been described (by Laurer and Blanchard) in Amphistomes. It consists of two so-called cerebral ganglions representing the brain; and from each of these there passes off on either side a chain of smaller ganglia, all of which distribute nerve filaments to the skin. As similar arrangements obtain in other flukes, we shall only here further remark that no one has hitherto discovered any organs of special sense in the true Trematodes or Flukes.

It remains for us further to observe, that the surface of the Amphistome, though quite smooth to the naked eye, is clothed with a series of minute tubercles, which may be readily brought into view under a half-inch object glass. Beneath the cuticle we find a layer of cellules forming the true skin; and beneath this, again, there are two, if not three, layers of muscular fibre; an anterior longitudinal series, and an inner circular set being readily distinguishable. The substance of the body is traversed by bands of cellular parenchyma or connective tissue, which here and there form thickened sheaths for the support of the various delicate organs above described.

The larval condition of *Amphistoma conicum* is at present unknown, but in all probability it lives in or upon the body of snails. This we infer from the circumstance that the larvæ or *cercariæ* of a closely allied species—the *Amphistoma subclavatum,* which infests the alimentary canal of frogs and newts—have been found by Professor de Filippi of Turin, and by Dr. Pagenstecher of Heidelberg, on the surface of the body of various species of *Planorbis;* whilst Professor Van Beneden, of the Louvain University, has discovered the larvæ in various species of *Cyclas.*

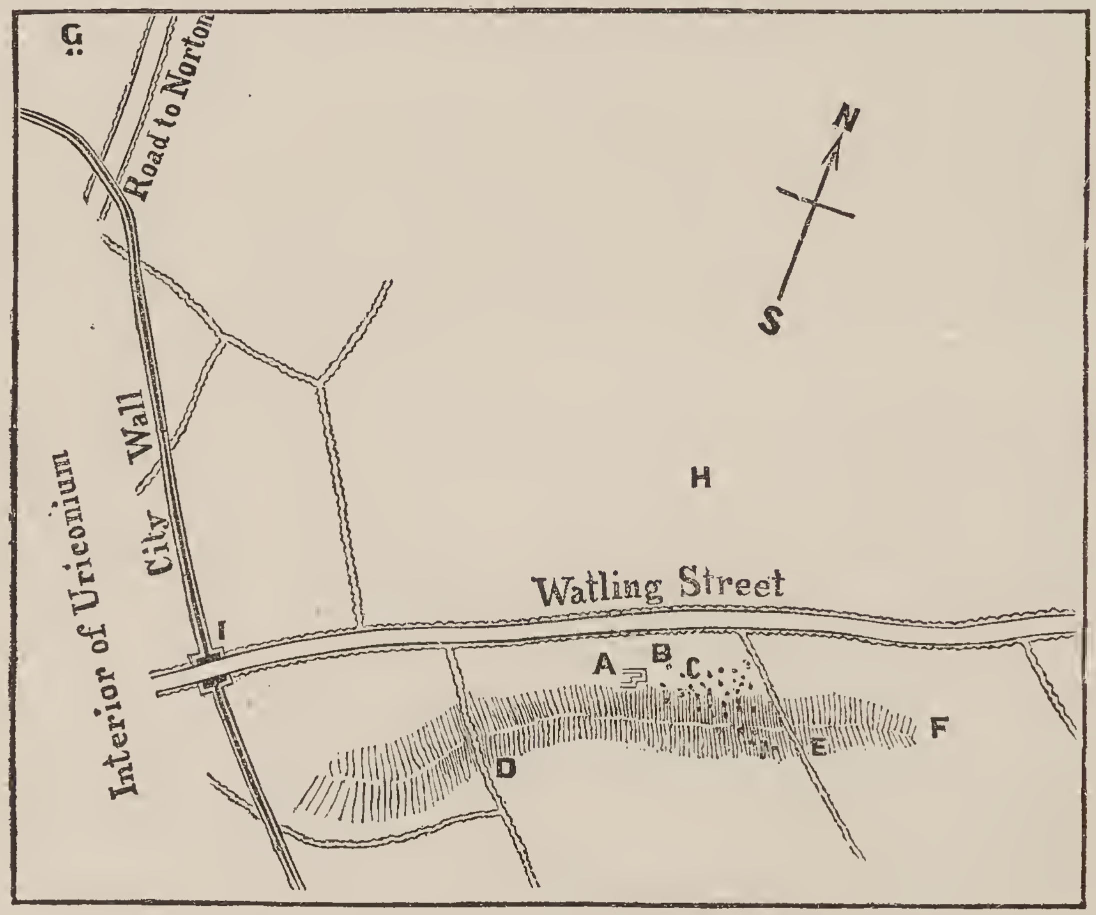
There can be little doubt, therefore, that some of the water snails harbour the larvæ of *Amphistoma conicum;* and, as a natural consequence, when deer, sheep, or cattle resort to ponds or running streams for the purpose of quenching their thirst, they swallow, accidentally, as it were, the aforesaid pond-snails. The cercariæ, or larvæ, are thus transferred to the paunch, where, attaching themselves to the walls of the interior, they complete their final stage of development.

THE ROMAN CEMETERY OF URICONIUM, AT WROXETER, SALOP.

BY THOMAS WRIGHT, M.A., F.S.A.

For several reasons, among which not the least was the want of funds, the excavations at Wroxeter on the site of the Roman city of Uriconium were discontinued during the spring and summer of the past year (1861), and further delay was caused in the autumn by the necessity of waiting until the crops had been cleared off from the ground. It had been determined to commence operations on this occasion upon the site of the principal cemetery of the Roman city, which lies at a considerable distance from the former excavations. At length, in the month of September, the ground was very liberally placed at the disposal of the Committee of Excavations by the tenant-farmer, Mr. George Juckes, of Beslow, and the men were employed in exploring this ground, by means of trenches, from the middle of that month to the end of November.

A slight plan of the ground will enable us best to explain the object and progress of these excavations. It may be premised that the invariable custom of the Romans forbade the burial of the dead within the limits of a town, for religious as well as sanitary motives. This rule was strictly adhered to in all the Roman towns in Britain which have been to any degree explored. It was followed in Uriconium, where the principal cemetery lay outside the eastern gateway, bordering the road which led towards Londinium (London), and which is now called the Watling Street. In most of the Roman towns in this island, we find that the principal cemetery lay, like this, on the road leading to the chief town in the island; but we can point out another motive for selecting this locality at Uriconium, in the circumstance that it was the highest ground round the city, and the least exposed to be overflowed by the floods



SITE OF THE CEMETERY OF URICONIUM.

from the Severn. In our cut, the letter I marks the site of the eastern gate of the city of Uriconium, the dark line representing the line of the town wall. The Watling Street, as will be seen, runs from it in nearly an easterly direction. To the south the ground rises from the road in a gentle bank, the brow of which, in the field where the excavations have been chiefly carried on, is marked by the shading from D to E. Attention had been called to this locality by the accidental discovery, it is supposed not far from the spot marked E, of seven slabs of stone bearing interesting sepulchral inscriptions, which are still preserved in the Library of Shrewsbury School. This discovery furnished at least a very strong presumption that this field formed part of the cemetery, and trenches have been carried from the hedge separating it from the Watling Street road over the whole extent of the bank, and further over the field to some distance to the south. One of the first discoveries, made at the spot marked B, low down on the slope of the bank, was a very important one—a thick slab of stone was found lying on its face, on which, when raised, a rather long and very well incized inscription was found, probably as early as the second century, commemorating a soldier, whose name appears to have been FLAMINIVS. T. POL. F. (the latter letter, of course, standing for *filius*), who was forty-five years of age, and had seen twenty-two years of military service. Unfortunately, the inscribed side of the stone has been much rubbed, and the inscription has not yet been completely deciphered. Further exploration showed that the whole of this end of the bank was filled with interments, consisting of cinerary urns and their usual accompaniments, which appeared to have been put into the ground in rows. These interments covered the ground marked in our plan with dots. Trenches, carried further towards the ancient town wall, or beyond the bank across the field, gave no traces of burials, so that this appears to have been the extremity of the burial-ground towards the town. The cemetery probably extended over the next field F, which cannot conveniently be excavated until the autumn of the present year. The excavators have since been employed in the field H, on the other side of the Watling Street, in the farm of Mr. Bayley, of Norton, but no discoveries of sepulchral interments were found there, and the cemetery would thus appear to have been confined to the southern side of the road. An accidental discovery, however, led to the examination of a garden in the hamlet of Norton, at G in our plan, and there was found one well-defined interment, besides traces of others. It is not improbable, therefore, that the tombs of the citizens were scattered over the ground outside the walls along the greater part of their extent. We have not only by these excavations ascertained the site of what was evidently the principal cemetery of Uriconium, but we have obtained a number of objects and ascertained a number of facts, which illustrate the manners of the inhabitants of Uriconium, and show us how entirely conformable they were to those of the Romans in their native Italy.

When we use the word *cemetery*, we do not of course intend it to be taken strictly in its modern sense, but merely to signify the locality where the sepulchral interments were collected together. The Romans did not inclose and consecrate a space of ground for burial purposes as we do in modern times, but the family of the deceased bought a bit of ground to bury him wherever they could obtain it to their own satisfaction, provided it was not within the walls of a town. The possessor of a villa in the country appears to have had his burial-place within the precincts of his own house, as was the case in the Roman villa recently uncovered at North Wraxhall, Wilts, by Mr. Poulett Scrope, and described in the Wiltshire *Archæological and Natural History Magazine* for October, 1860; and in that at Walesby, in Lincolnshire, described in the *Reliquary* for October, 1861. The inhabitant of a town, as we have just stated, bought himself a piece of ground outside the town; and from the circumstance of its being the repository of the dead, it became consecrated, and to trespass upon it was regarded as sacrilege. Nevertheless, the ground adjoining might be employed for any other purpose; and suburban houses and villas might be intermixed with the tombs, as was the case in Pompeii. In fact, the Roman seems, even when dead, to have still courted the proximity of the living, for he always by preference sought to establish his last home as near as possible to the most frequented road; and the inscriptions on his roadside tomb often contained appeals to the passers-by—in terms such as SISTE VIATOR (*stay, traveller*), or TV QVISQVIS ES QVI TRANSIS (*whoever thou art, passenger*)—to think on the departed. The epitaph on a Roman named Lollius, published by Grüter, concludes with the following words, intimating that he was placed by the roadside, in order that the passers-by might say, "Farewell, Lollius!"

HIC . PROPTER . VIAM . POSITVS
VT . DICANT . PRAETEREVNTES
LOLLI . VALE.

These examples will explain the position of the cemetery of Uriconium, and of those of the other Roman towns in Britain.

To explain the various objects which have been found in our excavations, it will be necessary to give a brief sketch of the formalities which attended death and burial among the Romans. The last duty to the dying man was to close his eyes, which was usually performed by his children, or by his nearest relatives, who, after he had breathed his last, caused his body first to be washed with warm water, and afterwards to be anointed. Those who performed this last-mentioned office were called *pollinctores*. The corpse was afterwards dressed, and placed on a litter in the hall with its feet to the entrance door, where it was to remain seven days. This ceremony was termed *collocatio*, and the object of it is said to have been to show that the deceased had died a natural death, and that he had not been murdered. In accordance with the popular superstition, a small piece of money was placed in the mouth, which it was supposed would be required to pay the boatman Charon for the passage over the river Styx. In the case of persons of substance, incense was burnt in the hall, which was often decked with branches of cypress, and a keeper was appointed, who did not quit the body until the funeral was completed. The public having been invited by proclamation to attend the funeral, the body was carried out on the seventh day, and borne in procession, attended by the relatives, friends, and whoever chose to attend, accompanied by musicians, and sometimes with dancers, mountebanks, and performers of various descriptions. With rich people, the images of their ancestors were carried in the procession, which always passed through the Forum on its way to the place of burial, and sometimes a friend mounted the rostrum and pronounced a funeral oration. In earlier times the burial always took place by night, and was attended with persons carrying lamps or torches, but this practice seems to have been afterwards neglected; yet the lamps still continued to be carried in the procession. Women, who were called *præficæ*, were employed not only to howl their lamentations over the deceased, and chant his praises, like the Irish keeners, but to cry also; and their tears, it appears, were collected into small vessels of glass, and this circumstance is termed, in some of the inscriptions found on the Continent, being "buried with tears,"—*sepultus cum lacrymis*,—and the tomb is spoken of as being "full of tears."—TVMVL . LACRIM . PLEN.

The next ceremony was that of burning the body. In the earlier ages of their history the Romans are said to have buried the bodies of their dead entire, without burning; and there seems to be no doubt that, at all events, the two practices, burning the body and cremation, existed at the same time, but the latter appears to have become gradually more fashionable, until few but paupers were buried otherwise. In the age of the Antonines the practice of cremation was finally abolished in Italy, but the imperial ordinances appear to have had but little effect in the distant provinces, where the two manners of burial continued to exist simultaneously. Both are accordingly found in the Roman cemeteries in Britain, in interments which were undoubtedly not those of Christians. Perhaps the practices varied in different parts of the island, according to the usages of the country from which the colonists derived their origin. It is a circumstance worthy of remark that, as far as discoveries yet go, no trace has been met with of burials in the Roman cemeteries of Uriconium, otherwise than by burning the dead.

The funeral pile, *pyra*, was built of the most inflammable woods, to which pitch was added, and other things, which often rendered this part of the ceremony very expensive. An inscription, preserved by Grüter, speaks of some persons whose property was only sufficient to pay for the funeral pile and the pitch to burn their bodies—*nec ex eorum bonis plus inventum est quam quod sufficeret ad emendam pyram et picem quibus corpora cremarentur.* It had been ordered by a law of the Twelve Tables, that the funeral pile must be formed of timber which was rough, and untouched by the axe, but this rule was perhaps not very closely adhered to in later times. When the body was laid on the pile, the latter was sprinkled with wine and other liquors, and incense and various unguents and odoriferous spices were thrown upon it. It was now, according to some accounts, that the *naulum*, or the coin for the payment of the passage over the Styx, was placed in the mouth of the corpse, and at the same time the eyes were opened. Fire was applied to the pile by the nearest relatives of the deceased, who, in doing this, turned their faces from it while it was burning; the relatives and friends often threw into the fire various objects, such as personal ornaments, and even favourite animals and birds. When the whole was reduced to ashes, these were sprinkled with wine (and sometimes with milk), accompanied with an invocation to the *manes*, or spirit of the deceased. The reader will call to mind the lines of Virgil (Æn. vi. 226) :—

> Postquam collapsi cineres, et flamma quievit,
> Relliquias vino et bibulam lavere favillam,
> Ossaque lecta cado texit Corynæus aëno.

The next proceeding, indeed, was to collect what remained of the bones from the ashes, which was the duty of the mother of the deceased, or, if the parents were not living, of the children, and was followed by a new offering of tears. Some of the old writers speak of the difficulty of separating the remains of the burnt bones from the wood ashes, and we accordingly find them usually mixed together. When collected, the bones were deposited in an urn, which was made of various materials. The urn, in Virgil, was made of brass, or perhaps bronze. Instances are mentioned of silver, and even gold, being used for this purpose, as well as of marble, and those found in Britain are often of glass; but the more common material was earthenware. One of the performers in the ceremony, whose duty this was, then purified the attendants by sprinkling them thrice with water, with an olive branch (if that could be obtained), and the *præficæ* pronounced the word *Ilicet* (said to be a contraction of *Ire licet*, you may go). Those who had attended the funeral, thrice addressed the word *Vale* (farewell) to the manes of the dead, and departed. A sumptuous supper was usually given after the funeral to the relatives and friends.

In the case of people of better rank, the body was burnt on the ground which had been purchased for the sepulchre, but for the poorer people there was a public burning-place, which was called the *ustrina*, where the process was probably much less expensive, and whence the urn, with the remains (*relliquiæ*) of the deceased, was carried to be interred. The tombs of rich families were often large and even splendid edifices, with rooms inside, in the walls of which were small recesses, where the urns were placed. None of the buildings remain at Wroxeter, or, indeed, in any Roman cemetery in our island, but we can hardly doubt that such tombs did exist in the cemetery of Uriconium, and that they were scattered along the side of the Watling Street. At the spot marked A on our plan, the foundations of a small building were met with, which appeared to have consisted of an oblong square, with a rectangular recess behind, but the western portion of it has been destroyed by the process of draining. When opened, ashes and fragments of an urn were found in the inclosed space, so that it is not improbable that this may have been a tomb with a room. The inscribed stone already mentioned, which was found not far from this spot, bears evidence, in the appearance of its reverse side and in its form, of having been fixed against a wall, probably over a door; and the other inscribed stones, found in the last century, had probably been placed in similar positions. The urn was perhaps here interred beneath the floor of the room.

In more than one case in the cemetery of Uriconium, the dead body was certainly burnt on the spot where it was to be buried. At the spot marked C in our plan, we found undoubted evidence of cremation in the grave. A square pit had been dug, on the floor of which the funeral pile had been laid. My friend, Mr. Samuel Wood, of Shrewsbury, who was present when this pit was opened, remarked that the remains of the timber of the funeral pile still remained as it had sunk on the floor, the ends of which were unconsumed, and the earth underneath quite red from burning. Mr. Wood gathered up some fragments of melted glass among the ashes, the remains of some of the small vessels containing aromatics or unguents, which were thrown into the fire; and, he adds, in a letter on the subject, written at the time of the discovery, "One curious point I noticed, that you could positively tell from which direction the wind was blowing at the time of combustion, as one side of the hole was quite burnt and all the wood; whereas on the opposite side, the ends of the fuel were there, with the one end only charred. The wind was in the west, or W.S.W. This, of course, is quite unimportant; but one might venture a guess that it occurred in autumn, when the prevailing wind is from the west, or south-west." At the spot marked G in our plan, where considerable traces of Roman sepulchral interments were found in the garden of a cottage occupied by Miss Bythell, a similar pit was found, with this difference in its circumstances: in the former case, the soil into which the pit was cut is a clayey loam, which would itself form a tolerably firm wall; but the soil on the site of Miss Bythell's garden was a light and sharp sand, which would crumble in unless supported. In this case, therefore, the pit, which was somewhat more than six feet square, was lined with clay, both bottom and sides, to a thickness of twelve or fourteen inches; and the heat of the fire had been so great, that the clay was baked quite through; and even the sand beyond it, in its changed colour and appearance, showed evident marks of the action of fire. Mr. Wood, who was also present immediately after this grave was opened, described it as having somewhat the appearance of a large square baked vessel. The remains of the corpse had been collected, and deposited in a very large urn, which was placed upon some flat tiles, and supported and surrounded with clay and broken flue-tiles. Under it was found a coin of the emperor Trajan, of the description termed by numismatists second brass.

In most of the other cases of interment yet discovered in the cemetery of Uriconium, a small hole or pit appears to have been sunk in the ground, and the urn, which had no doubt been brought from the *ustrina*, was placed in it and covered up. These interments were not far distant from each other, and, as I have already remarked, appear to have been placed in rows, nearly parallel to the road. Perhaps the ground may have been bought for this purpose in common, by associations of the townsmen—such as trade corporations; or it may have been set aside for burial purposes by the municipal authorities, and sold in small portions to individuals, as the practice now exists in modern cemeteries. It may be remarked that the accumulation of soil above the Roman level is here very much less than in the interior of the ancient city, where we have to dig frequently from ten to twelve feet to reach it. The top of the clay walls of the pit in Miss Bythell's garden was from fourteen to sixteen inches below the present surface; and the inscribed slab, commemorative of Flaminius Titus, which was found lying on its face, probably on the original level of the ground, or very near it, was met with at about eighteen inches below the present surface. We may, therefore, probably reckon the accumulation of earth on the side of the cemetery at from eighteen inches to two feet. The average depth at which the urns have been found is somewhat less than four feet, so that the Romans seem to have dug pits about two feet deep for their reception.

These recent excavations in the cemetery have contributed

SEPULCHRAL URNS FROM THE ROMAN CEMETERY OF URICONIUM. *(Scale 2 inches to a foot.)*

a considerable number of urns, many of them perfect, and others so broken only as to be easily put together, to the Wroxeter Museum, in Shrewsbury. A few examples, with some of the jug-shaped vessels also found in the graves, are given in the accompanying cut. The urns, which are of baked earthenware, of different shades of colour, but mostly brown or red, are of coarse substance, but always more or less well-shaped, and vary very much in size. The largest we have yet found is about eighteen inches high. The jug-shaped earthen vessels were perhaps used to contain some liquids which were interred with the remains of the dead; but when found they were filled with earth. Our next cut represents a group of glass vessels and other objects found in the cemetery of Uriconium. We know, from allusions in some of the ancient writers, as well as from inscriptions, that tears, unguents, and aromatics, were sometimes thrown on the funeral pile, and sometimes interred with the dead—contained, as it may be supposed, in small vessels of glass. An inscription in Grüter describes the deceased as being "moistened with tears and balsam"—EVM . LACHRIMIS . ET . OPOBALSAMO . VDVM. The reader will call to mind, also, the lines of Tibullus (Eleg. lib. iii.; El. ii. l. 19), in which he speaks of depositing with the dead the precious products of Arabia and Assyria, as well as the tears of relations and friends :—

> "Et primum annoso spargant collecta Lyæo,
> Mox etiam niveo fundere lacte parent.
> Post hæc carbaseis humorem tollere ventis,
> Atque in marmorea ponere sicca domo.
> Illic quas mittit dives Panchaia merces,
> Eoique Arabes, dives et Assyria.
> Et nostri memores lacrimæ fundantur eodem.
> Sic ego componi versus in ossa velim."

These precious objects were probably contained in the small narrow glass phials which are so commonly found in the Roman graves, and which, in the belief that they contained only the tears of the mourners, antiquaries have designated by the name of lachrymatories. Some experiments, made by my friend Dr. Henry Johnson, of Shrewsbury, upon the earth contained in these glass vessels, seem to confirm the belief that they were not merely receptacles of tears. He writes to me on the 11th of November: "Respecting the lachrymatories, I have lately seen rather a confirmation of what you said about these having been filled with unguents, incense, or something of that kind, which would by heat yield much carbon or charcoal. I took two of these little glass vessels which had dark matter in them, and which had never been emptied. I put some of the dark matter under the microscope, and I could see pure red grains

ROMAN GLASS VESSELS AND POTTERY FROM THE CEMETERY OF URICONIUM. (*Scale 3 inches to a foot.*)

of the sand of the field,* and intermixed with these many visible particles of pure black carbon, evidently introduced artificially into the sand. On putting some of the soil in a platinum crucible, and heating it red-hot for a few minutes, *all* the charcoal was burned away, and I got a pure red sand like that of the cemetery. The contents of these two vessels were quite black, though I have no doubt they were found deeper than the superficial covering of black mould. One of them had evidently been subjected to fire, so that the supposition that this had been filled with some unctuous oblation, and then acted upon by heat in the funeral pile, is not at all improbable."

These glass vessels help to demonstrate that the same forms were observed by the Romans in their performance of the sepulchral rites in Britain as in Italy. Some of them are found greatly affected by fire, and have been no doubt placed on the funeral pile; others, on the contrary, are perfect, and have evidently never been in the fire, but were no doubt deposited with the urn. Examples of them, in both conditions, are given in our last wood-cut. The one in the middle of the three to the right has been thus affected by the heat in a lesser degree; but the other, lying on the ground beneath it, has been so much melted as to have lost its original shape.

A very usual accompaniment of Roman interments is the lamp, usually made of terra-cotta. There can be no doubt that, under the influence of sentiments with which we are not well acquainted, lamps were among the usual offerings to the dead, and that, when offered, they were filled with oil and lighted. They were found in the tombs at Pompeii, where they were probably placed in the recesses of the walls by the side of the urns of the dead. Their frequent occurrence under such circumstances gave rise to a number of old legends of the finding of lamps still burning in tombs of the ancients, who, it was supposed, had invented a material for the lamp which, once lighted, would burn for ever. One epitaph, found at Salernum, and given in Grüter, which commemorates a lady named Septima, expresses, in what appears to have been intended for elegiac verse, the wish that whoever contributed a burning lamp to her tomb, might have a "golden soil" to cover his ashes.

HAVE . SEPTIMA . SIT . TIBI
TERRA . LEVIS . QVISQ
HVIC . TVMVLO . POSVIT
ARDENTEM . LVCERNAM
ILLIVS . CINERES . AVREA
TERRA . TEGAT

* To explain this, it must be stated that the soil of the field, which is hardly two feet deep, lies upon a deep bed of pure sand, and that the interments had all been made in the sand in which the urns and other objects were found.

It is probable that the lamp was burning when it was placed in the grave with the urn. Two lamps only have been found in our excavations in the cemetery of Uriconium, which are represented in our last cut, and are of the same form which the Roman terra-cotta lamp almost invariably presents. In one of them the field is plain; in the other it is adorned with the figure of a dolphin.

The same scarcity which thus characterizes the lamps, is also to be remarked in the Roman coins, of which only one has yet been met with in the cemetery by the Watling Street, a second brass of the Emperor Claudius; and two in Miss Bythell's garden, one of Trajan, the other of Hadrian. The coin of Trajan was found under the urn, and must therefore have belonged to the interment; and, as it bears distinct marks of having been exposed to the flames, it has evidently been burnt with the corpse. The early date of these coins is worthy of remark, and though it does not necessarily prove the early date of the interment, it may perhaps assist in explaining their rarity. However large may have been the amount of true Roman and Italian blood among the founders of the town, the number of the inhabitants was no doubt kept up and probably increased in after times by recruits from other countries, perhaps much of it German; and these strangers to Roman feelings, when they accepted Roman manners and customs, may have neglected many of the minor details. Perhaps they were not convinced of the necessity of exporting the current coin of the state, in however small quantities, to the infernal regions, and they may have deliberately retained Charon's passage-fare. They may also have discontinued the practice of placing lamps in the grave, or it may only have been observed occasionally. It must at the same time be remarked, that single coins are the objects of all others most likely to escape the notice of the excavators.

Nearly all the graves, however, appeared to have contained the urns and the small glass phials; and in some there were other vessels of glass and earthenware, and among the latter some good examples of the well-known Samian ware. The vessel in the middle of our last cut is a large and remarkably handsome glass bowl, which was found among the graves on the side of the bank. Behind it is a flat dish of the light red ware, which is found rather plentiful among the Roman ruins at Wroxeter, and appears to have been manufactured in the district. The fractured vessel, to the right of it, has been a very handsome bowl of Samian ware. The vessel to the extreme left is a much more uncommon ware, of a lemon-yellow drab colour, and ornamented with rows of small knobs. All these vessels have no doubt contained the offerings of the living to the *manes* of the dead.

It may be remarked, in conclusion, that the comparatively slow accumulation of earth on the site of the cemetery explains easily the almost total disappearance of its monuments which stood above-ground. We learn from early writers, such as the historian Bede, that people went to the cemeteries of the Roman towns to seek for materials long before they began to break up the towns themselves, and as these materials must have lain for ages visible on the surface of the ground, and at the same time consisted probably of large and useful stones, they held out a stronger temptation to such depredators. Fortunately, the stones most likely to escape were those which contained inscriptions, because the people who had succeeded the Romans entertained a dread of all inscriptions which they could not read, believing them to be dangerous magical charms. Hence we find, here and there, an inscribed stone lying where it was dropped or thrown, when every other fragment of the monument to which it belonged has disappeared.

THE SKIPPER, SKOPSTER, OR SAURY.

BY JONATHAN COUCH, F.L.S.

Linnæus expressed the wonder he felt that animals could be created with such properties as to be able to pass their lives beneath the waves; but we, on the other hand, may express our wonder that creatures whose proper residence is in the waters should be able to raise themselves high above it, and thus imitate the birds in sailing through the air. Yet who has not heard of the flying-fishes? and what landsman, and woman too, has not wished that at least for a little space they could be transported to the scenes where such amusing sights are met with, and view, without the inconvenience of a voyage, the flight of these little creatures as they spring up in haste to escape the hurried chase of enemies below? But scenes like these may be witnessed without encountering the sea-sickness and dangers of the sea; and we possess among ourselves, for a portion of the year, a fish which, strange to say, is able to imitate the actions of the flying-fish, although not endowed like it with wing-like fins. In the summer and autumn this faculty is not unfrequently called into action, and in doing this it finds even a more certain safety than is the lot of the fish which is usually called by that name; for while the latter in its blind haste often falls into an equal amount of danger from that which it sought to escape, by dropping on the deck of a ship, we have never known the other to encounter a like misfortune. But it is time we should more particularly mention the name of the fish to which our remarks apply; this species, then, is the *Esox saurus* of Linnæus, and *Scomberesox saurus* of Cuvier; of which a larger representation, in its natural colours, will be given in the "Natural History of Fishes of the British Islands," now in the course of publication.

By the unlearned fishermen of the West of England, the name bestowed on this fish is the Skipper, or more broadly the Skopster, and by some observers it is called the Sea-mouse, on account of a motion it sometimes adopts; perhaps when not very closely pressed by a pursuer, or it may be, even in sport, for the most timid fishes have their sports, more even than their voracious pursuers, and very amusing sports they often are. On these occasions first one of these fishes darts above the surface of the deep, which at that time is perhaps as calm and smooth as a mill-pond. It appears to run along upon the surface without for a moment dipping beneath, but barely touching the water with the points of its pectoral and ventral fins; the action appearing as if it bounded along like a mouse as it quickly passes from one hole to another. But in its onward course this individual is not long alone, and in a few seconds a whole bevy of these fishes are engaged in the race, until, perhaps tired with the exertion, they sink below and all is over. On other occasions the true flying-fish is more closely imitated, and the action of flight is plainly accomplished by a single vigorous spring, in which the tail and finlets are the moving power, and by which they are carried aloft for the distance of thirty or forty feet, when they sink again in a sloping direction—it is to be feared, into the mouth of some voracious enemy that has watched their motions from below. In the flying-fish it is the pectoral fins which form the buoyant instrument of flight; but these in the skopster are of small size, and it is to their construction and manner of attachment to the body that they become fitted to the habits of the fish; their shape being so curved that it requires little effort to enable them to rise from their usual depth to the surface—as the wings of the lark enable it to rise and hover, in a manner, beyond the capacity of most other tenants of the air; and when the fish has reached the surface, the vigorous action of the tail and the small fins near it are sufficient to give an impulse which insures what follows.

To witness these actions in perfection, the observer on land would do well to be possessed of a good glass of the binocular kind, and to station himself, at no great height, on some projecting portion of the western coast of the kingdom, in the summer or autumn. But there must also be called into action not only some degree of good fortune, but no slight stock of that commendable virtue patience, for this is not an exhibition that can be got up at our own pleasure; and even when it does occur, the gratification may receive some alloy in the reflection that, however agreeable to the observer, it is death to some of the performers.

This fish comes to our coast at about the end of May, and retires towards the close of autumn; and it usually swims at a slight depth from the surface, so that when nets are employed within a fathom or two of that range, many are caught, but when deeper they do not become entangled.

It is the opinion of fishermen that there exists some antipathy between this fish and some others of the gregarious sorts; in proof of which they allege that when the skippers have entered a bay in which there are what are technically called schools of pilchards—as they sometimes do in large multitudes—in a short time the pilchards leave the district: a circumstance which excites their notice, as being attended with a disappointment of their hopes.

The skipper has not been known to take the hook, which is to be ascribed perhaps to the form of its mouth, as well as to the want of an appropriate bait, rather than to indifference for food; which, on examination of the stomach, appears to consist of a great variety of materials. Sometimes, perhaps most frequently, it is formed of entomostraca, or those very small crustaceous animals which exist in myriads in the sea at almost all seasons. But I have also found pieces of red sea-weeds, and square pieces of the marine vegetable *Zostera marina*, with small stones; and as the zostera is not known to grow anywhere but in harbours where fresh water mingles with the salt, it is clear that such situations must sometimes be visited by these fishes. And that they do so is further shown by the fact, that in one instance an example of the fish was brought to me for examination that had been taken in a net, a few miles up a river, where it is only on rare occasions that the tide has been known to come.

The structure of the upper jaw is well fitted to retain any small but perhaps active prey it may chance to lay hold of, preparatory to its being swallowed; an operation which we may suppose not to be accomplished in an instant. On close ex-

P. H. Gosse, del.

Cephalosiphon limnias.

amination it will be seen that along the slender maxillary projection there exists on each side a row of minute teeth which, on a small scale, bear no distant resemblance to the lateral teeth on the snout of the saw-fish, and which are very thickly projecting along the border on each side, with their points directed a little downward.

The ordinary length of this fish is about a foot, but not unfrequently it is seen a few inches longer; the shape inclined to round near the head, more compressed along the body, and tapering towards the tail. The head flattened above, the jaws protruded, the lower jaw longest, upper jaw the most slender. Scales rather large, but easily lost; and then the general colour becomes green where in the perfect state it is a light blue. Lateral line obscure; the belly with a low ridge along each side. Eye lateral, conspicuous; nostril in front of it open. The pectoral fin is broad at the base, pointed above; dorsal and anal fins far behind, nearly opposite, and close behind them five finlets above and the same number below; but I have seen six and even seven finlets above and below. Central fins small; tail forked. There is a row of minute blue dots along the border of the first gill-cover, seventeen in number, which appear to be the orifices of mucous-glands.

A ROTIFER NEW TO BRITAIN—(CEPHALOSIPHON LIMNIAS).

BY PHILIP HENRY GOSSE, F.R.S.

In the admirable new edition of Pritchard's "Infusoria" (p. 670), Professor Williamson has included in the family *Floscularicæa*, between the genera *Limnias* and *Lacinularia*, a genus named *Cephalosiphon*, with the following brief characters:—"Rotary organ bilobed; eyes two; sheath single; two frontal horns, including the siphon." One sole species is mentioned, thus characterized:—"*C. limnias.* Sheath membranous, annulate, 1—6‴ to 1—5‴. On *Ceratophyllum.* Berlin, July."

As no references are given to any authority, I wrote to Professor Williamson for further information, suggesting that for "including," we should probably read "inclosing." I was favoured with the following note in reply:—

"I am afraid I can give you no information respecting it. I found it in the last edition of 'Pritchard,' and from the habitat (Berlin) I concluded that it had been one of those genera established by Ehrenberg, which he has scattered broadcast through half the journals of Germany. Hence I did not feel at liberty to omit it, though I could not trace its history. 'Including' should certainly have been 'inclosing,' as you suggest."

In Mr. Slack's "Marvels of Pond Life," p. 149, he has described and figured a tubicolous Rotifer, with a very long antennal process. He considered it to be *Limnias ceratophylli*, but noticed the discrepancy between the form of the trochal disk in my figure of that species in "Evenings at the Microscope," and that of his animal. Having intimated to this gentleman my suspicions that the creature was neither *Limnias*, nor any other with which I was acquainted, he was so kind as to send me from time to time a number of specimens, all found in considerable abundance studding the stems and leaves of *Anacharis alsinastrum*—a pond-weed which, Mr. Slack tells me, is fast displacing all other sub-aquatic vegetation in the waters about the north of London. The examination of the specimens thus transmitted, has confirmed the suspicion of its novelty to us, and has convinced me of its identity with the Berlin genus *Cephalosiphon*, and probably with the species *C. limnias*. This identification I shall, at least for the present, assume.

The animal manifests a very close affinity with *Œcistes*, *Limnias*, and *Melicerta*; in the form of its petaloid disk coming between the last-named two; for the outline of this organ (see Fig. A) may be described as two-lobed, with each of the lateral lobes having a tendency to divide into two; the entire form having a striking resemblance to the expanded wings of a butterfly, such as our little Orange-tip, for example. In the antenna, distinctness from each of the genera named is manifested, for while *Melicerta* has two rather long antennæ, *Limnias* two reduced to mere bristles, and *Œcistes* none at all, our *Cephalosiphon* displays a single one, of extraordinary length and versatile power. Like *Melicerta* and *Limnias* it shows no visible constriction or neck below the disk, whereas in *Œcistes* this is a conspicuous feature.

The animal inhabits a case slightly trumpet-shaped, generally of great length and slenderness, compared with those of its allies, standing erect on the pond-weed. It is irregular and floccose in outline, very opaque, and of a deep bistre or umber brown by transmitted light, but of a much lighter hue, cedar-brown, by reflected light. It is composed doubtless of an excretion from the skin as the foundation layer, thickened and opacified by the addition of the dark material, which I conjecture to be the fæcal pellets successively discharged in process of growth. Yet I must confess I have never seen the stomach or intestine charged with dark brown food, in any of those that I have examined, which have certainly been but few, in a healthy active condition.

Contrary to the rule in the allied genera, the petaloid disk is made to open, by the bending forward of the head towards the ventral aspect, and its widest margin is the dorsal one. This is shown by the position of the cloacal orifice with respect to the foot, as seen in Fig. 6. Immediately behind the disk are two minute lateral horn-like points, which project from the head, and curve towards each other. These are sometimes visible both in a frontal and a lateral view, and with the disk closed or open (see Figs. A and B), but at other times the closest scrutiny fails in discerning them (Fig. C). Behind these, in the median line, there is an organ which is never concealed: it is the single antenna, which stands up perpendicularly from the occiput to a great height (being almost half as long as the body, exclusive of the foot), and generally arches over the front; but is capable of vigorous and sudden movements to and fro, and from side to side. It is evidently tubular throughout; either a simple tube with thick walls; or else, if the walls are thin, furnished with a slender piston which runs through its length. By analogy, this organ ought to carry a pencil of diverging bristles at its extremity; and Mr. Slack has so figured it; and has, moreover, mentioned in a private letter to me that he has again detected these hairs of unwonted length. On the other hand, I have utterly failed to detect the slightest trace of hairs or of ciliary motion in the antenna of one which I watched most carefully with powers of 600 and 800 diameters, aided by an achromatic condenser; though the animal was in vigorous condition, and threw about its tube most waywardly. I did detect signs of what seemed to be both inspiration and expiration through the tube; for an atom of extraneous substance that by accident was adhering to the tip, was now and then suddenly drawn into the open mouth of the tube, and presently as suddenly blown out. The appearance certainly favoured Ehrenberg's notion of this organ being a *respiratory* tube.

The disk when withdrawn forms a sort of pimple or mammillary prominence, with a pursed aperture, seated on the front of the head. In this condition, and with this exception, the general form of the trunk is cylindrical, with a slight swell on the dorsal aspect, and with the upper end rounded to the base of the antenna, and the lower to a closely and strongly wrinkled foot (Fig. A), of which, however, I have been able to see only the extreme upper portion, at a moment of unwonted extension. If, as is no doubt the fact, the lower extremity of the animal was in contact with the surface on which the case was erected, the foot must be capable of being drawn out to amazing length. I do not doubt that such was the fact; yet the upper portion of the animal is certainly able to shift its aspect in the case, and that with a measure of persistency which appears rather to indicate a voluntary change in the foot-hold than a mere twist.

The specimens that I have seen were remarkably translucent and free from colour; but the outlines of the internal organs are so evanescent as to be difficult of determination. The digestive system shows a *mastax*, of the form of that seen in *Limnias*, which I have represented in "Phil. Trans." 1856, pl. xviii. figs. 66—71. From this a short œsophagus leads to a wide and long stomach, extending down the dorsal half of the body-cavity, and merging by a constriction into a short intestine, whence a slender rectum turns abruptly upward, and opens by a cloaca seated between prominent points, capable no doubt of a very great protrusion at the moment of evacuation. As I have before observed, I have not in any instance seen the alimentary canal occupied by food; in each case, the stomach and intestine were transparent, save for some minute oil-bubbles and pellucid specks, and were tinged with a pale yellow hue, probably owing to effusion from the surrounding biliary glands.

The whole ventral half of the cavity is filled by an almost commensurate ovary, which in these specimens contained only undeveloped ova, in their usual form of clear, highly refractile sphericles, each with a dim nucleus.

The nervous system shows a comparatively large brain, seated as a defined gray cloudy mass of irregularly lobed form, immediately below the antenna, and behind the discal mammilla (Fig. c). The structure that permeates the antenna, whether tube or nervous thread, expands upon, and is lost in, this brain-mass; and on its side I saw, with great distinctness, in one specimen, a bright crimson eye-speck. I could not, by focussing, get a glimpse of the eye on the opposite side, perhaps from the opacity or the unequal refrangibility of the intervening tissues; but the position of this one implied that it was one of a pair. In no other specimen could I find a trace of eyes.

I have not been able to see any muscular bands or threads.

The *Cephalosiphon* is very lively and active in its motions. It is very ready to protrude from its case; and not at all prone to retire upon ordinary alarms, such as a jar upon the instrument, that would send the *Floscularia* or the *Stephanoceros* into its retreat in an instant. It is very curious to see it protruding; the long antenna is first thrust out, and jerked to and fro, as a feeler, exploring the surrounding water for safety. This being assured, a considerable portion of the body projects, with a quick jerk, which then, by its bowings and turnings, seems to aid the antenna in its investigations; presently, a good piece more of the body comes out, until at last we see the commencement of the wrinkled foot itself; the jerking and feeling still going on. Perhaps I have not been fortunate in my specimens; but I have not witnessed the opening of the disk in any instance; and the animal appears chary of exposing its facial charms. Indeed, my delineation of the form of the disk rests on a single individual, so that I do not attach the same certainty to it as to other features which I have observed; and the more, as I could not trace the marginal cilia at work. Moreover, Mr. Slack has figured it of a very different shape.

The entire height of an average specimen in its ordinary state of extension is $\frac{1}{33}$ of an inch; of which the foot is $\frac{1}{50}$th, the body (from the cloaca to the base of the antenna), $\frac{1}{200}$th, and the antenna $\frac{1}{400}$th of an inch. The case generally reaches up to the cloaca. The greatest breadth of the body may be about $\frac{1}{700}$th.

NOTES ON THE PRECEDING PAPER.

BY HENRY JAMES SLACK, F.G.S.

Mr. Gosse, in transmitting the observations in the preceding paper, invited me to add any remarks, especially upon the great discrepancy between his sketch and that which I published in the "Marvels of Pond Life," to which he has alluded. However plainly a particular appearance might be presented to my view, I should hesitate in adhering to its correctness in opposition to so able an observer, if our opportunities had been equal, but in this case I have had the advantage of repeated and prolonged observations; while Mr. Gosse, even in the instance of the "single individual," does not seem to have seen the disk naturally expanded at all, and I conjecture his view of it must have been taken under some peculiar circumstances—perhaps of compression—which disguised its real form. I first discovered the creature—which I cannot reconcile with the description given in Pritchard of the *Cephalosiphon*—in October, 1860, and from a single specimen gave an account of it, which will be found in the *Marvels of Pond Life*. Upon receiving from Mr. Gosse a note expressing his belief that the thing might be a *Cephalosiphon*, although it was certainly not a young *Limnias*, I endeavoured to obtain fresh specimens; but did not succeed till November, 1861, during which month I sent a good many to him at Torquay. Some of them reached that place alive, but from some cause (perhaps not liking the air) not one expanded her disk as in Camden Town. As the weed was abundant, and the creatures plentiful, in the Hampstead pond, I saw no occasion to be in a hurry, and decided not to call the attention of other naturalists to them until Mr.

Gosse had completed his researches. Unfortunately, in the early part of December the pond was cleared out, and I could with great difficulty find a few bits of the *Anacharis*, and still fewer live specimens. I however sent some to Professor Williamson, of Manchester, to whose labours the last edition of Pritchard is so highly indebted.

It will be most convenient if I comment on Mr. Gosse's

FIG. 1.

statements in the order in which they occur. After attentively watching some dozens of the animals in an expanded state. I have never seen anything to justify the idea of the disk being bilobed, with a tendency to further division, and having a "striking resemblance to the expanded wings of a butterfly." The second of the annexed sketches is taken from the *Marvels of*

Pond Life, and I still maintain it to be substantially correct, although the attitude is more exceptional than I then thought. In that position the gizzard cannot be seen distinctly, as the observer looks down into the open disk as he would into a tea-cup held with its mouth slanting towards him. The feeler appears surrounded by cilia, and situated near one margin of the rim. This state of things is not common, but I have distinctly seen it since; and it will be understood, on referring to Fig. 1, which also represents an exceptional, but very convenient disposition of parts. In that sketch the proboscis, or feeler, is shown to be seated upon a prominence, which varies in shape, and is capable of considerable motion. When this is thrust forward, the proboscis is carried within the ciliary circle as I first saw it, and as my wife delineated it. The usual attitude of the animal before the disk is opened is like Mr. Gosse's Fig. *e*, the eye however being seldom visible. When the expansion occurs, the amount of protrusion of the body, and the angle at which it is bent, vary indefinitely. Perhaps the commonest position is for the body to be nearly upright, with the upper part bent at an angle like the handle of a walking-stick. The cilia are very long; they vibrate through their entire length, and often exhibit a row of retreating and a row of salient curves. In my Fig. 1, the body is unusually protruded, the projection above the tube, on the left, being the anus. In this sketch the disk is circular and continuous, except immediately in front of the proboscis, where a depression occurs, forming a sort of notch, but not nearly deep enough to justify the epithet "bilobed." I believe the animal can fill up this little notch by bringing the sides together, and relaxing the muscular contraction by which that portion of the margin is pulled down below the general level.

FIG. 2.

The tubes are generally as described by Mr. Gosse, but I have met with a few of unusual length, slightly twisted and strangely bent at the top on one side. In some specimens, probably young, they are transparent enough to allow the animal to be seen all the way to the bottom, and in that state are so flexible as to move about as it moves. What share the fæcal pellets may have in colouring the tubes I do not know; but, with one exception, the darkest food I have seen in healthy individuals has been of a very pale yellow-brown, very much lighter than the flocculent adhesions.

In one individual I observed two rather large oval eggs in the tube, and another adhering to the outside of the tube at the top. These were watched for several days in succession. One morning the outside egg had disappeared, and could not be traced. The animal did not live long enough for the development of the two others to be witnessed.

The disk may require some bending of the body to open it, but it is retained open in all sorts of positions. I have seen the horn-like points which Mr. Gosse describes, but I am at a loss to tell what becomes of them when the creature moves, as, if a glimpse is caught of them one moment, they usually disappear the next. I think the antenna has a piston to which the *setæ* are attached, and which carries them up and down at the will of the creature. On learning that Mr. Gosse had failed to see these bristles (*setæ*), I invited a microscopic friend, and we examined four specimens. In three they were conspicuous with careful illumination and a power of 180, and in one not. They were also seen by Professor Williamson, at Manchester. It is evident they were not everted at Torquay, or they could not have escaped so admirable a microscopist as Mr. Gosse, and one of my specimens did not exhibit them during many examinations. The proboscis is very flexible, and in one instance my wife saw it bent like the forefinger when half closed. My wife also noticed an apparent connection between the inner tubes of the proboscis, and a fine line running round the margin of the disk; which would be consistent with the theory of its being a respiratory organ as well as a feeler. Upon the minute anatomy of the creature I can add nothing to Mr. Gosse's valuable observations, except that the form of the gizzard was one reason why I at first considered it a *Limnias*.

My specimens have usually been very free in exposing their disks, much less easily frightened than the *Melicerta*, and if made to shut up and retract by striking the table, willing to try their fortune again in a few seconds. Once, however, I had a highly nervous lady to deal with, and even a loud noise in the street, or slamming a door in the next house, made her retire in alarm. The same effect was produced by the striking of a small German clock. These creatures have no difficulty in turning about in their tubes, and it is not uncommon to find one opening to the right, retracting suddenly, and then opening to the left, or making other changes equally inconvenient to any one attempting to sketch an accurate portrait.

Their food consists of very small objects, and is often so colourless as to give no aid to the investigation of their internal parts. This circumstance, together with the transparency of the tissues, renders minute observation so difficult as to give great value to the researches of Mr. Gosse. I should add, that the very striking rings in the foot of that gentleman's central figure, have not been exhibited by any specimens under my notice. My taking this creature for a young *Limnias cerato-phylli* arose from a general similarity of structure, and from a remark in Pritchard that the rotary disk of that animal was circular in a juvenile specimen. I have usually found floscules (*ornata, cornuta,* and *campanulata*) on the same weed with the new rotifer, and likewise *Stephanoceros Eichornii.*

ANCIENT AND MODERN FINGER-RINGS.

BY H. NOEL HUMPHREYS.

Our modern finger-rings have lost all characteristic meaning in their general form or details. The delicate allusion, the poetic sentiment, the playful conceit conveyed by the graceful forms of interwoven flowers, or other objects, have disappeared. The effect and meaning of the conjunction of various metals in the device is a lost art; and the poetic meaning once attached to gems is a forgotten branch of elegant symbolry. In short, the race of ingenious and artistic artificers, who devised the exquisite jewels of the 15th and 16th centuries, have no modern representatives.

So completely is the art of ring-jewelry forgotten, that it is now sought to give a poetic sentiment to the very defects which mark the degradation of the art; even in the unwrought and unmeaning wedding-ring of our day, a beauty is sought in its absolute want of any characteristic features whatever, by calling it, with a sentimental unction, the *plain* gold ring.

Before, however, I attempt to show what a wedding-ring might be made, and has been made, let us take a brief review of the origin of finger-rings in general.

The earliest kind of rings known appear to have been merely portable seals. In the first great empires of Central Asia of which we have any record, Babylonia and Assyria, the act of sealing was a most important one, and, as an act conferring authenticity upon any important document, stood in the place of the present practice of attaching to it the names of the principal parties concerned. Royal edicts were promulgated entirely through the medium of a seal; the decrees of the Assyrian kings being engraved upon a cylinder, a kind of rolling seal of cornelian or metal, from which they were impressed upon the requisite number of pieces of prepared clay—thus the seal was, in Assyria and Babylonia, a printing-press, which multiplied the royal edicts to any required extent. Small seals were worn on the royal finger, attached to a ring of metal, and such portable signets were used to give authority to deeds of minor importance. Even private individuals used both the large cylinder, as well as the lesser ring-seal.

The Greeks, so late as the time of Homer, did not use rings or seals, but shortly afterwards, the custom appears to have reached them from the East. In the time of Solon, seal-rings (σφραγίς) appear to have become usual; and with their use the art of counterfeiting them. This was the case also with coined money, as proved by the discovery of ancient counterfeits of some of the earliest kinds of coins known, especially the far-famed Tortoises of Ægina, so called from the highly-wrought image of a tortoise which was the device of the double drachmas of that state. In Athens great precautions were taken with regard to the forgeries of seal-rings; insomuch so, that by a law of Solon an engraver was forbidden to keep the form of the seal which he had sold. These early seal-rings of the Greeks were probably entirely of metal, the custom of mounting engraved gems in rings not having become usual at that period. But already superstition, which in early stages of civilization attaches itself to all things, had begun to attach itself to the seal-ring. The ring of Gyges, king of Lydia, which he is said to have found in a grave, was believed to convey to its possessor extraordinary powers: as was that of Charicleia, mentioned by Heliodorus, and also the famous iron ring of Eucrates.

Magic and rings became closely interwoven in the latter times of Grecian independence; and magic rings, made of wood, bone, or some other cheap material, were manufactured in large numbers at Athens; and could be purchased, gifted with any kind of charm required, for the small consideration of a single drachma.

The simple metal seal-ring was eventually superseded by one composed of gems, richly mounted in chasings of gold; and as luxury increased, several were worn at once, till at last the fingers of both hands were nearly covered with these ornaments; and that too at a comparatively early period, as we find the custom alluded to both by Plato and Aristophanes.

Eventually luxury took the turn of introducing rings of enormous size, and some exquisites went so far at a somewhat later epoch, as we learn from Quintilian, that they had a series of rings suited to the successive seasons of the year—as summer rings, winter rings, etc., many of them being doubtless of highly ingenious device and finished workmanship. We may imagine the devices to have consisted of such features as gracefully wrought representations of the divinities who were supposed to preside over different seasons—Ceres or Bacchus, for instance, for the Autumn, with jewel-work of wheat and grapes and other fruits ; or perhaps, for the same season, the zodiacal sign of the "Scales," to symbolize the equality of the days and nights at the equinox, the figure richly wrought in gold, with the sign of the Fishes, one having, as seen in existing sculptures, rare gems to represent the dishes of the Scales. Or in Spring, the head of a swallow, in allusion to the sun's entrance into that constellation at the period when the swallow first made his annual appearance in Greece, as one of the harbingers of the coming Spring.

There were no legal restrictions in Greece against wearing gold rings, though the Spartans always affected simple iron ones ; and the women, it would appear, scarcely pretended to this form of luxury at all, only wearing simple annulets of ivory or amber. This abstinence on the part of the ladies, may have arisen from the fact that the ring, as originating in the seal or signet, was a mark of power or sovereignty, and as such, inconsistent with the general social position of women in Greece.

It is as a sign of authority that a ring is made the means of transferring power, in romantic legends both ancient and modern. "Show this ring to the captain of the guard," etc., is a phrase often found in ancient and mediæval legends, for with the signet the power of the owner might be delegated to any person on whom he chose for a time to bestow it.

In Rome the custom of wearing rings was said to have been introduced through the Samnites, who are described by Livy as wearing gold rings enriched with gems (*gemmati annuli*). Some however state that the Romans adopted the custom in imitation of the Etrurians, in the reign of Tarquinius Priscus. The earliest Roman rings were, however, always of iron, and bearing a stamp or device intended to be used as a seal. To the end of the republic the ancient iron ring was still worn by those who affected to contemn modern luxury and innovation ; and among these was Marius, who, as Pliny tells us, wore an iron ring in his triumph after the subjugation of Jugurtha. Eventually, however, not only all patricians wore gold signet rings, but the equites also ; and other classes soon imitated their superiors. Eventually, however, legal restrictions were promulgated concerning the right to wear a gold signet. These regulations were afterwards known as the *jus annuli aurei.*

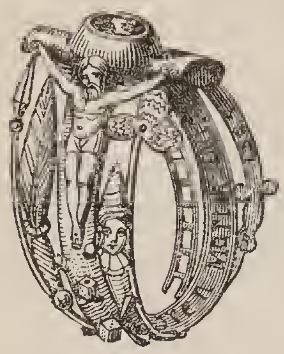
The emperors assumed the power of granting the right of the annulus aurei, or privilege to wear a gold ring; and this license was much coveted, as it was a sort of patent of nobility, the letter of the law requiring that the fathers and grandfathers of those licentiates should have possessed a property of 400,000 sesterces. At a later period, when the army became the real power in the state, and the Prætorian Guard frequently elected the emperor, the privilege of wearing the gold ring was granted to all soldiers. The keeping of the imperial ring (*cura annuli*) was confided to a state keeper; as the great seal, with us, is placed in custody of the Lord Chancellor. The devices on Roman signet-rings were generally subjects connected with the worship of the gods, or portraits of friends or ancestors; and in many instances persons had engraved upon their seal-rings symbolical allusions to the supposed origin and history of their families. The seal-ring of the dictator Sulla bore for device the figure of Jugurtha at the moment of his being made prisoner. Pompey used a seal-ring which bore three trophies in allusion to his three greatest victories. Augustus first sealed with a sphinx, then with a portrait of Alexander the Great, and lastly with his own portrait. This last custom became very usual; a portrait on the exterior of a letter at once making known its author; just as on the *carte de visite* of a modern exquisite, the photographed perfections of his person identify him at once with his card, without the necessity of a name. Many of the Roman rings were wrought with the greatest skill, both in the designs of the mounting, and the careful engraving of the device; as we learn from numberless exquisite examples still in existence in the great museums of Europe.

It was in the Middle Ages, however, after a period of comparative barbarism in art, that the greatest degree of intricacy in goldsmith's work, and especially in rings, began to display itself. Rich enamel, in curious devices, usurped the place of gems for a time, and designs in *niello* still further heightened the artistic effects of small jewelry towards the close of the 15th century. Benvenuto Cellini, the celebrated Italian sculptor, jeweller, architect, and painter, brought the devices of the ring, the brooch, and the ear-ring to a degree of elaboration and perfection never attained in the whole range of classical art, as far as we know of it, and for a century afterwards it continued to flourish. The quaint conceits of the devices, the effects produced, and sentiments conveyed, by the juxtaposition of various gems, and the introduction of mottoes exquisitely written on waving scrolls, produced a pleasing intricacy of design full of meaning and often epigrammatic point, such as the jewellers of more recent periods never dream of—jewel-making having fallen from all the glory of art into all the meanness of trade.

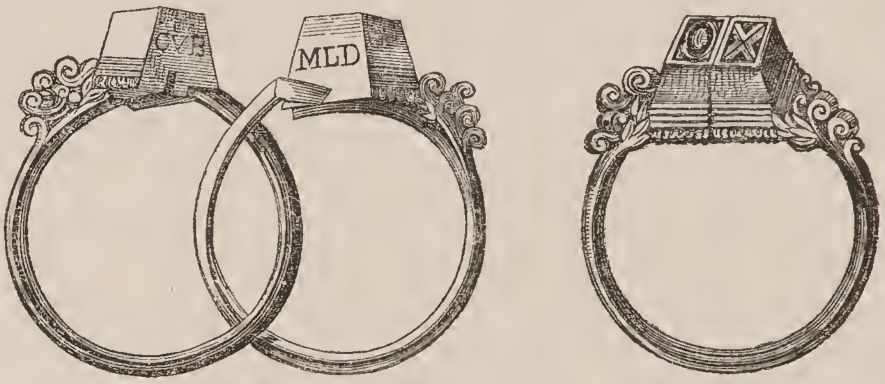
It may be thought, perhaps, that a modern public would not pay for a careful original design and its careful execution demanding such an amount of artistic labour as would leave the value of the gold and gems employed quite of secondary consideration. But let our jewellers try it. Even in Cellini's time a similar feeling prevailed, as illustrated in a story which Cellini tells of himself. He worked as a student in the shop of one Lucagnolo, a leading goldsmith of the day, but had permission to get other work on his own account. Cellini, while studying an antique statue, attracted the attention of the Donna Portzia Chigi, a princess of the wealthy papal family of that name. As a first mark of patronage, she engaged him to make a gold jewel for her (richly wrought with other devices), but in the form of a lily. Lucagnolo dissuaded him from undertaking the "job," assuring him that those minute and delicate works did not pay; pointing, at the same time, to a large, boldly-embossed, silver vase, that he was making for Pope Clement—one of those dinner-vases used at the time for throwing refuse from the plate during dinner—and assuring his pupil that such large, plain work "paid" much better. The master and pupil made a wager on the subject, Cellini maintaining that his work would prove the more profitable of the two. In twelve days Benvenuto had completed his work, a lily of gold, grouped with miniature fruit, and masks of Comedy and Tragedy, and a number of little devices, which, when submitted to Donna Portzia, gave her infinite delight (Benvenuto does not hide his light under a bushel), and she paid him more than half as much again as the price agreed on. The payment was made entirely in gold, as a token of extreme satisfaction, and accompanied, as he tells us, by compliments "*degne di cotal signora*," while Lucagnolo only received the exact payment of his work in heavy silver dollars, losing his wager and becoming (as Cellini tells us, with evident self-gratulation) the laughing-stock of the whole goldsmithian fraternity.

In reference to a preceding remark on the modern *plain* gold ring, and as an interesting historic example of the school of jewel-making of the fifteenth and sixteenth centuries, I will annex a representation of the marriage and betrothal rings of Martin Luther. They are not so rich and florid in design as many other examples I might have selected, but, as monuments of the great Reformer and his nun-wife, they have an interest of their own, and sufficiently illustrate a characteristic style of jewel-making which appears to have fallen into a state of collapse that seems beyond the power of all restoration, even by Societies of Arts, or Great International Exhibitions.

The *betrothment-ring* of Luther, which belonged to a family in Leipsic as late as 1817, and is doubtless still preserved with



the greatest care as a national relic of great interest, is composed of an intricate device of gold-work set with a ruby—the emblem of exalted love. The gold devices represent all the symbols of the "Passion." In the centre is the crucified Saviour; on one side the spear, with which the side was pierced, and the rod of reeds of the flagellation. On the other is a leaf of hyssop. Beneath are the dies with which the soldiers cast lots for the garment without seam, and below are the three nails. At the back may be distinguished the inside of the ladder and other symbols connected with the last act of the Atonement; the whole so grouped as to make a large cross, surmounted by the ruby, the most salient feature of the device. On the inside of the ring the inscriptions are still perfect. They contain the names of the betrothed pair, and the date of the wedding-day, in German, "Der 13 Junij, 1525." This was the ring presented to the wife at the betrothal, and worn by her after the marriage.



The *marriage-ring*, worn by Luther after his marriage, is still more intricate in its structure. It is an ingeniously contrived *double* ring, every intricacy of structure having its point and meaining. In the first place, though the double ring can be divided, so as to form two complete rings, yet they cannot be separated from each other, as the one passing through the other causes them to remain permanently interlaced, as an emblem of the marriage vow, though still forming two perfect rings; illustrating also the motto engraved within them, *Was Got zusammen füget soll kein Mensch scheiden*—What God doth join no man shall part. On the one hoop is a diamond, the emblem of power, duration, and fidelity; and on the inside of its raised mounting, which, when joined to the other hoop, will be concealed, are the initials of Martin Luther, followed by a D, denoting his academic title. On the corresponding surface of the mounting of the gem of the other hoop are the initials of his wife, Catherine von Bora, which, on the closing of the rings, necessarily lies close to those of Luther. The gem in this side of the ring is a ruby, the emblem of exalted love; so that the names of Catherine and Luther are closely united, when the rings are closed, beneath the emblems of exalted love, power, duration, and fidelity.

There can be but little doubt that these curious and interesting rings were designed by the celebrated painter and goldsmith, Lucas Cranach, and possibly wrought with his own hand, the marriage of his friend Luther being a special occasion which he doubtless wished to honour with every attention in his power. Lucas was, indeed, one of the three select friends whom Luther took to witness his betrothal, the others being Dr. Bugenhagen, town preacher of Wittenberg, and the lawyer Assel, who all accompanied him to Reichenbach's house, where Catherine resided.

In the rings above described there is, doubtless, such device, and meaning, and exquisite workmanship, as the Donna Portzia Chigi of the present day might assuredly reward with something more than the market-price, if produced by our jewellers, and pay for in gold, too, if the fitting opportunity should present itself, not omitting even the compliments *degne di cotal signora.*

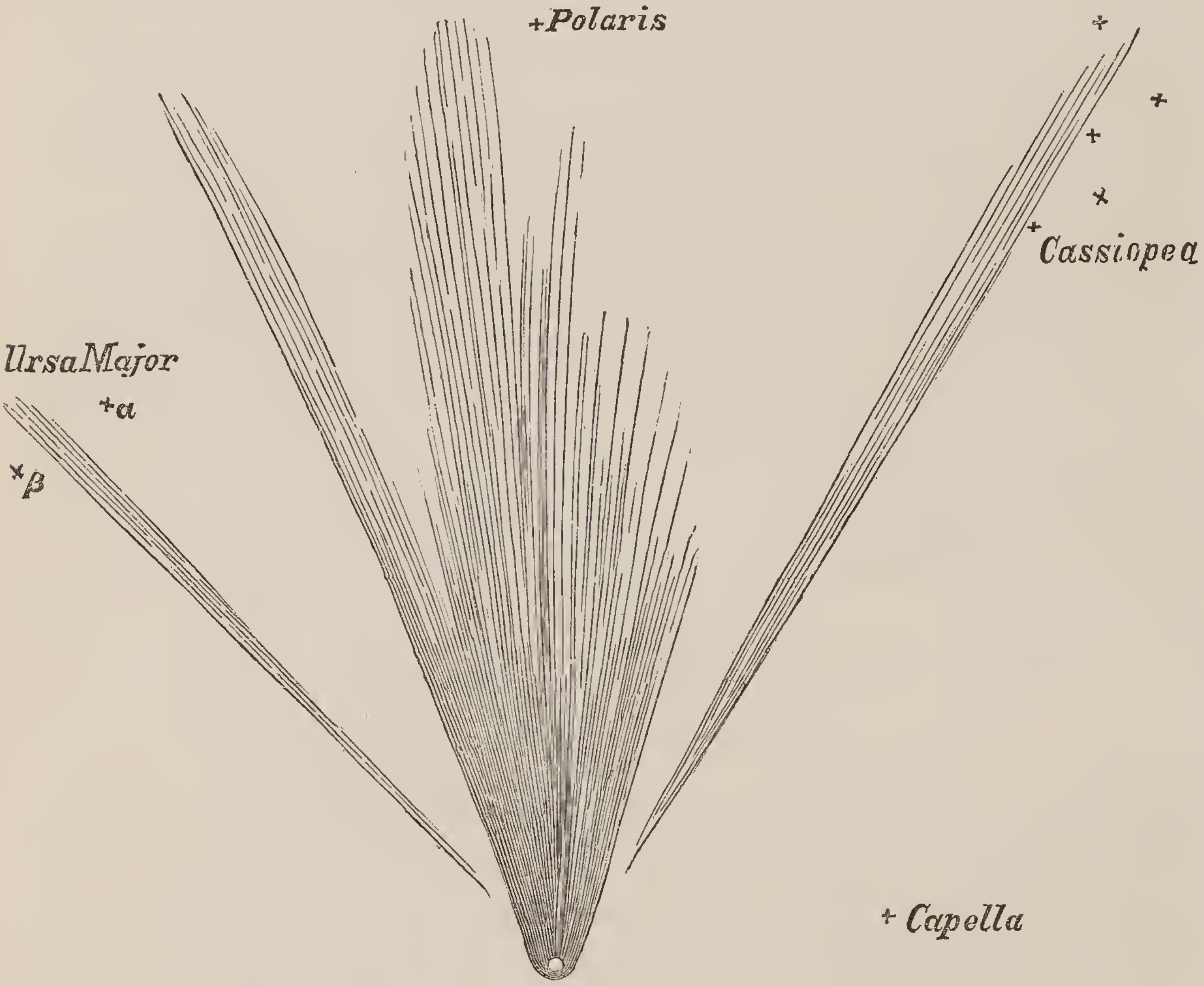
THE EARTH IN THE COMET'S TAIL.

BY THE REV. T. W. WEBB, F.R.A.S.

The reader will, no doubt, recollect the remarks that were made by several persons, and in various places, as to something unusual in the appearance of the evening of June 30th, 1861, and the interest subsequently attached to them by Mr. Hind's calculation that at that very time, or a little earlier, the tail of the great comet might, in all probability, have been enveloping the earth. The following additional and independent testimony to that conjunction is the more worthy of remark as being drawn from a perfectly different mode of observation.

On the night in question, after I had, like so many others, been astonished by the sudden appearance of the comet, and had studied and sketched the nucleus with its marvellous train of six envelopes, and had dismounted my telescope with the impression that there was little more that I could do, as well as in anticipation of the approaching moonlight, my attention was drawn by my wife, about 11h. 45m. to a faint ray, perfectly similar in appearance to the tail, lying nearly horizontally in the W.N.W. beneath the quadrilateral of Ursa Major, about

3° or $3\frac{1}{2}$° broad, having ψ Ursæ in its lower edge, and Cor Caroli about 1° above its upper, and traceable about half-way from the latter star to Arcturus: it pointed to the head of the comet, but in the twilight of the northern horizon no connection could be distinguished. About twenty minutes later it had risen higher, so as to stand midway between ψ and γ Ursæ Majoris, and its termination near ε Boötis was now plainly visible, much more so than previously, this part of the streak having become equally bright with the rest, and perhaps even brighter. Some time afterwards I could no longer see it, so that



Night of June 30, *July* 1, 1861, 12*h.* 30*m.* (*about*).

I concluded that it was probably only a cirrus cloud brought up by the N.W. wind then blowing; and this impression was confirmed by my erroneous idea that as the comet was evidently moving rapidly away towards the N.W., this ray, had it been a branch of the tail, ought to have rather sunk than risen in the sky. Fortunately its peculiar appearance and direction induced me to record it in all its details; but so backward was I to recognize its true character, that in a communication to the "London Review," in which it was mentioned, I had expressed a doubt whether the tail was sufficiently expanded to correspond with its supposed vicinity to the earth, when I received a letter from

George Williams, Esq., of Liverpool, which entirely altered my view of its nature. From his statement it appears that about 12h. 30m. he had seen the same ray in the direction of Ursa Major, as well as another, somewhat brighter, which diverged towards Cassiopea, the brightest part of the latter being at some distance from the comet, and appearing to recede from it until it was altogether lost. Like myself he had thought at the time that both might be cirrus clouds only; but that each should point to the nucleus of the comet, he considered a circumstance worthy at least of a remark, and he, therefore, recorded the appearance in a beautiful sketch, which I have his obliging permission to make use of, and of which a copy is here given. It was not surprising that I had missed the eastern ray, as that part of the sky was partially obscured by trees from my station at the telescope, and was wholly invisible afterwards from the window; but we had previously noticed that the right side of the tail had appeared to the naked eye to strike out from the coma for a few degrees in a more easterly direction; this, though not traceable as a separate stream, was, I have little doubt, the point of departure of the ray in Cassiopea. Thus it seems established, by the concurrence of two observers at distant stations, that these rays were not clouds, but the perspective representation of the sides of a conical or cylindrical tail, hanging closely above our heads, and probably just being lifted up out of our atmosphere. The rapid movement which I had noticed in the western beam, and which, according to Mr. Williams' sketch, was still continued afterwards, will, on careful consideration, be found in full accordance with this idea: for the tail was then receding so speedily from the earth that the sides of the outspread fan must, from the effect of perspective, have closed up with great swiftness towards the centre, and thus would be produced that apparent rising in the sky by which I was misled: the great amount, too, of that closing up in proportion to the time of the observation, shows how very near the object must even at that moment have been to us; and yet the central streams must obviously have been considerably closer to us than the apparent sides of the cone or cylinder. So that, from a review of the whole phenomenon, it seems not only certain that we were then in the immediate vicinity of the tail, but much more probable that we had actually passed through it, as Mr. Hind supposed, than that there still remained, according to the German astronomer, M. Pape, an interval of two millions of miles.

The next night proved cloudy, and I never saw ths western ray afterwards, but it may have been the same with that noticed by some observers on July 10 as deviating towards the star μ Boötis.

The want of entire continuity in these external streams would form no argument against their cometary character, even had it not been established by observation at two distant stations. The interruption might be only apparent, the result of the position of the nucleus in the bright midsummer twilight of the north horizon; but if real it would not be unprecedented. In the very curious comet of alternating light in June and July, 1860, one of the two sides of the tail was, towards the latter part of its appearance, separated from the head; and in that of 1843, so remarkable for its visibility close to the sun at noon-day, the splendid tail which had been darted out to such an amazing length had at one time no connection, visible to the naked eye, with the pale and seemingly exhausted nucleus. And so in the case of those "anomalous tails," those most inexplicable pencils of light, which are occasionally directed from the nucleus towards the sun, two instances are on record (in 1824 and 1845) in which they contained a fainter interval.

Admitting the probability of our passage through the tail, it cannot be thought surprising that there should have been at the time so little sensible indication of its presence. Whatever may be the nature of that wholly unknown material, there can be no question of its extreme and almost inconceivable attenuation. The air we breathe may be as dense in comparison with it, as water or even earth in comparison with air. The minutest stars have been frequently seen through thousands of miles of it, and it even ceases to be amenable to the all-controlling force of gravitation; so that Newton considered that the tail of a great comet might be compressed into the bulk of a single cubic inch before it would equal the density of our atmosphere, and Sir J. Herschel supposes that it may not contain more than a few pounds or even ounces of matter. It would, therefore, be highly improbable that there should be a sufficient quantity of it in the immediate vicinity of any one place of observation to render its presence manifest. Distance alone, by bringing its particles into more apparent concentration, could give it density enough to become perceptible, just as the same cause converts the unsubstantial and semi-transparent mist into the massive and ponderous-looking cloud. It was a more significant fact, and one which may not be generally known, that no electric or magnetic effect whatever was perceptible during its passage;* for such influences have been strongly suspected in cometary phenomena, and might act independently of any material admixture. We have certainly gained very little information, and less, perhaps, than might have been

* Some lofty cirri, however, the next morning, had a singularly wild and electrical aspect; and the Greenwich instruments showed a strong change the following night.

reasonably expected, from that memorable conjunction; but at any rate a great proportion of the terrors of ages has now been dispelled; we have found that we have neither deluge, nor conflagration, nor pestilence, to fear from the encounter of a comet's tail. There remains, indeed, the chance, an almost incalculably smaller one, that we might come in contact with a nucleus; and what might be the consequence of a close conjunction with that wholly unknown and most mysterious material it is, of course, impossible to say. We have no analogy whatever to guide us, and notwithstanding what has recently occurred, no experience to give us aid. It is certain that the nucleus consists of ponderable matter, since it obeys the law of gravity; and that it possesses the power of either originating or reflecting a vivid light; but beyond this, as its nature is wholly unknown, so must be the result of its collision. But no ground for apprehension on this subject exists. We need not have recourse to Kepler's idea of a guiding intelligence for our sense of security, while we are certain that every orbit is planned out, without the possibility of deviation, by infinite wisdom and paternal goodness; and that "known unto God are all His works from the beginning of the world."

JOTTINGS ON COPPER.

PERCY'S METALLURGY.*

The publication of Dr. Percy's "Metallurgy" affords a convenient opportunity for considering some interesting properties of copper, a metal which, next to iron, has been most conducive to human civilization, and which in various shapes still plays a very important part in industrial and domestic life. It appears that its English appellation originates in the fact of its early discovery by the ancients in the island of Cyprus, whence came the adjective Cyprian, corrupted into the substantive *cuprum*, from which the word copper was obtained. With the exception of titanium, it is the only metal exhibiting a red colour, which is sometimes shown very strikingly when minute irregularities of the surface cause a peculiar play of light. It is well known to possess the valuable qualities of malleability and ductility in a high degree; but its physical properties are easily modified. Thus cold rolling or hammering makes it hard and brittle, the malleability being restored by annealing at a red heat. As it ap-

* "Metallurgy: The Art of Extracting Metals from their Ores, and adapting them to various Purposes of Manufacture." By John Percy, M.D., F.R.S., Lecturer at the Government School of Mines. Murray.

proaches the melting-point, which lies between those of gold and silver, "it becomes so brittle that it may be readily reduced to powder by trituration," and workmen in foundries avail themselves of this property when ingots have to be broken up. It is customary to judge of the quality of the copper from the fracture thus produced. This is, however, a very inadequate test; and Dr. Percy relates an instance of a large quantity of copper being rejected at one of the dockyards on account of the appearance of its fracture, and which was afterwards accepted when it had been remelted and "laded" at a different temperature. We shall presently have something more to say on the peculiarities of naval mismanagement in reference to copper sheathing, but must first allude to the action of oxygen and other substances in affecting the quality of the metal in its various states.

There are probably three oxides of copper, of which only two are considered by Dr. Percy to concern the metallurgist: one the protoxide, consisting of one equivalent of copper and one of oxygen (Cu^2O), which is the basis of the ordinary salts of the metal. The other is the dioxide, consisting of two equivalents of copper and one of oxygen (Cu^2O). This is the red oxide, but Dr. Percy says it constitutes a principal portion of the dark-coloured scale formed when the metal is heated to redness with access of air, and we shall find it has an important action in the various processes to which the metal is subjected, in order to fit it for the uses of man. In a state of fusion, copper is able to dissolve this oxide; and when it is present in considerable quantities, the metal is brittle, whether hot or cold, and is technically designated, by the smelters, "dry." Rather more than one per cent. of dioxide is stated on the authority of Karsten to render *pure* copper incapable of being worked in ordinary temperatures without splitting into laminæ, and cracking it at the edges. Ordinary copper, however, which contains lead and other impurities, actually requires a certain portion of the dioxide to make it tough and malleable; and if the oxygen be removed by exposing "tough copper," in the state of wire or foil, to the action of dry hydrogen at a red heat, the metal becomes so brittle that it cannot be bent without breaking. Unfortunately, very little is known concerning the nature of this curious action of the dioxide, or of the proportion it should bear to other impurities in order to afford the best result. The copper annually wasted in the dockyards, for want of this and some other technical knowledge, is worth an enormous sum; but no government has hitherto exhibited enough intelligence to pay the comparatively insignificant cost of a set of experiments by which many intricate questions connected with the metallurgy of copper might be set at rest.

Having thus briefly adverted to the effect of oxygen on copper, we must select, from various important combinations, those which are alleged to take place with carbon, and which are known to occur with silicon and phosphorus. Let us commence with carbon, which was presumed to be chemically combined with copper during the process of *poling,* and to give rise to the brittleness of what is called "overpoled copper." These terms will be understood when it is explained that one of the processes of copper-melting consists in plunging a thick pole of oak or birch, in a green state, into melted metal which contains a good deal of dioxide; anthracite, or "pure free-burning coal, being previously thrown on the surface. The wood in contact with the copper is rapidly decomposed, much gas and vapour are evolved, which cause the metal to be splashed about, and every part of it to be exposed to the reducing action of the coal upon its surface." The chief effect of this process is that of deoxida tion; but it obviously provides conditions under which copper and carbon might unite, if their chemical affinities so decide. When the poling is carried on to the proper extent, the copper becomes tough by the removal of the superfluous oxygen. If, however, it is carried on too long, it is made brittle, in accordance with what has been stated of the use of a small quantity of dioxide in copper that is impure. Dr. Percy requested Mr. Dick to make a number of experiments to ascertain what action the carbon exerted, and although their results do not justify the assertion that small quantities of carbon may not combine with the copper and affect its properties, he ascertained that "comparatively pure copper is not rendered brittle by being heated or melted in contact with comparatively pure charcoal."

If copper is heated to whiteness in contact with silica and carbon, a compound is obtained which resembles gun-metal in colour, and is tough and much harder than copper. It may be rolled or hammered out while cold, but cracks under such treatment at a red heat. A proportion of 1·82 per cent. of silicon gives an alloy tougher than gun-metal, and probably adapted to manufacturing use. Much larger proportions induce brittleness. A still more interesting compound is obtained by dropping phosphorus—which should be covered with an electrotype coating of copper—into the metal in a melted state. In the Laboratory at Woolwich many experiments were made, of this nature, with a view to obtain a material adapted to the manufacture of rifled guns; but the improved modes of working iron, employed by Armstrong or Whitworth, threw them into the shade, as far as this special object was concerned. The quality of this compound varies with the proportion of phosphorus; 11 per cent. giving great hardness, but rendering the metal brittle. Perhaps the most interesting feature of the union of phosphorus and copper is the apparent capacity of the alloy to withstand the action of sea-water. It seems that, in 1848, Dr. Percy furnished Colonel Sir Henry (then Captain) James with various specimens of copper, which he placed in sea-water for nine months, and the result appeared so completely to establish the protecting influence of phosphorus, that the Admiralty was induced to grant £50 for further experiments; and accordingly Dr. Percy caused more plates to be made, in which ½ per cent. of phosphorus was introduced. These sheets were placed upon buoys in three different dockyards, and after a year or two, all that could be ascertained was that the authorities had caused them to be "painted all over." Some years after this, Sir Henry James discovered that the phosphorized sheets had resisted corrosion twice as well as others with which they had been compared; but the "Board," that serviceable screen for jobbery and ignorance, could not be induced to take further steps in the matter.

We have not pretended, in these brief remarks, to write a review of Dr. Percy's work. As might have been expected from the author's opportunities and reputation, it contains a large amount of important matter; but we confess it does not appear to us to have been sufficiently digested. It is not a very convenient book for reference, nor does it exhibit that faculty of generalization which characterizes the higher kinds of scientific works. It was also an error to issue it as if it had been a complete treatise. It is a misnomer to call it "Percy's Metallurgy," of which it is no more than the first volume—only two metals, copper and zinc, being dealt with. It may likewise be questioned whether it was judicious to devote so many pages to such matters as charcoal and coke burning; and we should imagine most students would have preferred the omission of elaborate details of this kind, in order that more of the actual science of metallurgy might have been condensed in a given space. The remainder of the work is promised during the current year, and when it is all before us, our opinion of its merits may be materially improved.

A PLANET'S SHADOW.

The Shadow of the Planet Mercury, and of a group of solar spots, as shown on a sheet of paper during the Transit of Mercury, Nov. 12, 1861, 8.30 a.m.

THE TRANSIT OF MERCURY ON NOV. 12, 1861.

BY THE HON. MRS. WARD.

"A TRANSIT of Mercury will happen on the morning of Nov. 12th. . . . The planet, at sunrise, will appear on the sun's disc, as a perfectly round and intensely black spot." So said the almanacs for 1861; and no doubt more than one possessor of a telescope added the query, not to be answered for nearly a year,—"Shall *I* see it? will fine weather, a favourably situated horizon, and personal life and health, combine to give me the pleasure of seeing a phenomenon which has not occurred for thirteen years, and will not, after this transit, occur again for seven years to come?" *

Such were my thoughts on being reminded that the transit of 1861 was *coming*, and no longer to be looked on as an event in the remote future. Time passed on its stormy way; the grand comet of June came unannounced, and disappeared in the distance; and November 12th found me surrounded by many favourable circumstances for viewing the transit. I was absent from home, but had borrowed an old and rather good

* The transits of Mercury which have occurred during the present century, were in the years 1802, 1815, 1822, 1832, 1835, 1845, 1848, and 1861. Those still to occur, will be in 1868, 1878, 1881, 1891, and 1894. They occur either in May or November, since, from the position of the orbit of Mercury, the planet can only pass between the earth and the sun, and near enough to a line joining the two bodies, to be seen upon the solar disc, in one or other of those months. (See Johnston's "School Atlas of Astronomy.")

telescope (by Tulley and Sons) of two inches' aperture, and had during the week preceding the transit accustomed myself to observing the sun's disc both directly and by projection (as in Fig. 3). The window of my room most happily commanded a view of the *eastern* heavens, with a tolerably unobstructed horizon. There were, indeed, a few trees in the way; but they were low, and concealed only that part of the sky where the density of the air would in any case render objects indistinct.

The afternoon of November 11th promised well. The moon truly "walked in brightness," and the telescope showed "Plato," "Pico," and other lunar heights, with their black shadows in satisfactory sharpness. So I hoped for a fine morning, and having never seen a transit of Mercury, anticipated the pleasure with some of the eagerness felt by old Gassendi, the first observer of such a phenomenon.*

On November 12th, I looked out at about a quarter to seven in the morning. Delightful sight! the sky was perfectly cloudless. The brightest stars were disappearing in the increasing light of morning, but Jupiter and Saturn still glittered in the south-east. The light of Saturn was nearly "burnt out in the pale blue air," yet its exquisitely delicate ring could still be detected, giving more the idea of a *film* than of a definite line on each side of the planet.† (Fig. 1.)


FIG. 1.

While Saturn remained visible, I felt I had time to spare, but when he disappeared, and even Jupiter's light waned, then I knew the real work of the morning was coming. Redder and rounder grew the glow of light exactly behind a small tree. Soon it sparkled through the branches, the sun had risen! and while yet only a semicircle, my telescope was there to watch it, its outline waving like rippling water.‡ But the disk rose grandly from branch to branch. Very curious was the effect,

* On November 7th, 1631, this transit, predicted two years previously by Kepler, was observed by Gassendi, Professor of Mathematics in the University of Paris. The next transit of Mercury which was observed, was on November 3rd, 1651. A young Englishman, named Shakerley, had found by calculation that this transit would be visible only in Asia, and he proceeded to Surat in India for the express purpose of witnessing its occurrence. He was successful in the object of his pilgrimage; and the anecdote remains as one of the romantic episodes of astronomy.

† The ring of Saturn became edgewise to the earth, though not yet so to the sun on November 23rd. It was, therefore, barely visible on November 12th; and on November 23rd I observed Saturn as a round disk without the slightest trace remaining of its ring.

‡ The rippling motion observable on the outlines of the sun, moon, and other heavenly bodies, is quaintly but well described by Derham. His descriptions, from original observations, are interesting from their freshness and truth; ever fresh and new, like the grand objects they describe. I quote from "Astro-Theology," sixth edition, 1731:—"There are some certain transient Roughnesses and Uneven-

when, the sun itself out of focus, I allowed it to project on paper the shadows of the intervening branches. Every twig, and every lingering ash-leaf, parched by the sere winds of autumn, but not yet fallen to earth, were shown in singular sharpness and waving in the breeze. Curious, too, when looking directly at the sun through the dark glass of the telescope, anxiously waiting its arrival behind a somewhat thinner part of the tree, a little pert tomtit or robin hopped to and fro, unconscious that he too was performing a transit across the sun's disk for my benefit. The bird was out of focus, the sun was in; and a few minutes later, came to more thinly crossing branches; (Fig. 2), and there, on his disk, was the unmistakeable BLACK

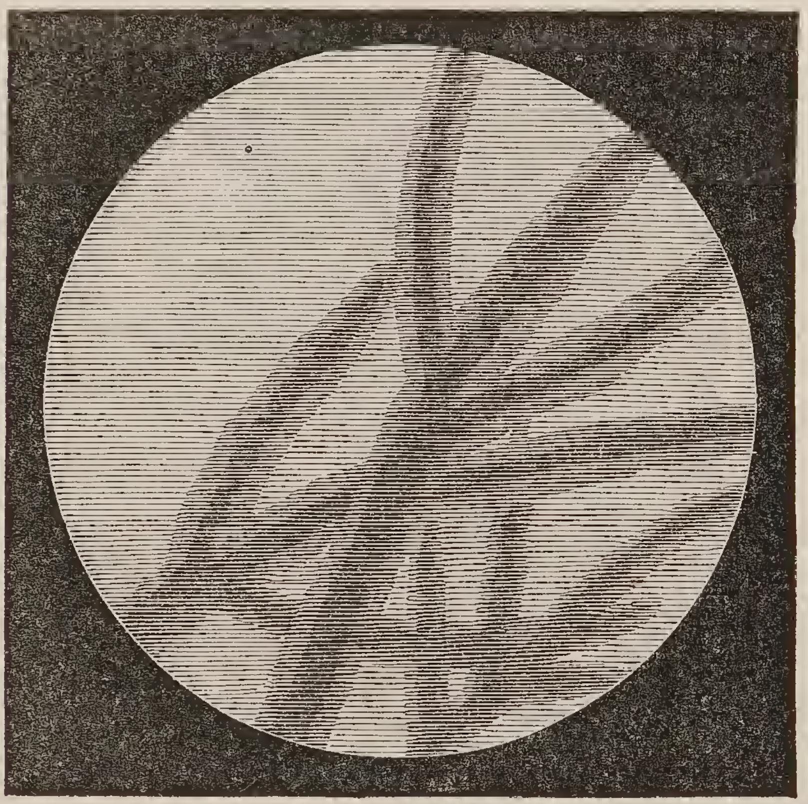


FIG. 2.

First View of the Planet Mercury, on the Sun's rising above some branches of a tree.

DISK OF MERCURY! It was nearer to the edge than I had expected to see it, and (truth to tell) it was very small; but exactly of the size which I knew it would appear, judging by the measurements of the sun, and of Mercury and the other planets, always given in Dietrichsen and Hannay's Almanacs.

The difference of longitude between Greenwich and my position (Kingstown, near Dublin) is about twenty-five minutes of time. Hence, when the sun rose at Kingstown, the planet had not only accomplished half of its transit (as was the case two minutes after sunrise at Greenwich), but had been more than

nesses on the Limb caused by Vapours, especially when the Moon is near the Horizon, and in windy and some other Weather. At which Times, the Motion of the Air and Vapours makes a pretty Crispation and Rouling, like Waves on the Moon's Limb, which have the appearance of moving Mountains and Valleys."

twenty minutes in retreat. I forgot this; and therefore when I descried the planet as above, at 8 A.M., I supposed I had still an hour and eighteen minutes in which to watch the transit, because it was to be over at 9h. 18m. This 9h. 18m., however, was but 8h. 53m. of Dublin time. Yet I have not to regret any idleness during those fifty-three minutes, the like of which are not to happen to me again for seven years, if ever again. I sketched the sun and the planet and solar spots repeatedly. I viewed them directly and by projection; and I called just one "witness to my Strange Site in the heavens," as the coastguard man wrote, who discovered Donati's comet, somewhat early in its career of celebrity. That witness came in good time to see it appearing when projected on paper, exactly as shown in the illustration which heads this narrative. To show it in this manner, the telescope was arranged as in Fig. 3, the window shutters being partly closed, and the curtains drawn, to add brilliancy to the effect. It struck me as a very curious circumstance that it should ever be possible to bring the veritable *shadow of a planet* into one's own room!

FIG. 3.

The figure heading this narrative gives a small portion of the solar disk as it appeared when projected on paper; it was not only *inverted* but *reversed*; that is to say, it was turned upside down, and shown, as in a looking-glass, left for right. The edge of the disk is to be imagined in constant undulating motion.

The sun, as observed directly with the telescope at this time, was as in Fig. 4. And now the planet rapidly neared the edge of the disk. I regretted much the low power of the telescope, as it prevented my looking out for some curious effects of irradiation which are said to have been observed on the entrance and departure of the planet during former transits. When the upper outline of the planet touched that of the sun (Fig. 5), I watched it intently; noting, however, nothing except that it took a considerable time to slide completely out of sight. It appeared as a *notch* on the sun's edge, becoming smaller and shallower, till at last it could no longer be distinguished from the rippling outlines of the sun. I then looked at a watch (one however which has the failing of being generally two or three minutes slow), and the time marked was eight minutes to nine.

Fig. 4.

And so the transit ended; the impression on my mind of a real movement having been best conveyed at its close, as it then became evident that the planet was passing out of sight. I thought the planet showed best as an *unusual* object, about ten minutes before its disappearance, that is to say, shortly before its upper edge touched that of the sun. The sun, through a telescope, always gives me the true impression of being a globe, not a disk. The solar spots as they come into sight or recede from view by the sun's rotation, are always foreshortened, as the engraved pattern, for instance, on a lampshade would be. Close to the sun's edge they are extremely slight and thin marks. But Mercury's shape, continuing unaltered, contrasted well with the solar spots. It was as though a small grain of shot were suspended in front of an illuminated lamp-shade.

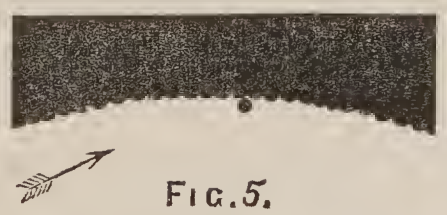


Fig. 5.

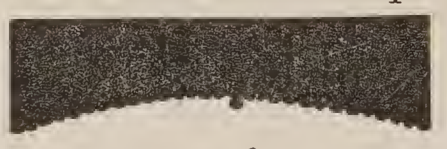


Fig. 6.

Fig. 7.

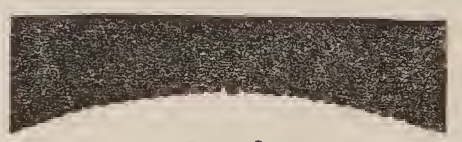


Fig. 8.

Mercury passing off the Sun's disk; the movement being from right to left, in the direction of the arrow.

The contrast to the solar spots was far less striking when the planet was nearer to the centre of the disk. But, in truth, the sight was altogether suggestive rather than striking, and was not very truly characterized in a newspaper paragraph which referred to it as "a grand phenomenon."

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

[It is proposed, under the above title, to give each month an account of the more interesting communications laid before the different learned and scientific societies.]

ENTOMOLOGICAL SOCIETY.—*January* 6.

On the Artificial Production of Varieties in Insects.—An animated discussion took place on a paper entitled, "Notes on Variety Breeding," read by Mr. C. S. Gregson before the members of the Northern Entomological Society at Manchester. The author of this paper says: "After years of careful study of the habits and food of insects, I determined to ascertain if a change of food would give a change of colouring and marking to species liable to sport, and during the last ten years I have been pursuing my experiments. The results of my experience go to prove that most unquestionably many species, some of them hitherto not often thought liable to vary, may be cultivated into varieties. For instance, *Bucephala*, fed upon sycamore, is much finer and darker than when fed upon any other food, though it is well known that this species is never found upon that tree in its natural state. After enumerating many variations produced by changing the food of the larvæ of insects the author stated, "What will, perhaps, interest you most to know, and undoubtedly what I know best, and have oftenest tried and succeeded in producing, is, that *Arctia caja*, fed upon *Petasites vulgare*, or upon the common colt's-foot, will produce darker specimens than when fed upon any other plant; and the chances are, that when fed upon this food, some of the specimens will prove extraordinarily dark. But there is a singularity in the fact that the darkest specimens so bred rarely open their wings." In opposition to the objections that such variations were the result of disease, it was shown that many of the specimens so varied were of larger and finer growth than the ordinary specimens. In the course of the remarks on this subject, Mr. J. Lubbock suggested the importance of ascertaining the effect of feeding successive generations of the same insect with substances calculated to produce variations, and expressed a hope that some entomologists would extend the observations over a series of years.

On the Causes which Influence the Production of a Fertile Queen Bee from a Worker Egg.—At a previous meeting of this Society, Mr. Tegetmeier called attention to a new theory, advanced by the Rev. Mr. Leitch, to account for the development of a queen bee from an egg, which, under ordinary circumstances, would produce a sterile worker. This fact, well known to all practical apiarians, was supposed by Huber to be effected by feeding the insect, whilst in the larval state, with a peculiar food termed royal jelly. The change, however, is always attended by an alteration in the size and position of the cell holding the future queen, which is enlarged and extended away from the plane of the comb, and in all cases turned downwards so as to assume the perpendicular position. The Rev. Mr. Leitch's experiments prove that the position of the queen cell is not of importance, as he inverted it in some cases, and in others placed it horizontally, but the queen was developed with equal certainty. He suggested that the cause of the more perfect development of the inclosed larva was due to the increased temperature to which it was subjected, and that it was drawn out from the other cells in order that it might be exposed on all sides to the warmth generated by the respiration of the bees that always cluster closely around the royal cell. At the present meeting Mr. Smyth read a paper, from Mr. Woodbury, maintaining the older theory, and stating that the transformation of any given worker egg or young grub into a queen, could be determined by placing a small amount of the food taken from a royal cell, and known as royal jelly, on the edge of the worker cell. In reply it was alleged that the food theory offered no explanation of the remarkable change of position that always is made to accompany the transformation, and the general opinion of the members present seemed to favour the view that the more perfect development of a worker egg or grub into a queen bee depended not upon one cause only, but was influenced by the threefold conjoined causes of increased, and probably altered food, enlarged size of cell, and greater elevation of temperature.

THE ROYAL SOCIETY.—*January* 9.

The Production of Sounds and Visible Vibrations by Voltaic Currents.—Mr. Gore furnished the following particulars respecting the production of vibrations and sounds by a voltaic current. It is found that when a voltaic current of suitable intensity, is passed by a mercury anode through a solution of ten grains of cyanide of mercury, one hundred of hydrate of potash in two ounces and three-quarters of hydrocyanic acid (containing five per cent. of the anhydrous acid), into an annular cathode of mercury, two or three inches in diameter, and one-eighth of an inch wide, visible vibrations of the negative mercury, accompanied by sounds, are produced; and the current, instead of being constant, becomes intermittent. If a voltaic current, from about eight Smee's elements, with large surface, is employed, the vibrations are small, and the sounds produced are high in musical pitch. If, however, another current of the same quantity (as determined by a voltameter), but resulting from a greater number (say twenty) elements of small surface, be employed, then the vibrations are large and the pitch of the sounds low or bass. These differences are still more conspicuous if a galvanometer of small resistance, with a short thick wire, be employed instead of a voltameter, and four Smee's cells be used instead of eight. If a current proceeding from two cells of a Grove's battery be passed through a primary coil consisting of 250 feet of thick copper wire, the vibrations are moderate in size and the sound of medium pitch. When a core of iron wire is placed in the centre of the copper coil, the vibrations become larger and the sound more bass. If this primary coil is surrounded by a secondary coil consisting of 4000 feet of fine wire, having the ends closed, and the core of iron wire is absent, the vibrations become very small and the pitch of the sound very high, these variations occurring although the current remains unchanged. It was found that if a battery of greater intensity be employed (say one of twenty Smee's elements), these remarkable effects were not produced. The inference drawn by Mr. Gore from these experiments was, that voltaic electricity, like heat and light, may be viewed as consisting of vibrations, which are ordinarly inappreciable, but which, under certain conditions, such as these described, may be gradually increased so as to become visible. These results are evidently worthy of the most attentive examination; their value as tending to elucidate the nature of voltaic electricity, can hardly be overrated, although it is evident that a sufficient number of facts are not yet accumulated to prove the inference that has been deduced.

On the Existence of Posterior Lobes in the Brain of Quadrumana.—Mr. W. H. Flower communicated some additional observations on the existence of the posterior lobes of the cerebrum in various genera of *Quadrumana*, as *Cercopithecus*, *Macacus*, and *Cebus*. These lobes also exist in *Presbytes* and *Hapale*, between the brain of the last and that of man, which are at opposite ends of a very extensive series, there is a gradual gradation, although in both posterior lobes exist which present certain characters in common. In the Lemur the recent brain presents the sylvian fissure, median lobe, calcarine sulcus, and general characters of convolutions, which prove that the brain of animals of this family is formed on the same general type as that of the higher *Quadrumana*. The gradation from the brain of *Homo* to *Hapale* is regular and gradual. The *Lemurs* are not, however, in the same line of degradation, but form a sub-series, which is parallel to the lower part of the larger group, this sub-series being distinguished by the shortness of the posterior lobes, the large size of the olfactory bulbs, and the inferior development of the cerebellum.

ROYAL GEOGRAPHICAL SOCIETY.—*January* 13.

Intelligence of Burke's Exploring Expedition.—In the absence of Lord Ashburton, Sir Roderick I. Murchison took the chair. In opening the meeting he read the address of condolence which had been presented by the president and council of the Society to her Majesty on the occasion of the lamented death of H. R. H. the Prince Consort. He then proceeded to say that by the mail of that morning he had received two deeply-interesting communications—one respecting Australia, and the other concerning explorations on the coast of Eastern Africa.

The letter and inclosures from Sir Henry Barkly, the governor of Victoria, conveyed intelligence of the successful crossing of the Australian continent by the expedition under the command of Mr. R. Burke; but at the same time told of the lamentable death of the leaders after their return to Cooper's Creek. They had accomplished the journey from Cooper's Creek to the banks of a river flowing into the Gulf of Carpentaria, by them supposed to be the Albert, but considered (according to corrected calculations) to be the Flinders River. They returned to Cooper's Creek, only to find the depôt abandoned by the party who should have awaited their return, and who, indeed, had only left the station a few hours before the arrival of Messrs. Burke and Wills, with King, their assistant. Provisions had been left for them, but the party were too much exhausted to travel on. Mr. Burke and Mr. Wills died of starvation, and the sole survivor of the expedition is King, who has been brought back to Melbourne. The object of the journey has been fully accomplished. A fertile tract, with wood, water, and pasture land, lies between Cooper's Creek and the Gulf of Carpentaria; and an opportunity is thus afforded for founding a settlement on the northern shores of the Australian continent.

The second communication was from Mr. Thornton, the geologist attached to the expedition of the Baron von Decken, on the coast of Africa, near Mombas. Mr. Thornton has fully explored the coast country from some distance inland, and has laid down several lakes and rivers. But the most important intelligence is that which he sends concerning Mount Kilimanjaro. Some discredit has been thrown on the statement of Mr. Rebmann, the missionary, that this mountain is covered with snow. Mr. Thornton, who has ascended Kilimanjaro to the height of 8000 feet, says that the summit of the mountain (which rises to 20,000 feet) is snow-covered, and that the snow lies in patches for a considerable distance down its sides. Further, on the north-east, south-east, and south sides, which are those that he has explored, there are distinct evidences of volcanic action in the lava-streams that have at one time poured down the mountain.

The papers of the evening, "On the Andaman Islands," and "On the Trade of New Guinea," were then read by Dr. Mouat and Mr. Galton.

The Andaman Islands were visited in 1859 by a party under Dr. Mouat, with the view of re-establishing on the Great Andaman a penal settlement. A short history of the group was given, and an account of the survey of the islands. The Great Andaman was stated to be not one island, but three, divided from each other by narrow straits, extremely difficult of navigation. The islands are of volcanic origin. The highest peak, 2400 feet, is found in the north of the Great Andaman, and the peaks gradually decrease in height from north to south of the island. All the elevations have steep descents on their northern sides, and slope gradually towards the south. The whole of the islands are covered with a dense tropical vegetation, and forests of mangrove line every part of the coast. The natives of the Andaman Islands are a peculiar people, short of stature, never exceeding 4 ft. 9 in. or 4 ft. 10 in. in height, little advanced in the arts of civilization, building wretched huts, but using canoes, employing bows and arrows as implements of war, brave, kind to each other, careful of their children, but extremely hostile to strangers. Most that is known about them has been gathered from the statements of two convict sepoys who escaped from the settlement at Port Blair, but voluntarily returned after having lived some time with the Andamaners.

A short paper on the trade of New Guinea was read, and then Sir R. Murchison called on Professor Owen to speak on the subject of the natives of the Andaman Islands. He said that Dr. Mouat had sent to him the only skeleton of an Andamaner that had ever reached England. He had found it to be that of an adult male in the prime of life, showing evidence, in the texture of the bones and the development of their parts, of having belonged to an individual who, though small of stature, must yet have been of accurate proportion. He had been most interested in the examination of the cranium, which he had expected to find allied to the Papuan or to the Negro variety. He had found, however, that the skull exhibited none of the characteristic peculiarities of the Papuan, and still less of those of the Negro; that it had no affinity with the Malay or the Mongolian type of cranium: in fact, that with the exception of the prognathous jaw-bones, in its classic oval and in its general proportions, it was most nearly allied to the skull of a Caucasian. In the course of his investigations some suggestions had presented themselves to him. Why is it necessary that, in determining the race to which the inhabitants of detached groups of islands belong, we should expect to find invariably that they are connected with the inhabitants of conterminous continents? In the case of many of these islands, particularly of Ceylon, it had been shown that the geological age of the island was much earlier than that of the adjacent mainland. Why, then, might not the inhabitants of such groups of islands be the descendants of races who had peopled continents which no longer exist, but of which these islands are the remains, and in comparison with which the present continents in the *eons* of geologic history are of very recent date? These are but suggestions. One thing, however, is certain, that the Andamaners, from whomsoever they may be descended, are *men* just as much as the inhabitants of any other portion of the globe, and that their frames are suited to enable them fully to enjoy their life in the situation in which they are found.

Mr. J. Crawfurd, F.R.G.S., president of the Ethnological Society, agreed with Professor Owen in what he had observed, and said that he might state, from his own experience, that natives of the Andaman Islands were capable of receiving training, and had been made very good household servants.

ZOOLOGICAL SOCIETY.—*January* 14.

HABITS AND STRUCTURE OF THE AYE AYE.—Professor Owen read an interesting description of the habits of that singular animal, the

Aye-aye, of Madagascar, which had been kept in confinement by Dr. Sandwith. The Aye-aye is an arboreal animal, about the size of a cat, with grasping hands and the teeth of a rodent, the forehand has a short opposable thumb, but is most strikingly distinguished by the very long and extremely attenuated character of the middle finger, which has the appearance of being deformed. The use of this remarkable structure was rendered evident when some branches, the wood of which had been perforated by large larvæ, were placed in its cage, when the thin finger was employed by the animal as a sounding instrument, being used in tapping, and as a probe to feel for and extract the grubs, which were immediately devoured with great relish; the peculiar teeth of the animal, which are formed on precisely the same type as those of a gnawing animal, enabling it to gnaw away the bark of the branches and a sufficient quantity of wood to allow it to reach the grubs. The animal feeds also on vegetable food, as dates and other fruits. The specimen, after remaining some time in the possession of Dr. Sandwith, was killed, and carefully preserved in spirit, previous to being remitted to England. The chief portion of Professor Owen's paper was occupied with a description of the details of the osteology of the animal. Its description will form the subject of future papers.

LINNÆAN SOCIETY.—*January* 16.

Discovery of the Welwitschia Mirabilis.—The first meeting of the current year (held at Burlington House) was most auspiciously inaugurated by a lengthened verbal communication from Dr. J. D. Hooker, F.R.S., who described to the meeting "the most remarkable plant that ever came to this country." Space will not allow us to follow Dr. Hooker with minute details, but we may remark that the new plant, for which the name of *Welwitschia mirabilis* is proposed, is not only structurally the most peculiar, but it is probably the ugliest plant that has ever been seen. It was discovered by Dr. Welwitsch, A.L S., beyond the northern limits of Cape Town, Southern Africa, and from the letters of that indefatigable botanist, as well as from the specimens exhibited by Dr. Hooker, we learn that the *Welwitschia* is a stunted-looking kind of tree, whose summit never reaches more than two feet above the level of the ground, whilst the short woody trunk never possesses more than two leaves. These extraordinary leaves are, in point of fact, the expanded seed-lobes, or cotyledons, which make their appearance as soon as the young plant rises out of the ground; and, what is still more astonishing, these aforesaid leaves live, grow, and remain attached to the stumpy trunk during the entire life of the tree, which, it is calculated, lives at least one hundred years. We may also further observe that these two persistent foliar organs spread out laterally; in some fine examples of the *Welwitschia* attaining, each of them, a length of nearly six feet. The flowering axes shoot up from the summit of the stumpy trunk, which is flattened at the top, and like a folded card-table is divided by a central line into two equal halves. The root is conical, and longer than that part of the trunk which appears above ground. There are many other points of peculiar scientific interest connected with the form and structure of this astonishing plant. These details, with ample illustrations, will duly appear in the next part of the Linnæan Society's "Transactions," for the issue of which, towards the close of the year, all botanists will consequently look forward with unusual anxiety.

NOTES AND MEMORANDA.

New Polariscope Object.—Mr. Davies, writing in the "Quarterly Journal of Microscopic Science," describes a double sulphate of copper and magnesia, obtained by mixing solutions of the two sulphates, and then crystallizing, as exhibiting beautiful polarizing powers. He says it is rather difficult to crystallize well. It ought to exhibit "peculiar flower-like forms."

The Mangold-Wurzel Fly.—The Rev. W. Haughton describes, in the "Quarterly Journal of Microscopic Science," that fly whose larva has recently proved destructive to mangold-wurzel. Until last year it seems that the male sex predominated, and consequently little harm was done; then, however, the proportions were reversed, the females being estimated as twelve to one, and hence the extent of their injurious work.

Circulation in the Tadpole.—The "Quarterly Journal of Microscopic Science," for January 1862, contains an interesting paper by Mr. Whitney, on the circulation of the tadpole, explaining the means by which this creature enjoys "a much higher circulation of the blood than the reptile arrangement will permit." By selecting very transparent specimens, and keeping others upon water diet, so as to prevent the intestines containing opaque matter, he was able to trace the connection between the three great arterial trunks (the cephalic, pulmonary, and aortic) with the lungs. In the course of his experiments he endeavoured to remove all opaque matter from the convoluted bowel by purgative drugs; but the nauseous preparations did not exhibit any cathartic effect.

Dispersion of Light.—M. Radau, writing in "Cosmos," upon the researches of Cauchy, and citing his formulæ, observes, "it results from these formulæ that the velocity of a luminous ray depends, in general, upon its colour; and that the unequal velocities of the different rays of the spectrum is the cause of their dispersion by the prism."

Gigantic Cephalopod.—M. Flourens has recently communicated to the French Academy an account of an enormous cephalopod, seen by Lieut. Bouyer, about forty leagues north of Teneriffe. It appeared to be about ten to fifteen mètres in length (from thirty-one to forty-six feet), having a soft gelatinous body of a reddish colour and shaped like an immense horn; the widest part being about two yards in diameter; and surrounded by very strong arms or tentacles. It was repeatedly shot at, and the balls passed through it without doing much harm. On one occasion, however, a quantity of blood and froth, of a musky odour, flowed from the wound. After being harpooned several times, the body of the creature was surrounded by a rope, and efforts were made to haul it on board. Unfortunately the rope cut the soft flesh, and only the posterior part was secured. The sailors wished to pursue the remainder of the monster in a boat, but Lieut. Bouyer was afraid that its long tentacles, armed with suckers, might enable it to swamp them, and it was therefore permitted to escape. M. Moquin Tandon added some further particulars, and exhibited a sketch. He observed that the fishermen of the Canaries often met with similar creatures, exceeding one or even two yards in length; but they were afraid to attack them. M. Milne Edwards recited numerous instances of the appearance of monster Cephalopods.—Rang had seen one with a body as big as a hogshead; and Steenstrup examined the body of another, which was thrown on the shores of Jutland; and which he denominated *Architeuthis dux.* M. Milne Edwards considered there was reason to believe that these large Cephalopods were not all of the same species; and he had no doubt that many kinds, which existed in the depths of the sea, far exceeded the bulk of any known invertebrate animal.

Artificial Crystals.—M. Becquerel has succeeded in producing opals and other crystalline minerals, in a short space of time, by strong currents of electricity. In order to succeed in these experiments, the solution must be pure, and of a particular strength, while the intensity of the current must be regulated by the nature of the materials. From a solution of sulphate of alumina he obtained, in the course of a few hours, a hydrate of alumina, like diopside, hard enough to scratch quartz. In like manner he has hopes of ultimately producing topazes and sapphires.

Why Oysters are not found in the Baltic.—The St. Petersburg naturalists tell us that while oysters are found in the Mediterranean, the Atlantic, the North Sea, and the northern parts of the Cattegat, they do not occur in the Baltic, and refuse to be naturalized there. These facts are accounted for by the small percentage of salt which the Baltic waters contain. The waters of the Mediterranean contain 3·7 per cent. of salt; those of the Atlantic, 3 to 3·6 per cent.; the north of the Cattegat, 1·8 to 2 per cent.; while the saltest part of the Baltic yields only 1·7 per cent. of salt.

One-Chimney Houses.—We find an account, in "Cosmos," of a plan of making all the fires of a house communicate with one chimney. The stoves employed are of a smoke-consuming kind, and the "unitary chimney" descends to the cellar, where it is closed with a plug, which can be removed when sweeping is required.

The Universal Achromatic Microscope.—This is the name given by Messrs. Smith, Beck, and Beck to a very valuable instrument upon a new plan, and intermediate in quality between the ordinary educational microscopes, and those of the first class. The form is peculiar, and evidently devised with greater regard to facility of manufacture, than elegance of effect. It is not, however, bad looking, and presents a combination of advantages not previously offered at so low a price. A heavy ring of metal supplies a solid foot, and on one side rises a short pillar, by which the body of the instrument is supported, and upon which it is balanced, so that it can be inclined and fixed at any angle. The body is square, but this does not affect the shape of the field, which is round as in ordinary patterns. The eye-pieces are on Kelner's principle, having the field lens in the focus of the eye lens, an arrangement which has the inconvenience of making any particle of dust on the former exceedingly troublesome, but which possesses the advantage of giving a large flat field, and of obtaining a given power from the objectives with a shorter body than the usual Huyghenian eye-pieces require. The objectives are two in number, of one inch and one quarter inch focal lengths. A large and conveniently placed milled head moves the coarse adjustment, while a lever, like those in Mr. Ladd's instruments, makes a fine adjustment, delicate enough for all ordinary purposes. The mirror beneath the stage may be readily placed so as to supply oblique light, and a condenser upon a jointed stem suffices for opaque objects that do not require to be strongly lit. The stage is furnished with a somewhat clumsy-looking but effective apparatus for holding slides, and assisting their adjustment by hand, and is so made as to receive Wenham's parabola, the polariscope, or other additions which the purchaser may require. In its simplest state this microscope will suffice for the generality of observations, and its capacities may be brought up to a high standard by a small additional outlay. We were particularly struck with the quality of the objectives: the quarter inch, with the second eye-piece, enabled us immediately to exhibit both sets of lines on the *Pleurosigma formosum*, and we have no doubt it would resolve much more difficult tests.

Derivative Character of Chinese Literature.—M. de Paravey, after carrying on many investigation into the accounts of the *Quadrumana*, given in Chinese works, finds his opinion confirmed, that the ancient books now extant, belonging to this singular people, were founded upon others, still older, and written in countries remote from China.

Movements of the Heart.—MM. Chauveau and Marey have applied a self-registering instrument to record the movements of the human heart, and they inform us that the systole of the auricle begins and ends before that of the ventricle, and that the systole of the ventricle and the beating of the heart begin and terminate simultaneously, From these observations they conclude that the beating of the heart is not the result of the auricular systole, but of the systole of the ventricle. They publish in the *Comptes Rendus* (January 6, 1862), a diagram of the lines of their registering instruments, corresponding with the movements in the heart.

Recent Eruption of Vesuvius.—The Abbé Giardono, professor of physics in the University of Naples, contributes to "Cosmos" some interesting particulars concerning the last eruption of Vesuvius. He states that the mountain has been in nearly constant activity since 1855, when a great flood of lava overwhelmed half the valley of Vetrana and the ravines to the west of the crater. In 1858 there was another outbreak which lasted two years, and devastated a fertile tract of country. During this long period the grand crater at the summit of the cone never ceased to vomit forth fire. Then followed three months' tranquillity, broken at mid-day on the 8th December, by a violent shaking of the earth, which was felt as far as Naples. The first shock was followed by eight others, at intervals of ten or fifteen minutes, some of a vibratory and others of an undulating character. Then came half an hour's rest, and at three o'clock, without any trembling of the earth or other warning, a dense *cumulus* cloud of smoke rushed from the flanks of the mountain, and towered above the cone, forming the *pine-tree* appearance so famous in old observations, and rolling down in huge masses, driven towards the sea by the N.E. wind. At Torre del Greco the darkness was excessive, and volcanic ashes, not in an impalpable powder, but in a granular form, were scattered over the surrounding country. This immense quantity of matter was emitted from a chasm opened in the side of the volcano. At this spot the first new crater was formed, and afterwards a second and a third in the same line. They were about fifteen hundred yards from the craters of 1794, and opened in the midst of cultivated ground, the first actually commencing under the house of a husbandman named Abbrucci, who was fortunate enough to escape with his family. About an hour after the first crater was opened, the flow of lava began, accompanied by showers of scoriæ and volcanic bombs. Dismal bellowing noises were heard throughout the country, but nothing like the tremendous explosions that occurred in 1850. At first the fiery torrent directed its course S.E. towards Torre del Greco, and as it descended it acquired a breadth of more than three hundred yards. It was not liquid, but like a stiff paste, full of large masses of scoriæ of curious forms. It moved slowly through the night, sometimes stopping, sometimes advancing, and at five o'clock in the morning of the next day had not progressed more than a sixth of a league. The lava was rich in augite, and of a black colour. Up to this time the grand crater had taken no part in the eruption, but it began to pour forth smoke, cinders, and lava masses, which fell at the base of the cone. The lesser craters diminished their energies, and the lava torrent stopped as if by magic. This, which seemed to be the time of safety, was the moment for the destruction of the buildings in Torre del Greco, as the earth shook violently and opened in numerous *crevasses*, splitting the buildings right and left. The eruption was also signalized by electric discharges from the great cone; claps of thunder pealed every five or ten minutes from the interior of the crater; and flashes of lightning, straight and forked, illuminated the clouds.

// THE INTELLECTUAL OBSERVER.

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THE CONDITIONS OF INFUSORIAL LIFE.

A SCIENTIFIC controversy, carried on by able and assiduous experimenters, cannot fail to enlarge the boundaries of knowledge, although it may not decisively affect opinion on the special subject in dispute. This has been the case with the discussions on spontaneous generation, or "heterogenesis," which have occupied the attention of French scientific men and of the Academy of Sciences for the last few years. The main question has not been elucidated so as to compel the assent of both parties to the same views; perhaps not a single eminent convert has been made on either side, but information has been elicited of a very valuable kind. Before M. Pouchet, of Rouen, came forward as the champion of heterogenesis, the balance of evidence was in favour of those who believe that infusorial life manifests itself only when germs are present, and other appropriate conditions provided; and so the matter still stands. It must not, however, be imagined that the parties to the controversy do no more than reiterate the old convictions. The spontaneous generationists have adopted a substantially new theory, differing as much from the opinions of their predecessors, as the speculations of Darwin differ from those of Lamarck; while the "panspermists," as M. Pouchet calls them, must feel the necessity of modifying their ideas of germs. It is unwise to let the dislike of a doctrine lead to the belief that it is extinct; but this feeling seems to have actuated the authors of that valuable work, the "Microscopic Dictionary," for in the second edition, dated 1860, we find these words in page 312, "the doctrine of spontaneous generation may now be said to have become a matter of history;" although at that very time the *Comptes Rendus* gave ample proof that many of the acutest thinkers in France were engaged in experiments, and counter-experiments, which have not yet ceased.

It is not the intention of the writer to discuss the fundamental principles of the opposing theories; but before giving an account of M. Pouchet's observations, which have a value quite independent of his main argument, it will be interesting to show what his views really are, and we find them abundantly stated in his work entitled "Heterogenie," published at Paris in 1859. He declares that he has never said a word to lead any one to suppose that he believes in the generation of animated beings without the aid of vital power; that, on the contrary, he has always thought that organized beings were animated by forces which were in nowise reducible to physical or chemical forces (p. 428). He considers generation, or the manifestation of life on the globe, to have been one of the first acts of creation, and he believes that similar acts are continually taking place. As a rule, heterogenists have developed a system adverse to great convulsions in Nature; but M. Pouchet adopts what may be called spasmodic theories of geology, and he tells us that the manifestations of spontaneous generation do not now reach the same proportions as in ancient times; that they have grown smaller like other telluric phenomena, because we have not now in fermentation that immense mass of dead matter resulting from "so many cataclysms and funerals of animals; and therefore, instead of the gigantic races which surged up from the midst of agitated elements, we only witness the production of the lowest forms" (p. 462).

As will presently be seen, this strange supposition is a most unphilosophical induction from some interesting experiments on the effect of mass, in a fermenting material, in determining the kind of organism which will be produced. M. Pouchet further contends that his views harmonize with the system of Nature, as exhibited in the generation of the higher kinds of animals; and with the opinions of certain physiologists who affirm that in a great number of animals of all classes, the "first lineaments of ovules" have no adhesion to the internal apparatus which produces them, and that the ovules form themselves, under the influence of a special force, in the midst of a granular fluid secreted in the cavity of the apparatus (p. 374). According to this hypothesis, the mother does not form the egg, but it develops itself; and the maternal apparatus exerts a dynamic force upon it, which reproduces the original type (p. 378). In further exemplification of these views, he asserts that the ovary is the seat of an independent genetic force, and that, in like manner, organic matter may be the seat of an analogous force, so that the generation of ovules from what he calls "the proligerous pellicle, or scum which appears on infusions of vegetable matter as fermentation proceeds, is precisely analogous to that of natural ovules in the ovary" (p. 378).

Having explained the chief points of M. Pouchet's theory of heterogenesis, his method of proof next engages attention, and this may be described as a process of elimination. He endeavours to show that air, which contains no germs, water, which contains no germs, and a decomposing solid, which contains no germs, may, by mutual contact and influence, give rise to living forms. Here it may be remarked that the almost inconceivable minuteness of some germs, and the great difficulty of insuring their perfect destruction and exclusion, is quite sufficient to throw a doubt upon the accuracy of many of his experiments, without doing any injustice to him as a skilful manipulator; and although we may fail to detect the precise source of error, we are justified, by another class of experiments, in believing that error did exist. It is important, in the present state of physiological science, to deal with these questions inductively; and if certain experiments appear to prove M. Pouchet's theory, they can only be fairly met by counter-experiments of the same kind, conducted with greater precautions, or by analogous experiments of equal importance, and indicating an opposite conclusion. How this has been done will be seen hereafter. Let us now select from M. Pouchet's book the most interesting observations on the conditions of infusorial life.

It is well known that the fermentations or chemical changes in infusions provide one of the necessary circumstances for the development of infusoria, and as boiling infusions checks this action, it is inimical to the appearance of life. Four of M. Pouchet's experiments place this in a striking point of view. Four large vessels were covered by one glass shade, so that all might be exposed to the same influences; each vessel contained 300 grammes* of liquid. The first was filled with water which had been boiled for fifteen minutes, and twenty-five grammes of hay, which had also submitted to ebullition, and the other three with a different mixture. After three days, during which the four vessels had been exposed to a temperature of 24° centigrade scale (or 75° Fahr.), the first exhibited a slight pellicle and a few vibrions, long and short (*vib. granifer* and *vib. levis*). The second vessel, containing water which had been boiled, and five grammes of hay which had not been boiled, had a well-formed pellicle, a much larger quantity of the same vibrions, and an abundance of kolpods (*K. triticiformis*). The third contained water which had not been boiled, and five grammes of hay that had been subjected to the action of boiling water for a quarter of an hour. This contained the same vibrions as the preceding, more numerous than in the first, and less so than in the second vessel, and also a few of the kolpods. The fourth vase contained water and hay as before, neither having been boiled. Its pellicle was much thicker, its inhabitants the same, but much more numerous. In another case a strong decoction of hay was exposed

* The gramme is 15·434 grains troy.

to the air for thirty-five days without giving any signs of infusorial life.

Another curious set of experiments was made with fragments of human bone; all the vessels being placed under similar conditions. These vessels were filled with the same filtered water. In the first were five grammes of the skull of an Egyptian, which M. Pouchet brought from the necropolis of Sakkara; the second contained the same quantity of a Merovingian skull, and the third was supplied with pieces from a contemporary cranium. Each was placed under a bell-glass, and left alone for a month, at the expiration of which time the Egyptian bone liquor exhibited a numerous family of epistylis, enchelis, and vibrions. The Merovingian liquor was rich in *Glaucoma scintillans*, to the extent of legions, together with a few vorticellids; neither of which appeared in the first glass. The broth made from a contemporary skull had its own peculiar inhabitants in the shape of kolpods. The three vessels were then placed under one bell-glass, but they still maintained the peculiarities of their population.

M. Pouchet remarks, that it is not only the nature of the fermentable substance, but its quantity, that determines the kind of infusoria that appear. For example, he took similar vessels, placing in each thirty grammes of spring water, but different quantities of hay. They were all covered by bell-glasses, kept at about 75° Fahr., and examined in a week. The first, with ten grammes of hay, had a thick pellicle, and the liquid contained a great quantity of *Kerona lepus*, some pear-shaped animalcules, and large cysts. The pellicle likewise contained a quantity of small cysts. The second vessel, with five grammes of hay, had a thinner pellicle, no keronians, a few piriform creatures, and fewer cysts. The third vessel, with two grammes and five decigrammes of hay (that is, about thirty-three grains), showed no keronians, no large cysts, a few small cysts, and very minute indeterminable animalcules. The fourth glass, which had one gramme twenty-five centigrammes of hay (about nineteen grains), presented infusoria, "infinitely less than those in the first vessels, and of indeterminable character."

Pouchet considered, somewhat hastily, that these experiments proved that the air was not the vehicle of the germs, and that the quantity of the decomposing matter exercised some peculiar influence. To the latter part of this supposition, he calls it a "puerile objection" to affirm that the requisite aliment existed in different quantities. It should however be remembered, that a proximate analysis of hay would show that it contains certain substances in exceedingly small proportions, so that the fermentation of a little bit would only give rise to an infinitesimal quantity of particular products. It has long been known that a large mass of hay in a pailful of water is more productive of the higher forms of infusoria, than trials made in a tea-cup; but we cannot ascend by such experiments to the spontaneous production of the mammoth from the general smash and corruption of older families in the organic world. Tropical swamps exhibit some of the conditions of vastness of decomposition, which M. Pouchet considers essential to the exhibition of heterogenesis on a grand scale; but can he show that they produce larger creatures than would appear, if similar materials were operated upon under the same atmospheric conditions in an experiment of moderate size?

The state of division of the fermentable matter exercises a considerable influence on the generation of infusoria, by hastening the chemical changes which make the fluid their fit abode. Thus, a vessel containing water and chopped hay produced a richer and different crop of animalcules, from another in which the hay was in a mass. With respect to the influence of different sorts of water, M. Pouchet coincides with Burdach in finding that of dew the most prolific; after which comes rain-water, and then spring-water. He likewise observes, that water which has been boiled is less favourable to the production of infusoria than the same fluid in its ordinary state. Such observations are easily explicable upon the theory of germs; but by adopting a singular process of reasoning, M. Pouchet endeavours to show that they support his own views.

As mincing the fermentable material increased the productiveness of the fluid by accelerating decomposition, we should expect a similar effect would follow an increase in the supply of atmospheric air; and accordingly if two vessels are taken, and in one chopped hay is kept near the surface, and in the other the same substance is retained under a greater depth of fluid, the first will exhibit the earliest, most numerous, and highly developed life.

The prevalent theory of the distribution of germs supposes the air to be the means of their dispersion, by first suspending them, and then dropping them, wherever atmospheric dust falls. It likewise appears, from numerous experiments, that a fresh supply of air is necessary for the production of the higher forms of infusoria, and that liquids in close vessels only yield lower kinds; the probability being, that some of the gaseous products of decomposition exercise an inimical effect, when they are not permitted to escape. But although pure air may, with some exceptions, be designated, with M. Pouchet, "indispensable to the life of microzoaries," he discovered that the vacuum of an air-pump did not destroy them. Fray and Burdach stated that infusoria appeared in an atmosphere of hydrogen or nitrogen; but M. Pouchet sums up the results of numerous experiments by affirming, that he has never seen the appearance of a proto-organism in water deprived of air, or in water aerated with nitrogen, hydrogen, or carbonic acid; oxygen alone forming an exception. We may here cite a curious observation of M. Pasteur,* on the peculiar fermentation which produces butyric acid. The agent in this process he declares to be an animalcule, which appears in considerable numbers, like small cylindrical rods, isolated, or united in groups, moving in undulations and "pirouettes," and multiplying by fission. They may be transplanted like yeast, setting up the butyric fermentation in appropriate substances; and they have this peculiarity, "not only do these infusoria live without air; but air kills them. Carbonic acid does not affect them."

The influence of heat and light on the production of infusoria engaged much of M. Pouchet's attention; and we find him repeating previous experiments, and adding others entirely new. The results he arrived at were, that no animalcules are generated in infusions kept at a temperature below + 5° cent. (41° Fahr.) In macerations, kept at a temperature of 12° cent. (54° Fahr.), eight days often elapsed before many adult kolpods appeared, while, at 26° cent. (79° Fahr.), four days sufficed to produce "numerous legions, perfectly developed." He likewise observed the tendency of different temperatures to develop different species in the same solutions, and came to the conclusion of Gruithuisen, that from 80° to 96° Fahrenheit was the greatest heat at which infusoria were generated at all. When however they were in existence, they could support extreme changes. Thus, if animalcules living in a liquid at 22° cent. (72° Fahr.), found themselves at the freezing point, in the course of a few minutes, they manifested no inconvenience. In order to test the assertion, that infusoria would revive after being actually frozen, M. Pouchet made several trials, which had the result of showing, that a mass of ice usually contains minute spaces filled with water, which has not congealed, and it is in these that the animalcules live. When however an entire mass was solidified, the larger species perished, and their dead bodies remained, while monads and vibrions frequently escaped. Some vibrions he found able to sustain the intense cold of 15° below zero in the centigrade scale, or 27 degrees below the freezing point of Fahrenheit.

A moderate intensity of light was observed to be more favourable than an excess of luminosity, and direct sunshine in very hot weather had an injurious effect. White light was the most favourable, then red, then violet, blue, and green, for the production of the protozoa; although microscopic vegetation was affected in an opposite way, green being the most favourable,

* *Comptes Rendus*, 25th February, 1861.

blue and violet coming next, and then white light, red being inimical. M. Morren had stated that the action of light was indispensable to the production of vegetable organisms, and that if a series of vessels filled with water were exposed to a more or less intense illumination, those with least light exhibited fewest protophytes and of the most simple construction; but M. Pouchet on repeating his experiments came to an opposite conclusion. In one instance he placed a piece of crumb of bread in a large glass, covered it with three black shades, and placed the whole in a situation of complete darkness. In a week the surface of the bread was covered with blue mould, *Penicillium glaucum*, between the filaments of which were swarming an abundance of *Monas lens*, and several vibrions. In another instance M. Pouchet placed, in a dark corner of his laboratory, an infusion of hay, covered with a bell-glass painted black, over which was put a strong sheet of gray paper, and over this again another black shade with a roll of linen round its base. The whole of this apparatus was further protected against the intrusion of light by double curtains, black, and tawny *(fauve)*. In three days, the temperature being warm, the liquid was covered with a thick pellicle, while monads, vibrions, and kolpods were abundant.

The passage of a current of electricity through the infusion materially hastens, according to M. Pouchet, the production of infusoria, his experiments being performed with one element of Bunsen's battery. Atmospheric electricity afforded still more striking results: the more it abounded, the faster the infusoria appeared, especially if the tension, instead of being suddenly produced by a storm, lasted for several days. Under such circumstances he obtained kolpods as highly developed in three days, as would have been obtained, with the same temperature and less electrical excitation, in double that time.

Contact with mercury, and mercurial vapours, had no injurious effect on infusoria; and, contrary to what had been affirmed by M. Morren, air which had traversed sulphuric acid neither killed them nor hindered their production. A wooden cover, almost touching the infusion, exerted a favourable influence; and the shape of the vessel was important, so far as it promoted, or hindered, the action of light and air on the fermentable matter.

It has been explained that M. Pouchet endeavours to prove his theory of heterogenesis by an exhaustive process of experimental reasoning. He seeks to show that the supposed germs do not exist in the air he employs, nor in the water, nor in the putrescible solid; but still the infusoria appear—produced, as he believes, by the same vital force that presides over the generation of the higher animals; and which, he tells us, "engenders in the ovaries of created beings, other beings similar to themselves, while in putrifactive substances it produces only microscopic animalcules." It will at once occur to every reader, that although the germs of the larger infusoria might be excluded with moderate precautions, those of the smaller kinds, which must be extremely minute objects under the highest powers of magnification our microscopes possess, would, if widely disseminated, be so difficult to keep out of any large and complicated piece of apparatus, as to justify doubts in the accuracy of any series of experiments leading to a conclusion demanding unusual severity of proof. And even the successful repetition of any set of experiments, which appear to support a theory at variance with the general conclusions of science, ought not to command our assent unless other modes of testing the question afforded the same results. It would also be reasonable to give greater weight to the simplest methods, if complete in themselves, as offering fewer chances of error, than trials made with more complicated apparatus, and presenting a greater variety of parts. Following this rule, it is no disparagement to M. Pouchet's qualifications as a manipulator if we accept his experiments for their general information, and at the same time reject their conclusiveness for the particular end he had in view. In this spirit we may cite several of his illustrations without recurring to the generation arguments at every step.

Under the head of "Eliminations of the Putrescible Body," we find that maize, peas, haricots, and lentils, were separately burnt in an iron ladle at a red heat, and their remains placed in distinct vessels with distilled water, and covered with separate bell-glasses. In twenty days of warm temperature, the maize vessel exhibited an abundance of a fungus *(Aspergillus)*, but no animalcules, nor did any appear till another fifteen days had expired; the peas yielded numerous and varied microzoaries, and especially *Monas attenuata.* The lentils did the same, and the beans a still thicker population of the same monads. "*Criterium*" vessels, with the same seeds not burnt, produced abundance of animalcules in three days, and of a higher grade than in the former cases. Here we see the influence of minute variations in the chemical composition of the several incinerations, and possibly also of their mechanical condition, in offering appropriate circumstances for the evolution of different germs.

In another experiment, some hay was heated to 200° to 210° centigrade, and even a little higher, till it began to burn, and it was then immersed in distilled water, covered with a plate of glass, and put under a shade. After four days of warmth, the infusions contained a quantity of dead vibrions, with a large population of *Glaucoma scintillans* and minute monads. From these and similar experiments, it is plain that the production of infusoria is not dependent upon germs contained in solid bodies.

With reference to the water and its action, M. Pouchet elucidates it by experimenting with an artificial combination of oxygen and hydrogen. Having obtained a sufficient quantity of water in this manner, he boiled half of it to destroy any germs that might have fallen into it, and then made an infusion with some hay that had been heated to about 200° centigrade. The whole was covered with a bell-glass, and in a few days displayed two species of paramecia. The other half of the artificial water was treated with hay that had been heated, and yet the same infusoria appeared. These experiments, says M. Pouchet, prove that water is not the receptacle of the "germs" on which his opponents rely. They merely show that water containing no germs will suffice as a medium in which germs from some other source may be developed. Another illustration of the action of water was obtained by skimming off, from an infusion of China aster, "an immense quantity" of kolpods, which were transferred to distilled water, and remained in perfect health for fifteen days; from which M. Pouchet concludes "that it is not the matter dissolved in the water which feeds the microzoaries, or at any rate they can live a long time in pure water." Another curious experiment was performed by grinding up with a muller, or pestle, a legion of kolpods. One half of the homogeneous paste thus obtained was diluted with water, *filtered*, and placed under a bell-glass; the other half was mixed with the same quantity of water, but not filtered. In a week of moderate temperature, the filtered water exhibited an innumerable quantity of vorticellids, and not a single kolpod; while the non-filtered mixture displayed no vorticellids, and no kolpods, but small monads. Upon these facts our author remarks, "The partisans of the transmission of eggs through the intervention of atmospheric air, cannot in any way explain what happened in these two experiments. If the two vessels had contained kolpods, the supporters of ovarism would have declared that the eggs of these animalcules were so small that the grinding process had not broken them up." From a single experiment of this sort no general conclusion can be drawn; but, as we shall presently see, there is no reason to believe that the air contains an unlimited supply of germs of all sorts: one portion will contain none at all; another, those of a particular kind, while a third will differ from the other two. Speaking of the minuteness of certain animalcules, M. Pouchet quotes Owen, to the effect that a single drop of water may contain more monads (*M. crepusculum*) than there are human beings on the globe; and he adds, but this microzoary can manifest itself wherever we offer it appropriate infusions, and that on the aerial diffusion theory, the atmosphere must be so encumbered by its germs, that if we add those of other infusoria in similar proportion, we should have the air so crammed with them, that it would almost reach the density of iron. This remark affords an illustration of the good effect of such controversies, for it led to a complete rectification of the thoughtless assertions often made on the abundance of germs; and other experiments placed the question upon a very different footing, as we shall see when we come to the part taken in this scientific warfare by M. Pasteur. In an endeavour to convict the germ party of absurdity, M. Pouchet took a large quantity of beef, divided it into three portions, and placed them in three separate vessels of water, covered with plates of polished glass, leaving an air space of one millimètre* (about a three hundredth of an inch). One of these vessels was put in the roof of the Museum of Natural History, another left in a laboratory on the second floor, and the third placed on the ground floor. In three days each glass was filled with one species of little monad (*M. crepusculum*), to such an extent that if they were to be accounted for by the fall of atmospheric germs, M. Pouchet estimates that more than sixty-two millions must have existed in each cubic millimètre of air. Of course the germ theory does not necessarily demand such an abundance of eggs, and the experiment is a proof of fecundity rather than of anything else.

Observations of what takes place in close vessels are essential to a comprehensive view of the conditions of infusorial life. If air is entirely excluded, we cannot expect to find that any will be developed, unless under special circumstances, like the butyric fermentation, to which allusion has been made. Messrs. Schultze and Schwann published some experiments, in Poggendorff's Annals, in 1837, tending to show that if a maceration was well boiled, and no air admitted except what had either passed through fire or sulphuric acid, no infusorial life would appear. To these M. Pouchet opposed new observations repeatedly performed with great care. M. Schultze placed some vegetable and animal substances in a flask with distilled water, which was boiled to destroy any germs. Two tubes, furnished with bulbs, passed through the cork closing the flask. One tube contained sulphuric acid, and the other a solution of caustic potash, so that all air transmitted through them would come into contact with these destructive substances. The experimenter passed air through the tube every day for two months, during which no form of life appeared, although abundance was developed in a similar flask in the same situation which had free access to the atmospheric. Repeating this experiment with the precaution detailed in his work, M. Pouchet

* The millimètre is ·03937 of an English inch.

found the liquid clear till the twentieth day, when it became cloudy. Four days later he discovered a little blue spot, which was the first appearance of the fungus *Penicillium glaucum*. This plant increased, vibrions appeared, and likewise monads of indeterminable species. The repetition of Schwann's experiments produced a similar result. Messrs. Joly and Musset give an account of similar experiments in the *Comptes Rendus*,* in which they say they have vainly submitted the organic substances employed to prolonged ebullition, in vain submitted the air to a very elevated temperature in tubes brought to a white red heat (*rouge blanc*), or passed it through sulphuric acid; in all cases they found very simple organic substances developed in their infusions. It may be well to mention at this point the observations of M. Pasteur, who has shown that the spores of mildews are not destroyed by being exposed to the action of concentrated sulphuric acid for several days. Other germs of objects of low organization may be equally difficult to kill.

It was considered by M. Pouchet that if the air contained the supply of germs usually imputed to it, and ready for deposition in a suitable liquid, the first washings of the air ought to contain the largest number, and subsequent washings would exhibit a marked diminution. To test this, he took eight of Wolff's bottles, and partially filled them with a decoction of hay, which had been boiled for an hour, filtered, and introduced boiling hot into the vessels. After this he passed steam through the series of bottles for half an hour. They were then left for fifteen days, when every vessel exhibited a population of kolpods, the last of the series being as rich as those preceding it. During two years he frequently repeated these experiments, with various contrivances to facilitate the stoppage of any particles the air contained, and he arrived at the conclusion that "the animalcules were, normally, equally numerous in all the vessels—in the first as in the last." In one case, however, he had the curious fortune to find the first vessel solely occupied with *Navicula obtusa* and a green conferva; the second chiefly with *Dileptus folium*; the third with small animalcules and several rotifers; the fourth with the same conferva as in the first, and some kolpods; the fifth exhibited vorticellæ, epistylis, and glaucomæ, while other objects had been developed in the sixth and seventh. During this experiment a large measure of air was daily blown through the series of bottles. Upon this M. Pouchet remarks, that while the results are inexplicable upon the germ theory, they are easily explained by heterogenesis, as "each vessel has engendered special generations, because it was the seat of particular modifications, which time had diffused unequally through the macerations." The "unequal

* 21st January, 1861.

diffusion of modifications" appears to be an assumption made to suit the hypothesis—not the observation of a fact; and if true, it might supply the conditions necessary for the development of different germs.

Passing over a variety of experiments that are well worthy of attention, we come to M. Pouchet's remarks on the scum, or pellicle, which makes its appearance on the surface of infusions, and which he calls the "proligerous pellicle" (pellicule proligère). This pellicle, he asserts, is composed of the "*débris*" of "animalcules," at first of the lowest kind, afterwards of higher grades. He gives it the epithet "proligerous" because he considers it to play the part of "an improvised ovary which produces the animalcules;" how those previously formed were produced he does not so clearly explain. Of these pellicles he discovers several kinds:—1. The granulated pellicle, composed of the carcases of monads and bacteriums. 2. The matted pellicle, formed by the interlacement of the bodies of long vibrions. 3. The pseudo-cellular pellicle, which appears after the generations of small monads and vibrions have passed away, and is composed of deceased kolpods, or great monads. 4. The composite pellicle, in which the previous elements are combined. In confirmation of his views, M. Pouchet quotes Dumas to the effect, that if a piece of flesh be left in water, it is resolved into minute organic particles which exhibit spontaneous motion, and which combine to make more complicated forms. A similar observation was made by Mr. H. J. Clarke, of Cambridge, U.S.,* who states that on watching the decomposition of a proboscis of a young *Aurelia flavidula* (a jelly-fish), he observed the whole of the component cells in violent agitation, like a single layer of shot shaken in a flat pan, each cell appearing like a monad, when the inner wall fell to pieces, and they scattered in various directions; others looked like chilomonads, and others like hexamita. The same observer affirms that the fibrillæ of the decomposing muscle of a Sagitta looked and behaved like vibrions, and that Professor Agassiz verified his experiments. In conclusion he remarks, "I do not pretend to say that everything that comes under the name of vibrio and spirillum is a decomposed muscle or other tissue, although I believe such will turn out to be the fact; but this much I will vouch for, and will call on Professor Agassiz to witness, that what would be declared by competent authority to be a living being, and accounted a species of vibrio, is nothing but absolutely dead muscle."

The preceding account of M. Pouchet's labours will suffice to demonstrate that they possess great value, quite independent of the particular theory which he has so ardently espoused. Let us now devote a few moments to some counter-experiments

* *Annual of Scientific Discovery for* 1860. (Boston.)

of M. Pasteur, which are highly instructive. He introduced the same quantity of a fermentable liquid in several glass bulbs, drew their necks out in a lamp, and twisted them in various directions, but left them all open. In the greater number he boiled the liquid for several minutes, leaving three or four in which the heating was not carried to ebullition. All were then placed in a situation where the air was still. In from twenty-four to forty-eight hours, the bulbs which had not been boiled, but whose contents had experienced that temperature in preparation, exhibited "divers mucors," and their liquor was "troubled," while the fluid in the remainder remained limpid for months. Upon these results M. Pasteur remarks, "All the bulbs were open; without doubt it was the sinuosity and inclination of their necks which protected their liquid contents from the fall of atmospheric germs. Common air, it is true, entered briskly at the beginning; but at that time the liquid was very hot, and slow to cool, so it caused all the germs conveyed by the air to perish; and afterwards, when the liquor was cool enough to render possible the development of germs, the air entering slowly allowed its dust to fall in the opening of the neck, or on the walls of the entrance." Upon cutting off the neck of one bulb, and placing the resulting aperture vertically, mildews and bacteriums appeared in a few days.* M. Pouchet attached importance to proving that common air did not abound in germs. M. Pasteur, in the interest of the opposite party, demonstrated the same thing. He took a number of glass bulbs partially filled with an infusion, boiled them to produce a vacuum, and sealed up their necks. These, on being broken in various situations, allowed air to rush in, and were again sealed up. For the most part, the liquor became cloudy after a few days, and the vessels exhibited a greater variety of mucedines and torulaceæ than if they had been freely exposed to the air. But it happened many times in each series of trials that the fluid in some vessels remained as unchanged as if it had received "calcined air," which M. Pasteur asserts to be unproductive, in opposition to M. Pouchet. In the course of these inquiries, air was obtained from various localities, among others, at Montanvert, from the Glacier des Bois, and only one of the vessels filled in that situation gave birth to a mucedine.

Thus we find the two classes of experimenters agreeing in one conclusion, that the air does not contain that prodigious quantity of noticeable germs that former microscopists imagined to exist. Nor have observations been successful in discovering enough germs to account for the appearance of animalcules of the larger sort, which soon occurs under favourable conditions. M. Pouchet has been at great pains to collect the particles which

* *Comptes Rendus*, January to June, 1860, p. 303.

float in the atmosphere; but while he discovers numerous starch grains wherever men are congregated, and finds that the lungs of animals near towns contain a microscopic débris of all sorts of substances, including even fragments of clothing, neither he nor any one else has met with any number of infusorial eggs. Nor can we even affirm that much progress has been made in recognizing and distinguishing the various germs which different species are believed to produce. It moreover appears that many observers have mistaken certain parasitic animalcules for eggs of the creature they inhabit. At least, so M. Balbiani tells us. According to this gentleman, certain acinetans belonging to the genus *Sphærophyra* enjoy life under two aspects. First, they appear as small cylinders, covered with swimming cilia, and furnished with suckers and styles. In this condition they swim freely, and devour their neighbours in the usual way. Then comes a change in their affairs. They assume a spherical form, strip off their ciliary vestment, but retain their suckers, and wait quietly till touched by some roving animalcule, to which they cling. Gradually they work their way into the interior of their prey, not breaking the tissue, but stretching it before them as they advance, and suffering it to close behind them, leaving only a minute channel by which their numerous progeny subsequently escape. When once comfortably seated in the middle of their involuntary hosts, their peregrinations cease, and their vitality is chiefly manifested by the movements of the contractile vesicle. As they grow, their family increases, and they augment the size of the cavity in which they dwell, without occasioning any apparent inconvenience to the paramecian or oxytrichan which they have invaded. M. Balbiani states, that he has noticed a single animalcule sheltering more than fifty of these parasites at a time.*

THE CUNEATIC CHARACTERS OF BABYLON, ASSYRIA, AND PERSIA—HOW THEY WERE FIRST EXPLAINED.

BY H. NOEL HUMPHREYS.

Long before the brilliant and successful guesses of Dr. Young, and the subsequently triumphant labours of Champollion, had led to the deciphering of the hieroglyphics of Egypt, a young and unknown German scholar, Grotefend, had succeeded in reading several names in the cuneatic character of the Per-

* In converting centigrade degrees into those of Fahrenheit, the nearest whole numbers have been taken.

sian system. It was not till 1818, after the arrival of the "Rosetta stone" in England, on which Egyptian inscriptions were accompanied by a Greek translation, that Dr. Young laid the foundation of the method now adopted for the interpretation of Egyptian hieroglyphics; and it was not till a few years later that Champollion developed his great system of interpretation, which has since been reduced to order and comparative certainty by the labours of Lepsius, Bunsen, Birch, and others.

Unaided, therefore, by the labours which have led to the interpretation of the Egyptian method of writing, and long before any successful attempt had been made to interpret any of the Persian or Assyrian inscriptions of Central Asia, M. Grotefend, in 1808, first read off the names of Darius and Xerxes in the *cuneatic* inscription of Behistun. When M. Grotefend determined to make an attempt to decipher those singular wedge-shaped characters, all was utter darkness on the subject; for the assertion of Tyschen, of Rostock (1798), and afterwards of Munten, of Copenhagen, that the proper mode of reading the cuneatic character was from right to left, was only calculated to mislead; while the supposition of those authors that they were real phonetic signs, though nearer the truth, was scarcely likely to be more advantageous to the student, as, if the characters were read backwards, no useful result was likely to be attained.

The efforts of Grotefend were therefore perfectly unaided by the labours of his predecessors in the field of research, which he entered in the year 1800. The inscription which stimulated his curiosity and led to those first steps which have proved the basis of all subsequent discovery, was the one copied from the rock of Behistun by the traveller Niebuhr; who succeeded, by the aid of a telescope, in making an extremely accurate copy of it, although at a height of 300 feet—about as high (to make an approximate comparison) as the cross of St. Paul's. This inscription, in which the writing, formed into three distinct groups, bore conspicuous evidence of being written not only in three distinct sets of characters, but in three distinct languages. The three groups were, in fact, three copies of the same proclamation, addressed to three different races all owning the sovereignty of the Achœmenian dynasty of Persia. That the inscription belonged to the period of that dynasty, M. Grotefend was led to conclude from a long course of historical study.

In selecting one of the groups of writing as the subject of his experiment, he fortunately pitched upon the one written in the latest kind of character—the Persian—from which system nearly all the pictorial and symbolic signs had disappeared, only the phonetic or sound-expressing characters having been preserved, and these reduced in number to about thirty or forty characters. With these facts, however, M. Grotefend was unacquainted, as they are the fruits of recent discovery. He therefore went to work entirely unaided, except by his own indomitable perseverance and ingenuity.

Having determined in his own mind the probable date of the inscription, he next came to the conclusion that, if he could pitch upon a group of characters likely to represent a proper name, he should obtain some clue, or some ground for guessing at the probable meaning and value of several important characters. With this view he endeavoured to find a group of letters likely to represent the name of Cyrus, or of any of his immediate successors. Here, however, he was met by what appeared for a time an insurmountable difficulty, for although such names as those of Cambyses and Cyrus are of very unequal length, the number of characters in any group, which by their frequent repetition appeared likely to represent proper names, were all of nearly equal length. At last, however, the persevering student fixed upon a group to which he gave the following value, experimentally, D. A. R. E. V. SCH. Thus read, they gave the name of Darius, as pronounced in the ancient Persian. By sheer good fortune, he had hit upon the actual name of Darius in this purely hypothetical experiment, and his first step was, therefore, like that of so many great discoveries, scarcely more than a bold and happy guess. Being however led on by certain courses of experiments too long and intricate to detail, the fortunate student became gradually convinced that he had thus hit the bull's-eye by a random shot. With this conviction he sought diligently for another name, and eventually fixed upon a second group of characters which he thought ought to represent the name of Xerxes, or rather, as pronounced in the ancient Persian, KH. SCH. H. E. R. SCH. E. He was again successful, aud he afterwards deciphered, in a similar arbitrary fashion, the name Hystaspes and others.

He had, however, up to this point, adopted no method of testing the truth of these assumptions, but at last hit upon an infallible method, which may be explained as follows; taking the characters from a set of Persian cuneatic alphabet, arranged according to a recent interpretation, which happens to lie upon my table, and which, though imperfect, will answer the present purpose, as shown in the accompanying diagram.

It was evident that the first and second letters in the first name ought not to occur at all in the second. They did not. The third letter in the first name ought to be the fifth in the second name; and it was so. The fourth letter would not occur in the second name, but the fifth letter of the first name ought to be the fourth and the last of the second name; it proved to be so. The sixth of the first name would be absent in the second, but the final SCH of D A R Y E U SCH should necessarily be both the second, on the last character but one in KH. SCH. H. E. R. SCH. E.; and it was so.

Thus was the first step in the interpretation of the cuneatic characters of the Persian system put to proof; and the result was acknowledged to be a brilliant discovery. in conse-

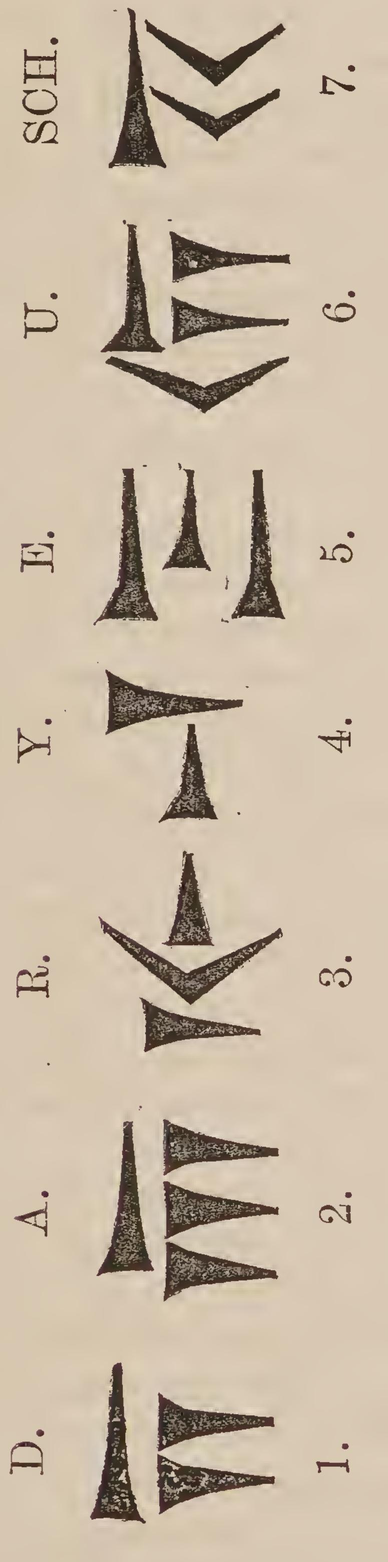


Fig. 1.

Fig. 2.

quence, however, of different methods being employed in the Persian system for writing the same words, the discovery was not entirely accurate, yet it was such a step as fairly led to the expectation that further progress would speedily follow. Yet such was not the case. So far and no further, with trifling exceptions, did the discoveries of the German scholar and his immediate successors extend; and for nearly half a century no further material progress was made. The whole of the great discoveries in Egyptian hieroglyphics, in short, took place before another great step in the reading of the wedge-shaped characters of Asia was achieved.

It was not, in fact, till the magnificent discoveries of Assyrian remains by Botta, and the subsequent researches of Layard, that Rawlinson, Lassen, Hinks, Norris, and other scholars, aided by recent progress in the knowledge of Sanscrit, Zendic, and other ancient Asiatic dialects, completely mastered the cuneatic characters of the Persian system; the intermediate labours of Millin, Rask, Bournouf, and St. Martin having led to no very material results.

Even now, the Assyrian and Babylonian forms of the cuneatic systems are but very imperfectly known, although the Persian may be said to be mastered. The earlier forms of cuneatic writing are, in fact, much more complicated, containing as they do a vast number of pictorial and symbolic characters, while the alphabetic or sound-expressing signs form only a supplemental part of those earlier systems. They have still also the old *determinative* signs of the Egyptian system, and are overloaded with many other incumbrances belonging to the pictorial and symbolic stage of the art of writing, which it will require much time to reduce to order, even after the principles are well understood. Nevertheless, passages of great historical interest have been read off by Rawlinson and other cuneatic scholars, with a very near approach to their general import, though minor details admit of much dispute. But we are on the eve of a final and perfect interpretation of the ancient records of the Asiatic empires; a result of modern scholarship which may throw new and entirely unexpected light upon the history of those regions.

INSECT VISION AND INSECT SLEEP.*

BY THE HON. RICHARD HILL.

I.—INSECT VISION.

NOVEMBER 24, 1860.—In setting up in a collection our several crickets, locusts, and grasshoppers, we see that there is a prevailing colour as marked and as intense in the eyes as in the body: thus, locusts are red; grasshoppers green; and crickets black; and their eyes are of similar decided hues. Are we to

* These notes have appeared in the pages of a journal which circulates only in the island of Jamaica; the author wishes them to have a wider publicity, and has kindly forwarded them to this work for that purpose.—EDS.

infer that objects to them have the same tint as these hues of the choroid? Are they coloured as we see landscapes to be when we look through a window of painted glass? Through the red, are objects beheld as if they were blazing in a fiery furnace; or do they appear as frigid as a snow scene in blue eyes as through the blue glass? Some purpose is served by the relation. Let us see, or let us make inquiry what it may be; if it ends in nothing certain, it will, at least, be attended with instruction and amusement.

In the solar spectrum, there are rays independent of those of light, which impart a sensation of heat. These calorific rays are most abundant a little beyond the red verge of the spectrum, and diminish gradually towards the violet. When it was observed, in the Conservatory at Kew, that plants suffered from the scorching influence of the calorific rays through the glass covering, a series of experiments were pursued to ascertain the possibility of cutting off the heat-imparting rays by means of tinted glass. A glass tinted of a pale yellow-green prevented the permeation of the heat rays to the maximum of the calorific action. The pinky hue of the light was modified, and the scorching influence subdued. What they sought to accomplish was effected. They obtained a properly moderated heat.

White is the simultaneous sensation of all the prismatic colours. By suppressing red, we obtain a bluish-green hue; by suppressing the blue and the green, we obtain an excess of yellow and red. The purest air, or clearest water, gradually extinguishes, by absorption, the rays passing through them. The lesser stars are visible on the loftiest mountains; but their lessened light hardly affects the sight in the stratum of the atmosphere at the depth of the plain below. The natural stimulus of the retina is the action of the luminous rays. Modifications are essential where the activity of perception may be allied to the conditions of diseased sight. "Many are the waves and coruscations—the fiery clouds and flaming spectra which haunt the amaurotic when certain morbid complications exist," and when the optic nerve is peculiarly influenced, a compensatory modification of the peculiarity in regard to tint is made by the adoption of coloured glasses for the sight. We may presume that what is in excess in the locust is modified by the red pigment of the eye, and what is superabundant in the grasshopper by the yellow and the blue.

The eyes of insects are what are called facetted eyes. They are cut in hexagonal compartments, and have the appearance and the power of multiplying glasses. The outer coat is composed of a thin plate, resembling horn. It is stiff but flexible, and compact but transparent. Immediately beneath each corneule or hexagonal compartment, that is, beneath the facets of the outer covering of the eye, is a layer of colour. It covers the whole of the inner surface of the corneules, excepting only in the centre of each where a minute aperture is seen, admitting light by the iris. Between the iris and the end of the cornea is a space, flattened and convex, filled with an aqueous humour. Each convex lens corresponds with each facet. The rays of light passing through them fall upon a transparent space occupied by a vitreous humour. The choroid in the eyes of insects, like the choroid in the vertebrata, is the proper vascular structure of the organ of vision. The pigment of the choroid is subject to much variety of colour in different insects. In some it is nearly black, in others dark blue, violet, green, purple, brown, and yellow; and in some, two or three layers of pigment are of different colours. The usual arrangement of these variegated pigments is, first, a dark-coloured portion near the bulb of the optic nerve, then a lighter colour, and lastly, again, a darker near the cornea.

Puget adjusted the eye of a flea (*Pulex irritans*) in such a way as to see objects through it. On applying the microscope to the multitude of mirrors, nothing could exceed the singularity of what was seen. "A soldier appeared like an army of pigmies; for what it multiplied it diminished; the arch of a bridge exhibited a spectacle more magnificent than an edifice erected by human skill; and the flame of a candle seemed the illumination of a thousand lamps." The minute regularity of the objects in each of the facets, so disposed as to converge to a central ganglion, make but a single picture in perception. The great optic nerve uniting into a focal point the coincidence of what Dr. Wells designates "*the visual direction*," impresses an image intensely concentrated. The perception of each impression being confined to that of the object immediately in a line with the axis of vision, the impacted lights and shadows of a thousand representations of one and the same form—the visual product of a thousand facets—give a stereoscopic representation under a thousand adjustments, and render the small organ of the small animal, in power and concentration, a microscope.

The successive zones in the insect eye modify the rays that penetrate the sight, passing by each facet, and by the centre of each converging cylinder radiating to the optic ganglion. The layer of pigment does nothing but diminish the quantity of light, and adjust it. It is found in most if not all *diurnal insects*, and the iris being perforated with as many holes as there are facets in the cornea, it is subjected to multiplied modifications. As might be expected, this pigment is not met with in any of the *nocturnal insects*.

Insects that fly require an ample field of vision. The combined corneules become one large pupil. The multiplied facets render superfluous eyelids and muscles to move the eye. In consequence of the vision being directed to the whole circumference, it comprehends, by relative adjustment, all objects around. A simpler eye occurs in the grovelling insects that see only what is near with distinctness. In insects which fly by night, like the moths, there is, in place of the black or coloured pigment, a substance of a resplendent green, or silvery colour, serving not to absorb, but to reflect the rays of light, and enabling them to see by a more obscure illumination than that of daylight. The eyes of moths look always luminous, and appear as if they were phosphorescent, from this reflecting power. This organization gives a solution to the reason why moths fly to the candle. They lose all discernment in the blaze of radiance that overwhelms them by reflection; and they perish in the flame into which they rush.

After I had entered among my notes the preceding memorandum, I requested my friend, Mr. Toase, to verify for me Puget's examination of the facetted eye of an insect, by an inspection of the organ under his excellent large microscope. He kindly complied with my request, and sent me the following interesting letter:—

"Kingston, 21st January, 1861.

"MY DEAR SIR,—I have taken a dragon-fly (*Libellula*) as the study of the eye of an insect. * * *

"The eye was first simply removed from the head of the dragon-fly and examined under a good lens:—seen thus, it seemed as if it were covered with intensely small drops of water, something like dew.

"The eye was next immersed in solvents, and cleaned with a fine camel's-hair brush, leaving nothing behind but the cornea. This to the naked eye had the appearance of a white transparent horny substance, having the form of a shallow cup.

"It was now placed under a microscope with a power of 250 diameters, or magnifying 62,500 times.

"Under this power the bead-like appearance, noticed with the simple lens, resolved itself into a definite form, resembling precisely the cells of the honeycomb as they appear on the broad plane. Like these cells, each division was hexagonal. The substance of each division was convex exteriorly. We are reminded that this is the form which economizes space the most, and that it is also the form always taken by the *equal* sized round bodies when *equally* pressed together. This law we see exemplified in the cellular tissue of plants, and we account for the elongated form of the cells of the fibrous tissue, by *unequal* pressure. We see this law in the formation of the cells of the honeycomb, as equally sized globular cells equally pressed *laterally* and forming hexagonal cells. We see it again, though imperfectly, it is true, in soap bubbles. Might we not, therefore, infer that this peculiar form is the natural effect of a known law, and that it could not assume any other form? But to remove all doubt, we must prove our premises, that is, if the facettes of an insect's eye, composed originally of an immense number of spheres of equal size, equally pressed, laterally, pass into the hexagonal form, or suffer any other modification.

"That they are of equal size is manifest from simple inspection.

"We will now see if experiments prove they are, or have been, spheres; but I must first speak of some further examination of the cornea.

"I counted the number of facettes, or faces, by the micrometer, and found in each eye 12,500, but I think they are somewhat more numerous.

"Around each facette I found a fringe of fine hairs, which seem to fulfil the purpose of eyelashes.

"I now placed the cornea in such a manner, that, in looking through the microscope, and *through* the cornea, I could see the flame of a candle. I then saw, not one flame, but an immense number of flames; in fact, an illumination of candles on a large scale, which arrangement quite corresponded with the hexagonal form of the facettes: thus there was a row of flames, and above this another row, not one flame above another, but intermediate flames in intermediate rows, and so on one row with another.

"Each facette is then a distinct eye, producing a distinct image in each facette.

"An ordinary observer might infer that the insect saw not one object, but a multitude of objects; not one flower, but thousands, producing a complete 'embarras de richesses,' most confusing to the poor fly. It is natural that we should be led to such a conclusion. But, on the other hand, we are taught by analogy that 'order is Nature's first law.' To help us to the clue of this second point, or of this apparent confusion, we will continue our experiments.

"Taking for granted that spheres were upon the disk, I severed them with a needle and found one end of the several pieces circular, and the other pointed; in fact, each separate ocellus, or eye, had the form of a cone, the basis forming the facette, and the apex converging to a centre. Each was embedded in a mass of pigment—in plain terms, black paint; with each apex receiving a filament of the optic nerve. Each separate ocellus, therefore, has a separate power of vision.

"Each facette, cone, and filament being separated from all other facettes, cones, and filaments by a layer of pigment, forms a separate ocellus, so circumstanced that no ray of light received by one passes into another, and all the filaments being severed from each other by the pigment, they in no way interfere with one another.

"We now see, by experiment, that as each ocellus takes up a distinct picture, each picture is, necessarily, slightly altered in perspective. The images, by the direction of the facetted mirrors severally, are each slightly varied; but being united on the central ganglion, they form one perception of one object, or one scene. This is only a multiplication of the incidents of our own vision with two eyes. If we close one eye, we see an object in a certain perspective; if we close that eye that was open, and open that which was shut, we see the same object in another perspective; yet if we open both eyes we do not see two images of the same object in different perspectives, but only one object in proper visual union by coincident perception.

"The moveable eyes in ourselves, and the immoveable eyes in the insect, do not affect this analogy. The multitude of facettes accommodate the immoveable eyes to a whole panorama. The stereoscope will illustrate all the facts in both circumstances of vision. In the stereoscope we have exhibited to us two representations of the same object in different perspectives:—the difference corresponds with the distance between the two lenses through which we are looking; they are both immoveable, but visually combined they are but one perception of one and the same object. In the same way insects, with their multiplied incidents of vision, see by coincidence but one representation from a multitude of eyes.

"I trust, my dear sir, I have met your purpose in testing Puget's experiment.

"Believe me, etc., "Thos. D. Toase."

II.—THE SLEEP OF INSECTS.

The ocelli, or secondary eyes of insects, which Linnæus regarded as a kind of coronet, and called *stemmata*, and which Reaumur conceived were designed for that near vision, which the primary eyes, by their immoveable structure, could not accomplish with proper distinctness, have, I have but little doubt, by the experiments which have been made on vision, and on the excitement of sleep, a very important influence in determining somnolency in insects. The vast field of objects commanded in vision, without the concentration of attention, is one of variety, but not of accuracy. In insects there is no dilation or contraction of a pupil to accommodate the sight to the circumstances of light and darkness. By attention we are conscious of perception. If the attention be limited to one point of a landscape, it sees only the objects *there*, and though there be visual impressions, there are no visual perceptions, where the mind is not attentively absorbed on what it is looking at. It is without the consciousness of seeing.

How do insects, with their great orbicular eyes always exposed to external stimulants, sleep? Sleep, like the inclination for food, is periodical. The habit in the lower animals is the alternation of light and darkness, in the degree in which one indicates day and the other night, for in a total eclipse birds retire to roost, and the diurnal insects resort to repose, and the nocturnal awake.* The influence that tends to wakefulness or

* Sir Hugh Lyon Playfair, in his lectures on the application of physiology to the rearing of cattle (Lect. 2nd), gives a very remarkable illustration of the influence of rapid alternations of light and darkness, without reference to the diurnal revolutions of the earth, in inducing sleep and inclination for food, in the Italian mode of rapidly fattening ortolans. At a certain hour in the morning, the keeper

to slumber is the condition of the nervous system. If its functional activity be protracted, the vision gives way under the exhaustion of the nervous powers. If the action of the mind be purely intellectual, if the feelings be not excited under that action, the waste sensorially suffered is to be repaired by sleep, and the sensation of slumber becomes uncontrollable. The demand for sleep is the desire to have it; and whether the absence of sensorial impressions results from the settling of the mind to rest, or whether it be that darkness cuts off all stimulation from light, or silence conduces to repose, sleep is induced by the cessation of all visual or emotional excitement. If the mind be withdrawn from the consciousness of it own operations, or if it be acted upon by a monotony that either wearies attention, or distracting it, leaves the sensorial image without perceptive impression, the result is slumber, or the nervous relaxation of sleep.

> "Tir'd Nature's sweet restorer, balmy sleep!
> He, like the world, his ready visit pays
> Where fortune smiles;—the wretched he forsakes."
>
> YOUNG'S *Night Thoughts.*

When the mind divides itself between the thoughts and the emotions, mental activity being unsuspended and the feelings unappeased, the restlessness of anxiety becomes the inquietude of wakefulness; and though there be weariness of both heart and soul, the balm of slumber may be desired, but tired Nature remains ungratified by the restoration of sleep.

Having thus indicated the circumstances under which beings slumber, that combine an intelligent nature with a sensational one, let us examine *how* insects sleep.

When the senses are blunted to external impressions under the lessened excitability of the mind, and our ideas, more confused than vivid, are carried beyond ourselves in time and place, we instinctively lie down to repose. All the creatures organized with eyelids close the eyes against the influence of light. The temperature of the body sinks, owing to diminished nervous energy, and we seek with soft things to rest upon,

of the birds places a lantern in the orifice of the wall, made for the special purpose of darkening and illumining the room. The dim light thrown by the lantern on the floor of the apartment induces the ortolans to believe that the sun is about to rise, and they wake and greedily consume the food upon the floor. The lantern is withdrawn, and the succeeding darkness acting as an actual night, the ortolans fall asleep. During sleep, little of the food being expended in the production of force, most of it goes to the formation of flesh and fat. After the birds have been allowed to repose for one or two hours to carry on digestion and assimilation, the keeper again exhibits the lantern through the aperture. The mimic daylight awakes the birds again; again they rise and feed; again darkness ensues, and again they sleep. The representative sunshine is made to shed its rays four or five times every day, and as many nights follows its transitory beams. The ortolans thus treated become like balls of fat in a few days.

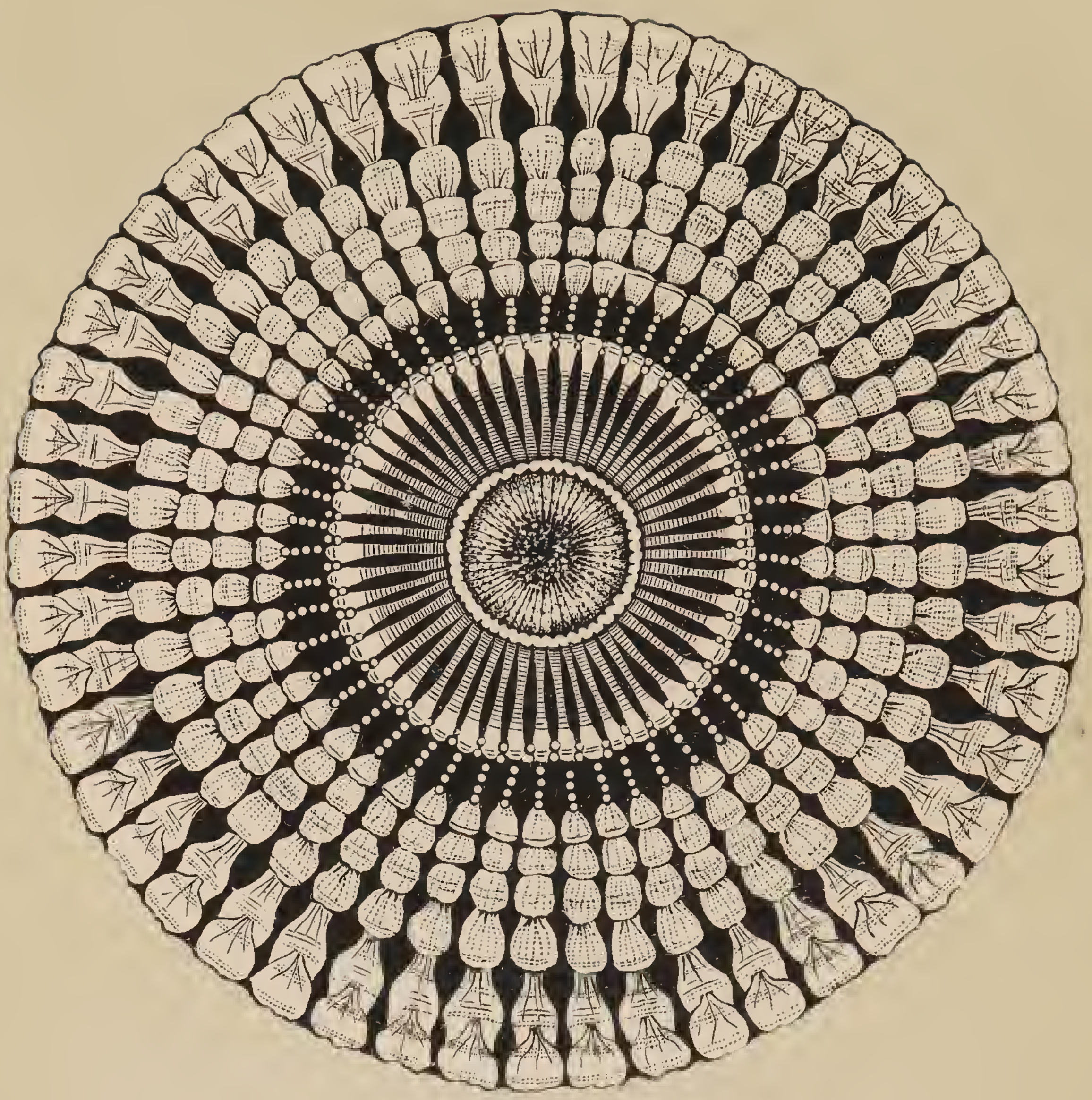
warm things to cherish us with heat, and then we go to sleep. The lower animals instinctively do what we do, though each accommodates itself differently. The horse will sleep standing in the warm shelter of the stable, though it lies down in the pasture; the bird reposes perching, but with its head buried in the feathers of the wing; the serpent coils itself in a circle, or folds itself into the smallest possible space; the fish screens itself in the weeds, or buries itself in the sand or in the mud of the stream; the insect withdraws from the scenes of its ordinary activity, and is in a state of somnolent rest, when it remains motionless. As the insect has no eyelids, no external closure of the eye gives evidence of sleep.

As all the physiological facts of sleep in the vertebrate animal coincide with effects exhibited by the heart and brain, and as insects have neither of these organic centres, then sleep cannot be induced by any peculiar change, either in lessening or quickening the flow of blood from one extremity to the other, but must result solely from the quietude of the senses, and from electrical incidents externally. Monsieur Cabanis, in his *Rapports du Physique et Moral*, has observed in man that some of the members and senses go to sleep sooner than others. He assigns the soporific influence sensationally to fatigue. The part first feels drowsy in which the flow of the blood is affected. Among the senses, the eye is the first that goes to sleep; after it, the smell, taste, hearing, and touch become successively drowsy. The touch is never entirely insensitive. The sight is more difficult to awaken than the hearing; a slight noise will rouse a sleep-walker who had suffered light upon his unshut eyes without any apparent influence; but insects, if affected at all internally, are very little affected in this way.

The insect world are acutely acted upon by atmospheric circumstances. Rain or cloudy weather operates upon them like a continuance or recurrence of night. It is not the warmth or the dryness of the air, its humid state or its coldness; it is the electrical condition that affects them. The constant alternations of sleep and waking, in whatever way they may be induced by repose or affected by functional activity, are regulated as periodical recurrences by the electrical laws of the seasons, by the reiteration of day and night, by the daily variations of the barometer, and by the conditions that move the magnetic needle from east to west at stated hours every day. Extreme weariness will prevent sleep if fatigue is unaccompanied by powerless attention and unsettled sensation. Let us see how these known facts may serve to explain the sleep of insects.

We shall comprehend some of the physiological incidents of slumber by attending to the processes of mesmeric sleep, as developed by Mr. James Braid in his work on Neurypnology, or the *rationale* of nervous sleep, in relation with animal magnetism. I would be brief with my extract, and yet I can scarcely venture to abridge his language. He says he induced cataleptic sleep, which he designates hypnotism, by keeping the eyes fixed on an object, and the mind rivetted on the idea of *that* one object. He so regulated the distance of it from the sight as to produce the greatest possible strain upon the eyes and eyelids. "It will be observed," he says, "that, owing to the consensual adjustment of the eyes, the pupils will be at first contracted; they will shortly begin to dilate; and after they have done so to a considerable extent, and have assumed a wavy motion, the eyes will close involuntarily with perceptible vibrations. Ten or fifteen minutes elapse, and the arms and legs are found disposed to be retained in the position in which they are placed. If the patient has not been so intensely affected as this implies, then, if he be spoken to in a soft tone of voice, and desired to retain the limbs in that or in an extended position, the pulse will speedily become greatly accelerated, and the limbs involuntarily fixed. It will now be found that all the organs of special sense, excepting sight, including heat and cold, and muscular motion and resistance, and certain mental faculties, are at first prodigiously exalted. It is such an exaltation as happens with regard to the primary effects of opium, wine, and spirits. After a certain point, however, this exaltation of function is followed by a state of depression far greater than the torpor of *natural* sleep. From the state of the most profound torpor of the organs of special sense and tonic rigidity of the muscles, they may at this stage be *instantly* restored to the *opposite* condition of extreme mobility and exalted sensibility, by directing a current of air against the organ or organs we wish to render limber, and which had been in the catalepti-form state. By mere repose the senses will speedily merge into the original condition again." Now, none of these processes, in inducing sleep, would be applicable to insects whose eyes are immoveable, if the provision for seeing was confined to the two large globular eyes on each side of the head; but being provided with ocelli, or auxiliary eyes, placed on the vertex of the head, these facts illustrate the drowsy insect. The structure of these auxiliary organs is just that of one of the lenses of the compound eye, but being so placed that they can be set close to what they examine, and can concentrate the attention to the exclusion of the objects that occupy the globular facetted eyes, it is possible that such visual concentration, when the insect retires to repose, induces just that perceptive vibration described in cataleptic sleep by which slumber can be brought on.

An insect composes itself to sleep with its antennæ folded. Some of the beetles adjust them to their breast; the butterfly



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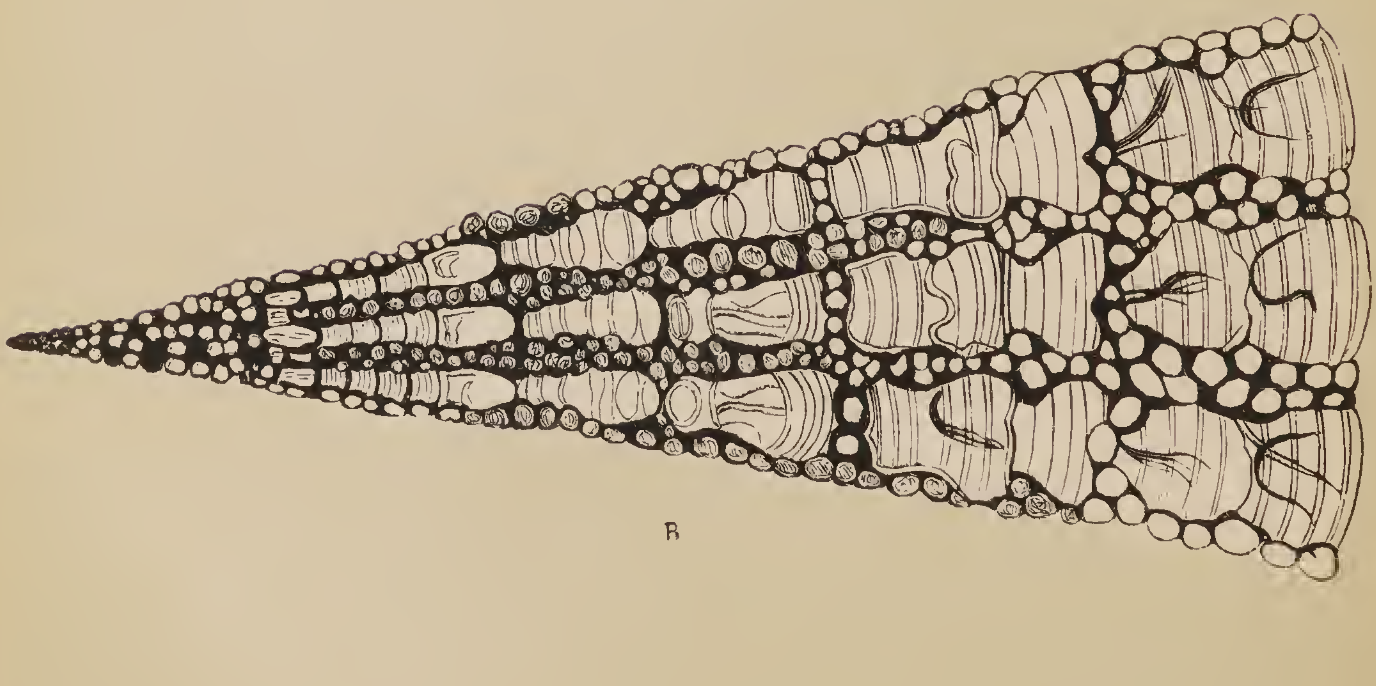

B

A.—[illegible]
B.—[illegible] more magnified, [illegible]

seeks some particular aspect of a tree, and folds vertically its wings, throws back the antennæ, and remains motionless and insensible to all external circumstances. When caterpillars, which are insatiable feeders, are observed resting immoveable with their heads bent down, they are asleep. The geometers may be remarked stretched our for hours projected from a twig resembling the angular stem of those trees they are feeding upon, and the processionary caterpillars, whose night marches, in marshalled communities, are regulated with such remarkable exactness, that they resemble battalions platooning over a field, in "strict love of fellowship combined" in passing the day in inaction, spend it in repose.

Whatever may be the controlling cause that renders some insects diurnal feeders and flyers, and some nocturnal and crepuscular movers, frolicking or feasting in the twilight, the solution must be sought in the adaptive differences that regulate the "*sleep of plants.*" Some plants repose by night; others expand in the darkened hours, and slumber under the stimulation of light. Whether the closing of the flower be at nightfall, or its opening be as soon as daylight fades, or whether it be the reversal of this order, the differences are precisely the same as in those animals that sleep through the day and awake at night, or that awaken in light and slumber in darkness. The regular intervals that lead to sleeping or waking are the recurrences of those *electrical* incidents that attend the interchanges of day and night in the atmosphere.

ON THE APPLICATION OF THE MICROSCOPE TO THE ART OF DESIGN.

BY HENRY J. SLACK, F.G.S.

Manufacturing experience affords many instances of surprising success achieved by ornamental goods, whose patterns were judiciously selected from natural objects; but although examples of various combinations of form and colour occur in great profusion in those portions of the natural world which are accessible to unassisted sight, the microscope constantly presents us with a rich store of ideas which the decorative artist would do well to study and employ. If colour be the especial subject of his pursuit, the wings of butterflies or the wing-cases of beetles, the petals of flowers—such as London-pride—minute sea-weeds, and other common objects, are highly instructive; and if we were requested to point out an illustration of the union of extraordinary splendour with grateful repose, we could not do better than refer to the armour in which the diamond beetle is arrayed. When Mr. Owen Jones completed his "Alhambra Court," at the Crystal Palace, every one was struck by the mingled softness and gorgeousness of the aspect. The eye could look steadily without being wearied, while a visit to the House of Lords, when its colours were new and fresh, afflicted observers with an unpleasant sense of tension, rapidly followed by weariness, from which there was no escape. Even in the cases of persons afflicted with colour blindness, we sometimes find that what may be called colour discords are productive of disagreeable impressions, while colour harmonies, although only partially perceived, call forth pleasurable emotions.* Still more striking are the effects of colour harmonies and discords upon individuals whose physical and mental organs are in a sound and cultivated state. They are not satisfied with the mere avoidance of mistakes, or with the presentation of the most elementary concords which pigments can produce. Their tastes lead them to desire to untwist all the chains of colour harmony; they love the complicated effects of tertiary combinations, and are discontented with brilliance if it be destitute of repose.

What constitutes repose in colour is a difficult question, but it is probably connected with the physical action of different kinds of light on the optic nerve. Red, blue, and yellow, in the proportions which theoretically produce white light, are agreeable; but not exclusively so, and nearly all the modifications of prismatic colour obtained by means of crystals and the polariscope are satisfactory in a greater or less degree to the eye. It naturally follows that the more vivid the light emanating from coloured bodies, the more strikingly the defects of harmony are disclosed, and although there are many cases in which brightness and intensity become sources of a high degree of pleasure, they are not unfrequently productive of sensations akin to pain. In the scales which adorn the diamond beetle, the lustre, under good illumination, is nearly equal to that of the most brilliant gems, and yet the eye can rest upon it without fatigue. An attentive observation will show how this depends upon the juxtaposition of cool and warm tints, the gorgeous yellows and orange chromes being relieved by a due proportion of blues and greens. Diamond beetle colours are not wanted in large masses, but the first manufacturer who composes them into a border, whether it be for porcelain or a textile fabric, with a warm chocolate ground, can scarcely fail to be rewarded for his pains.

* This is not an imaginary case; the writer knows a gentleman to whom no colour appears as it does to other people, and who is apparently insensible to pure red rays, but who is much annoyed by many colour discords, and able to arrange a nosegay so as to produce an agreeable effect.

Before leaving the subject of microscopic colour study, let us point to the use of the polariscope for observations, which no other method can place so readily within reach. It is usual to display polarizing objects in their most striking situations, when they present contrasted masses of pure prismatic colour. From these, however, the decorative artist will learn little; but if he takes a concentrated solution of nitre, or tartaric acid, and allows a drop to crystallize rapidly on a warm slide, he is tolerably certain to obtain his material in such forms, and in such varying thicknesses, as will enable him to produce a number of interesting tertiary combinations, by adjusting the polarizing and analyzing prisms to the best positions for the particular effect desired. These experiments require a selenite stage, and the means of rotating *both* prisms, and not the polarizer only, as is the case with the arrangements that some opticians send out.

For a combination of green tints and forms, adapted to the jeweller and enameller, the desmids may be recommended, of which some useful specimens are figured in *Recreative Science*, vol. ii. p. 279. The beautiful fluted and otherwise marked bottles of the Foramenifera fern, called Lagenæ, would furnish classical patterns for the glass-blower, and his attention should likewise be directed to the polycystina from Barbadoes, whose siliceous shells of varied shapes glitter like the finest crystal when lit up by the dark ground illumination which the parabola affords.

Another class of objects that merit attention for the suggestions they afford, are the spines of the echinus, or sea urchin. The sea urchins belong to the *echinodermata*, or "hedge-hog skinned animals," a class which comprehends star-fishes, sea hedge-hogs, or urchins, and those curious creatures the sea cucumbers. Many readers will be familiar with Edward Forbes's classical work, entitled "British Star-fishes;" but for the benefit of those who do not know his remarks on the urchins, we may state that in one of moderate size he found 3720 pores arranged in ten series, or "avenues," with one sucker to every two pores. Their shells are composed of nearly 600 angular pieces fitted together like a mosaic, each plate being enveloped in the lining membrane, by which it was deposited, and which provides for its growth. These plates are furnished with about 4000 spines, every spine being built up of a multitude of pieces deposited by a living tissue, and producing a radiating pattern as shown in the tinted plate, which has been engraved from a drawing by Mrs. Henry Slack. Fig. A represents a thin section of an usually beautiful spine, illuminated by a unilateral slanting light, arranged at such an angle as to mass certain portions together in solid diverging rays. Fig B gives a truer idea of the minute structure ; but A is far more suggestive for the purposes of decorative art. It only requires reducing to strict symmetry to supply an idea for an oriel window, a tesselated pavement, or the centre of a plate. A slight change in the angle of the illuminating pencil, coupled with an increase of its brilliancy, produces a splendid effect at night. The solid-looking rays shine with a lustre between that of glass and gems, while the more transparent portions assume a pearly or a silvery hue. In this state we have suggestions for a star of an order of knighthood, or a superb brooch. With the echinus spine, as with other objects adapted to our present purpose, the decorative idea varies with the mode of illumination, and that which is best for artistic effect is not always the most desirable for a scientific analysis of the structure. A complete set of these experiments requires a good microscope, furnished with a Lieberkuhn and dark cells, a side silver reflector (which had better be on a separate stand), and the parabolic illuminator, with all of which the object should be tried. It is also imperative that the mirror under the stage should be mounted upon an area capable of throwing it out of the perpendicular plane of the instrument, and that the aperture of the stage should be large enough to admit light sufficiently oblique to produce the effect of a dark ground.

We may refer, in concluding these brief remarks, to the compound polyps, and the polyzoa, so common on our coasts, and which can scarcely be excelled in beauty when properly shown. A small sketch of the *Laomedea geniculata* is given in p. 131, vol. iii., of *Recreative Science*. When living, the tentacles resembled pendants of frosted glass, the cells were clear crystal goblets, and the stalks of a horny texture and colour. From these polyps a clever designer could easily have devised a pattern for an epergne, a portion of a border for a tesselated pavement, or a figure for a sitting-room paper or a lady's dress. The rational use of such objects cannot be attained by mere imitation, but through the apprehension of a principle or an idea, and its reproduction according to the purpose of the manufacturer and the laws of decorative art.

THE COMMON LIVER ENTOZOON OF CATTLE.

BY T. SPENCER COBBOLD, M.D., F.L.S.,

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If the attractive-looking amphistome, figured from Blanchard, and described in the preceding number of this periodical, has excited a desire for further information on "parasites not generally understood," the writer is confident that the more familiarly known creature whose portrait is annexed, will be found worthy of the most attentive consideration.

This little entozoon, more powerful for the destruction of its friends than are our huge armaments for the annihilation of our enemies, destroys in England alone some tens, and even hundreds of thousands of sheep annually, besides afflicting in a lesser degree the larger cattle;* added to which, our own *viscera* are sometimes deemed worthy of a visit; though, happily, this is of extremely rare occurrence. Obviously, therefore, the naturalist who shall be able to point out any means whereby the ravages of the common liver fluke may be frustrated, will confer a great boon on society at large, and more especially on agriculturists and cattle-breeders, who are most nearly interested in the welfare and preservation of their flocks.

On more than one occasion the writer has sought to convey to the parties above mentioned accurate intelligence as to the mode in which the liver flukes gain access to their *hosts*, or, in other words, to the bodies of the herbivorous quadrupeds they infest; but, as happens too frequently in such cases, he has found the vague opinions of a bygone age deemed more worthy of credit than the clearly enunciated facts of recent scientific discovery. When a still brighter light, however, shall have brought to view all the missing links now wanting to complete the chain of evidence, the promoters of science will more hopefully seek to enlighten those who, in so far as *natural* knowledge is concerned, are unwisely clinging to the "tales of a grandfather."

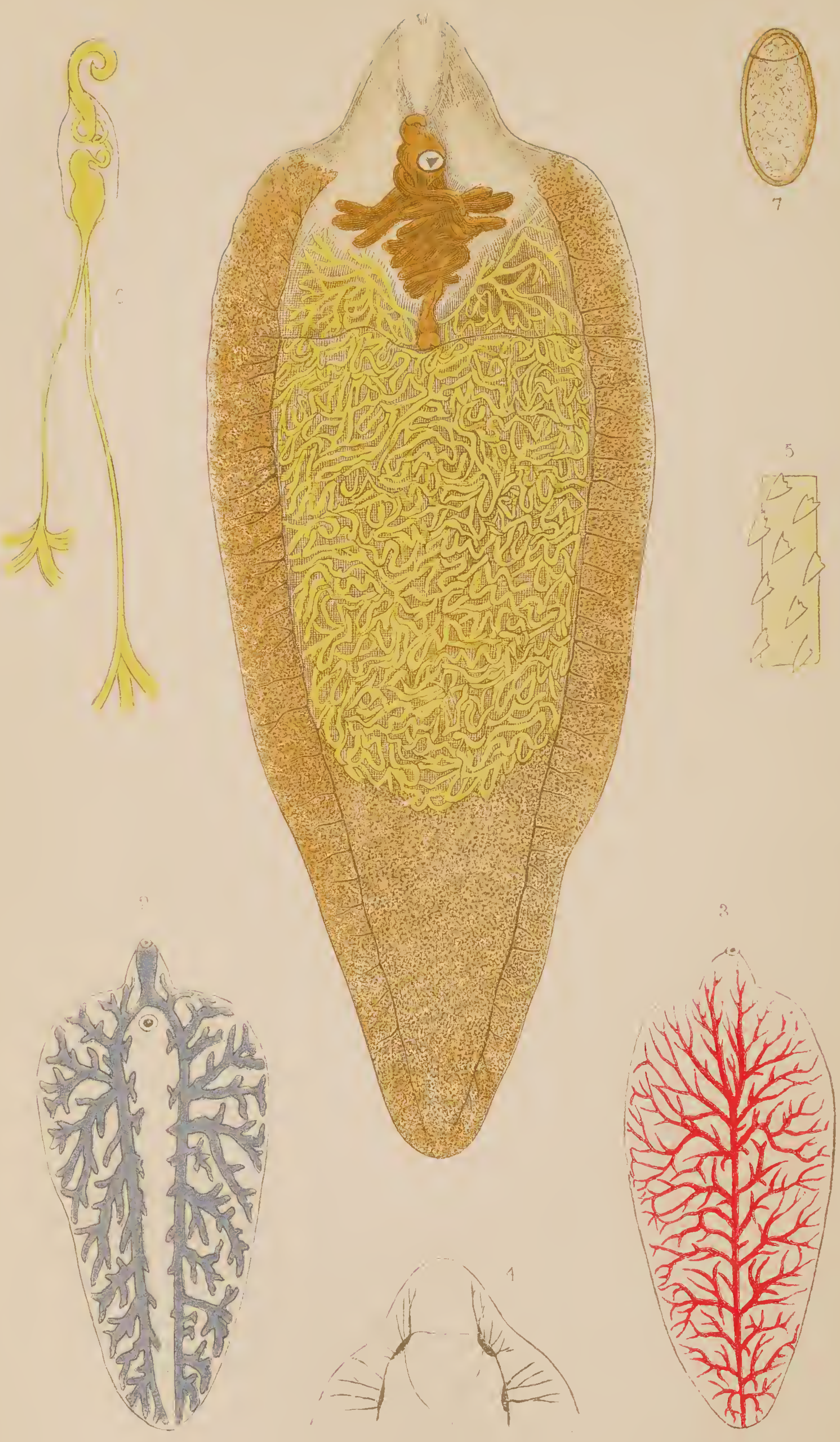
* Lest the writer may be thought to exaggerate the numbers here spoken of, he begs to call attention to an extract from that trustworthy and admirably conducted northern journal, the "Edinburgh Veterinary Review." At p. 63 of last year's volume the following passage occurs:—"In England this scourge of the ovine race has occasionally reduced the number of sheep so much as to materially enhance the price of healthy animals. For instance, in the season of 1830-31, the estimated deaths of sheep from rot was between 1,000,000 and 2,000,000. By supplying turnip, oleaginous cakes, and grain, sheep partially affected can be fattened; and those not affected can be kept sound by a limited daily allowance of one or other of these foods." Supposing the number to have been 1,500,000, this would represent a sum of upwards of £4,000,000!

The general reader and the accomplished scholar are probably little aware of the extreme difficulties which attend experimental investigations into the modes of reproduction found to obtain in entozoic life, and yet it is by these artificial means alone that practical science can successfully carry out its benevolent purposes. If conducted properly, the necessary experiments not only require time and the sacrifice of personal interests; but, in addition, a special supply of funds for the purchase of the larger animals to be operated on. In this country, such grants from governmental sources are not usually entertained, but on the continent—in that despised little kingdom of Saxony, for example—we find a ready hand tendered to the indefatigable cultivators of helminthological inquiry. One of the foremost of these is Dr. Frederick Küchenmeister, of Zittau, who, in the preface to his well-known work on human parasites, says, "The animals employed in experiments by myself, and at my own cost, were rabbits, cats, dogs, and a few sheep. The greater number of the pigs and sheep thus bestowed were procured at the expense of the Saxon ministry of the interior, by Professor Haubner, of the Veterinary School at Dresden; a considerable number of sheep being also provided at the expense of the Agricultural Society of Saxon Lusatia, and by the kindness of individual landowners."

In England the Royal Society and the British Association, following the example of the Parisian Academy of Sciences, have frequently devoted small sums to private investigators and dredging committees, for the judicious purpose of forwarding researches of a more or less purely scientific character; and it would be gratifying to hear that other public bodies had volunteered similar assistance to independent workers whose pursuits embrace more practical aims, and whose discoveries could not fail to benefit the community at large. The subject matter under consideration is one of those in which much still remains to be accomplished; but, before pointing out the special requirements of the case, the writer requests attention to the following ascertained facts respecting the structure and habits of the common liver fluke of sheep and cattle.

This entozoon has been known from the earliest times, and the animal may almost be said to have acquired a literature of its own. However, as regards the obscure opinions formerly entertained concerning it, little, perhaps, need be said; but those who may desire a list of references are invited to consult the author's *Synopsis of the Distomidæ*, quoted on a former occasion.

The scientific names of this parasite involve a question of some importance. Amongst naturalists generally it is continually spoken of under the combined generic and specific titles



Fasciola hepatica.

of *Distoma hepaticum;* but working parasitologists, who are at the same time acquainted with the writings of the earlier scientific observers, know very well that these titles are both incorrect and inappropriate. The proper generic appellation of this parasite is *Fasciola*, as first proposed by the illustrious Linnæus (1767), and subsequently adopted by F. Müller (1787), Brera (1811), Ramdohr (1814), and others. Unfortunately, however, Retzius (1786) and Zeder (1800) changed the generic title without good cause, and the majority of writers, following their authority, obstinately refuse to employ the original name, although fair dealing with the posthumous reputation of its distinguished author, and a consideration of the distinctive types of structure displayed by the two genera (*Distoma* and *Fasciola*), alike demand the retention of the Linnæan title. In later times, M. Emile Blanchard (1847), of Paris, has strongly advocated the final adoption of the Linnæan nomenclature, and the writer himself has also from time to time (in 1854,-56,-58, and 1860) demonstrated the propriety of rejecting the commonly received synonym. Another distinguished French naturalist, namely, Professor Moquin-Tandon, has also employed the term *Fasciola*, but by placing in the genus several species not properly belonging to it, such as *Distoma lanceolatum* and *D. heterophyes*, he has unwittingly rendered "confusion worse confounded."

The *Fasciola hepatica* is not only of frequent occurrence in all varieties of grazing cattle, but has likewise been found in the horse and ass by Daubenton; also in the hare and rabbit by the writer himself and others, in the squirrel by Tozzetti as previously mentioned, in the great kangaroo (*Macropus giganteus*) by Bremser and Diesing, in various antelopes and deer by Pluskal, etc., and also in the beaver (*Castor fiber*) by Czermack. Its occurrence in man has been recorded by Pallas, Bauhinus, and Bidloo, doubtful instances being also given by Mehlis and Duval. More recently, Professor Partridge of King's College detected it in the human gall-bladder, particulars of the case being described in the second edition of Dr. Budd's well-known treatise on "Diseases of the Liver." Giesker of Zurich mentions an undoubted example where the Fasciola had lodged in the sole of a woman's foot, whilst a similar case came under the observation of Mr. Fox of Topsham, Devon, the entozoon being located beneath the skin, about three inches behind the ear. Mr. Harris of Liverpool has likewise related an example where six or seven flukes had apparently penetrated the scalp of a little child, and there is every reason to believe that all these entozoa are referable to the species under consideration.

If attention be directed to the accompanying coloured plate, it will be noticed that the central figure, copied from Blanchard, exhibits the ventral surface of the *Fasciola hepatica;* and, as the animal seldom attains the length of an inch, this drawing (fig. 1) represents an ordinary specimen magnified about six diameters linear. To the naked eye the skin appears smooth, but microscopic aid shows the cuticle to be furnished with numerous rows of minute pointed spines (fig. 5). In the Amphistome we find two pores, one at either extremity of the body; but in the genus Fasciola, as also obtains in the majority of flukes, the oral and ventral suckers are more nearly approximated. The latter pore is frequently termed the *acetabulum*, and in the illustration before us it is seen occupying a median position at the base of the neck. It does not communicate with any cavities internally, and is simply employed as a "holdfast." The oral sucker forming the mouth leads to the short œsophagus, which very soon divides into two primary stomachal or intestinal trunks, which latter in their turn give off branches and branchlets; the whole together forming that beautiful dendritic system of vessels which has often been compared to foliar venation. This remarkably formed digestive apparatus is accurately represented in the annexed diagram (fig. 2), which should be contrasted with the somewhat similarly racemose character of the water-vascular system, shown on the opposite side of the plate (fig. 3). Let it be expressly noted, however, that in the digestive system the majority of the tubes branch out in a direction obliquely downwards, whereas those of the vascular system slope obliquely upwards. A further comparison of the disposition of these two systems of structure with the same systems figured and described as characteristic of the Amphistome, will at once serve to demonstrate the important differences which subsist between the several members of the two genera.

These distinctions stand out with equal cogency if we carefully examine the arrangements of the complicated reproductive apparatus; and here again the colours introduced into the plate at once enable us to institute a new comparison, and at the same time supersede the necessity of an otherwise extended description of the parts. All the orange-yellow-brown masses, with their delicate, connecting, dark coloured lines belong to the female division of the reproductive elements of this hermaphroditic species; the dark, central mass of folded tubes being the combined uterine cavity and oviduct, in which the eggs complete their final stage of development, before they gain access to the outer world. The multitude of little botryoidal organs occupying the sides of the body, and all that part which may legitimately be called the tail, are the so-called yelk-forming glands, and it will be observed that they communicate with the above mentioned oviducal, uterine folds, by the intervention of two common ducts, which run transversely inwards from either side, and meet together in the middle line. The canals in question convey the yelk-granules, which are formed in this curious set of organs, specially developed for their secretion in the flukes. The terminal portion of the male reproductive apparatus (fig. 6) is not unlike that of the Amphistome, the *vasa deferentia* uniting to form a sac, which is lodged within a sheath-like pouch; the latter embracing the lower part of the spirally protruded intromittent organ. The testes, instead of displaying the simple lobular character seen in the Amphistome, are split up, as it were, into tortuous bands, the two glandular masses together occupying the centre of the body. According to Blanchard, the glands are intimately blended with one another, and he also recognises the existence of a third duct, which he represents as connected with the shorter *vas deferens*. Be that as it may, the extent and complication of these organs are sufficiently calculated to excite astonishment; whilst, at the same time, they afford a very fair criterion of the reproductive powers enjoyed by this group of animals. The eggs are a trifle larger than those of the Amphistome, the chorion or shell being of a yellow-brown colour (fig. 7), and provided with a lid to facilitate the escape of the enclosed ciliated embryo. The nervous system consists of two cerebral lobes, one on either side of the oral cavity, and of a series of feebly developed ganglia, connected to the former by continuous filaments (fig. 4). Only two or three pairs of ganglia have as yet been indicated, but the filaments have been traced on either side of the body, to within a short distance of the caudal extremity. Küchenmeister altogether denies the existence of a nervous system in the fluke; but he is obviously unacquainted with the original discoveries of Mehlis and the subsequent descriptions of Otto and Blanchard.

Turn we now to the consideration of the habits of *Fasciola hepatica*, which, in so far as they relate to the excitation of the liver disease in sheep, acquire the highest practical importance. Intelligent cattle-breeders, agriculturists, and veterinarians have all along observed that the *rot*, as this disease is called, is particularly prevalent after long continued wet weather, and more especially so if there have been a succession of wet seasons: and from this circumstance they have very naturally inferred that the humidity of the atmosphere, coupled with a moist condition of the soil, forms the sole cause of the malady. Co-ordinating with these facts, it has likewise been noticed that the flocks grazing in low pastures and marshy districts are much more liable to the invasion of this endemic disease than are those pasturing on higher and drier grounds; a noteworthy exception occurring in the case of those flocks feeding in the salt-water marshes of our eastern shores. The latter circumstance has suggested the common practice of mixing salt with the food of sheep and cattle, both as a preventive and curative agent; and there can be little doubt that this remedy has been attended with more or less satisfactory results. The intelligible explanation of the good effected by this mode of treatment we shall find to be intimately associated with a correct understanding of the genetic relations of the entozoon in question, for it is probable that the larvæ of *Fasciola hepatica* exist only in the bodies of fresh water snails or small aquatic animalcules.

It is not intended in the present communication to offer a lengthened account of the various discoveries and facts which enable us to make this last-named statement; but correlating all the known data afforded by the experience of the parties above mentioned, by observant naturalists, by our own researches, and more particularly by the recent experimental investigations of continental helminthologists, we shall provisionally state in a tentative manner the conclusions to which a due consideration of all these facts inevitably lead. The deductions here recorded may eventually require modification in respect of their minor details, but in the main they will be found substantially correct, and therefore be likely to convey that kind of information which can scarcely fail to interest those more immediately concerned in the preservation of cattle:—

1. The *Fasciola hepatica*, or sexually mature liver-fluke, is especially prevalent in sheep during the spring of the year, at which time it constantly escapes from the alimentary canal of the *host*, and is thus transferred to open pasture-grounds.

2. It has been shown by dissections that the liver of a single sheep may, at any given time, harbour several dozen specimens of the fluke, and it is certain that every mature entozoon will contain many thousands of minute eggs.

3. The escaped flukes do not exhibit powers of locomotion sufficient to prove them capable of undertaking an extended migration, but their movements may subserve the purpose of concealing them within the grass or soft soil where they have fallen. Their habit of coiling upon themselves probably facilitates the expulsion of their eggs.

4. The eggs can only escape from the oviduct of the entozoon one at a time, but there is every reason to believe that large numbers of loose ova are expelled from the infested sheep in the same manner as the flukes themselves.

5. By the dispersing agency of winds, rains, insects, feet of cattle, dogs, rabbits, and other animals, and even by man himself, the eggs are carried in various directions, not a few of them ultimately finding their way into pools, ponds, ditches, canals, and running streams.

6. The freed eggs, if mature, contain ciliated embryos, capable of active progression when brought in contact with dew on the blades of grass, rain-drops, pools of water, ponds, and lakes. The prolonged action of moisture without, aided by vigorous movements of the perfected embryo within, serves to loosen the lid-like end of the egg-shell, by the opening of which the animalcule is set free.

7. The ciliated embryo, or *proscolex,* as Van Beneden calls it, contains within itself a solitary germ, which is developed by a process of internal budding into a non-ciliated larva, or *scolex* in the language of the Louvain Professor.

8. The ciliated embryo, after swimming about for a time, sooner or later selects and attaches itself to the surface of the body of a pond-snail, a slug, or the soft body of some aquatic insect. In this situation it looses its ciliated covering, and subsequently gains access to the interior of the selected *host.*

9. Once within the viscera of its *host,* the embryo disappears, leaving the hitherto contained germ-bud, or *scolex,* to undergo its further development, which is accomplished rapidly, a second progeny being at the same time formed within its own interior.

10. The enlarged and independent scolex is now transformed into a large sac, or cyst, for the support and protection of its contained progeny. In this condition it is frequently called a "Nurse," or "Sporocyst," and when rather highly organized, is known by the title of "Redia."

11. The nurse-progeny, or trematode larvæ, thus produced within the scolex, are usually furnished with tails, and when fully developed are the well-known Cercariæ. Van Beneden calls them *proglottides,* but the term is inappropriate.

12. The Cercariæ have a tendency to migrate from the bodies of their molluscan or insect *hosts,* and they are quite capable of an independent existence. During these wanderings in the water, or in moist pastures, they are occasionally brought in contact with the human body, and, in a few instances, appear to have succeeded in penetrating the skin.

13. It is not certain whether the Cercariæ are taken into the bodies of quadrupeds when the latter are drinking water or eating solid food, but it is probable that they are transferred in either way. It is not unlikely that they are often swallowed while still within the bodies of their molluscan or insect *hosts.*

14. From the digestive organs of the sheep or cattle the Cercariæ bore their way through the tissues into the liver, in which situation they part with their tails, and become encysted. This constitutes the so-called *pupa* stage.

15. The pupa, thus encysted for many weeks, or even

months, attains a higher organization, at last becoming converted into the sexually mature *Fasciola hepatica.* It then gains access to the liver ducts, passes into the common biliary outlet, or *ductus choledicus communis,* from thence is transferred into the intestinal canal, being finally expelled from its vertebrate *host* in the manner previously described.

If due consideration be awarded to the conclusions above given, it will at once be perceived that the multitude of remedies which are daily administered to sheep for the cure of the *rot,* or *cachexia aquosa,* can prove of little avail. Every year we hear of the adoption, often with enthusiasm, of new so-called specifics, or of ancient medicines whose employment had long fallen into desuetude. Thus, for example, in the April number of the *Journal des Vétérinaires du Midi* for 1860, we find M. Raynaud strongly recommending soot, in doses of from one to three spoonfuls, to be followed up by the administration of a grain of lupin for tonic purposes. In like manner we have received from France wonderful accounts of the medicinal virtues of a certain fœtid oleaginous compound, the value of which has been lately put to a fair test by our distinguished veterinarian, Professor Simonds. This last-named gentleman having with infinite care and trouble undertaken a series of experiments with the nauseating remedy in question, informs us, in the *Scottish Farmer and Horticulturist,* as a result of his inquiries, that he fears "we must conclude that this supposed cure of *rot* in sheep has proved quite ineffective for good in our experience."

It is not now proposed to enter into details respecting the genetic relations of *Fasciola hepatica;* but the writer begs to inform estate-owners, agriculturists, sheep-farmers, stock-masters, and all other parties interested in the welfare of flocks and in the production of cheap and wholesome food, that a true solution of this important economic question, in so far as it relates to the production of healthy meat, can only be obtained by the further prosecution of our experimental researches. In this attitude only can we ultimately hope to achieve a certain knowledge of the means of preventing, if not of entirely eradicating, this fearful disease; and the writer confesses that it seems to him strange that the cost of these necessary experiments should hitherto, in this country at least, have exclusively rested with those who have given much time, aided by such talents as they may possess, to practically scientific inquiries. On independent grounds he has himself, year by year, sought to throw light upon the origin and development of the various internal parasites which either annoy or destroy our valuable animals; and as, in some instances, these experiments have proved eminently instructive, he cannot avoid expressing regret that the costly nature of these investigations has alone prevented their further prosecution.

Those who desire to know what has been doing in other lands towards the elucidation of this important subject should, in particular, consult the Treatise *De la Reproduction chez les Trématodes endo-parasites, par J. J. Moulinié. Extrait du tome III. des Mémoires de l'Institut Génévois;* and also the excellent helminthological memoir by Dr. H. A. Pagenstecher, of Heidelberg, entitled *Trematodenlarven und Trematoden,* at the close of which latter the author appends a note referring to the above-mentioned work, finally adding, "We are encouraged again to take up our hitherto fruitless searchings among land-snails, and we hope, with M. Moulinié, that the next steps in this direction will clear up the history of the development of *Distoma hepaticum.*" In this desire the writer heartily concurs, regretting only, for the reasons previously stated, that his brother-workers on the Continent should deprive the fair fluke of its proper generic name.

A VISIT TO THE PYTHON IN THE ZOOLOGICAL GARDENS.

BY SHIRLEY HIBBERD.

DURING the past six weeks the number of visitors to the Zoological Gardens has been considerably augmented by the announcement that the large Python might be seen "incubating her eggs." On the 13th of February I had the pleasure of witnessing the novel spectacle, in the company of a few friends, and the event furnishes a proper opportunity for placing on record a few particulars of the addition thus made to our knowledge of herpetology. Previous to 1849, so we learn from Dr. Sclater's "Guide to the Gardens," "no attempt had been made in this country to exhibit the class of reptiles under conditions which might make it possible to understand anything of their habits." The attempt then made has been eminently successful, and many disputed points in the history of the Reptilia have been settled by the opportunities which the Society's collection has afforded for observation, inquiry into the habits, and specific distinctions of those representatives of the class which have been domesticated in the gardens. There are two structures devoted to them, No. 49, the reptile-house, and No. 50, the python-house. In these warm houses the reptiles are exhibited in a way to ensure perfect safety to visitors and perfect freedom, within proper limits, to the inmates of the comfortable, roomy, glass-fronted dens, which are variously furnished with stumps of trees, beds of clean pebbles, drinking and bathing troughs, and other accessories to the well-doing of the formidable pets. Among the principal inhabitants of these houses are, first, *Python molurus*, from India, the subject of this notice*; *P. regius*, *P. reticulata*, *Boa constrictor*; *Chilobothrus inornatus* (the yellow boa); *Crotalus durissus*, the rattlesnake; *Naia haje*, the cobra; *Cenchris piscivorus*, the water viper; *Pelias berus*, the common viper; and a very good collection of snakes, viperines, and batrachians.

Before detailing the results of our visit, a few words on the position of Python molurus in the recognized classification may not be out of place. The method of arranging the Reptilia, adopted respectively by Oppel, De Blainville, Dr. J. E. Gray, Cuvier (*Règne Animal*, 2nd edition), and Bell, are very nearly identical in their leading features; those of Merrem and Fitzinger differ considerably from the systems which have been generally recognized in this country, because they rely chiefly on the characteristics of the integuments; whereas structure and function are comprehended to a more or less extent in the arrangements which have been found most useful. Objections may be made to each of the systems hitherto devised, on the ground that the basis of classification varies at each stage, which is unavoidable in a natural arrangement. The result of this in Dr. J. E. Gray's classification is, that the crocodiles are separated from the turtles by the whole distance of the intermediate orders, the ophidian serpents standing midway between the extremes. Cuvier groups the chelonians and crocodilians side by side, as possessing a heart with a single auricle and limbs; the saurians follow, having a heart with a double auricle, teeth, and limbs; next come the ophidians, comprising all snakes and serpents. At the bottom of the scale are the batrachians. Professor Bell departs from this system only to place the lacertæ below the ophidians, and there is scarcely an exception in any of the systems to the assignment of a position midway between the extreme highest and extreme lowest—to the great class of serpents, which are inferior to the crocodiles, in having either rudimentary limbs or no limbs at all, and superior to the batrachians in the comparatively high functional capacities of the brain and heart.

Cuvier regarded the ophidians as most deserving the name of reptiles of any of the order, for the simple reason that they are without feet. He arranges them in three families—anguis, with scaly skin and three eyelids; true serpents, with scaly skin

* It is labelled Python sebæ, but described by Dr. Sclater as Python molurus.

without a third eyelid; naked serpents, which have no scales. The true serpents, as grouped by Cuvier, comprise those which have no sternum or shoulder-blade. Many of them have, however, rudimentary posterior limbs, of which the boas and pythons are examples. The protrusion of these in the form of anal hooks is usually visible, and they are no doubt of some use to the animal in locomotion, and in that peculiar act of grasping a tree by the tail while lying in wait for prey on the bank of a pool or stream. Professor Owen (*Odontography*) proposes to divide the Ophidia into two groups, in order to separate those which feed on small invertebrate animals from the typical ophidians, which swallow animals of greater diameter than their own. The first have the jaws articulated in a way which admits of no expansion, whereas in the typical ophidians the superior maxillaries are joined by an elastic tissue with the intermaxillary bone, and the articulations of the maxillary rami and the pterygoid bones are also elastic, and a dislocation of the whole framework takes place during the act of deglutition.

The pythons and boas form a very distinct family in the order Ophidia. The hinder limbs are developed under the skin, and terminate in a horny spine on each side of the vent. They are without venom, but are compensated for that by their immense muscular force, by the exertion of which they crush their prey, by the almost painless process of constriction. The pythons at the Zoological Gardens illustrate the external aspects and habits of the family in a most satisfactory manner, and the preparations at the British Museum and College of Surgeons, afford the fullest information of their anatomical structure and typical relationships. There are so few differences between boas and pythons, that those terms have little else than a geographical signification. Those of the old world are usually known as pythons, those of the new world, as boas; though boa is a classic term, and, according to Pliny, was applied by the ancients to certain old-world serpents which were supposed to subsist on the milk of cows. But as Boa is a Brazilian name for a serpent, there is an end of all difficulty as to how the word should have the same meaning both in the East and the West. In the true pythons, the crown of the head is shielded to behind the eyes, the upper and lower labial shields are deeply pitted, and the nostrils are vertical. In the boas the labial shields are smooth, not pitted; the crown is covered with scales, and the nostrils are lateral between two plates. The species which has recently attracted attention on account of its fertility, is Python molurus (Gray), known also as P. Coluber (Linn.), P. Javanicus (Kuhl), P. Tigris (Daudin). It is a native of Hindustan and Java. It is understood to attain to a length of thirty and more feet, but large specimens are becoming rare, in consequence of the extension of civilization in the districts where the species is found.

The classical stories of mighty snakes and serpents are all outdone in the event which has been, of late, so attractive in the Zoological Gardens. The sea-serpents which Aristotle describes as upsetting the triremes (l. viii. c. 28), the strangling of the monsters by the young Hercules, Virgil's Laocoon, and the snake that compelled the Romans to retreat from Bagradus, are all, no doubt, truths in disguise; but here is one of the most formidable of the true serpents, and an altogether grand specimen of its race, engaged in a tender maternal office, and exhibiting the utmost solicitude for its charge. Most of the full-grown serpents are shut up in their clean glass dens in solitude, but this motherly python has a male companion, with whom she has lived in peace for the greater part of her term of eleven years' captivity in the Gardens. The male is a small animal—that is, comparatively speaking. His length may be about fifteen feet, and at the time of our visit he was lying coiled up and torpid in his blanket, engaged in the uncomfortable process of changing his skin. The female measures twenty-two feet in length, her weight is about one hundred and twenty-eight pounds. As the proportions are very nearly identical in pythons and boas, it may be interesting here to give the measurements of a specimen in my own collection, the remembrance of which may be useful in assisting visitors to the Gardens to form an estimate of the proportions of the female python during the brief glimpses now obtainable, as she occasionally presents herself to view between the folds of her blanket. This is a specimen of boa-constrictor from tropical America. It measures, in extreme length, twenty feet three inches, the girth at ten feet from the head is seventeen inches, girth just below the head eight inches; width of upper jaw at its junction with the gullet three inches; length of the upper jaw with its four rows of teeth four inches, and the inner plate of the lower maxillary is not so large as the body of a full-grown rat. So far as I could judge by the cursory view obtainable, as the intelligent keeper of the python removed the blanket aside, she is very slightly larger than my own specimen; and I asked the question whether, in the act of feeding, these pythons were ever observed to lubricate the prey with saliva, according to the time-honoured statements in the books. The keeper could declare, from many years' experience in feeding these serpents with rabbits and ducks, that no such lubrication ever takes place.

According to the narratives of Mr. McLeod, Mr. Broderip, and other observers equally reliable, the prey is never heeded unless it exhibits signs of life. The serpent watches it, and strikes it suddenly while it is in motion. The blow is followed by a rapid coiling of the serpent around the prey, and the constriction upon it breaks every bone, and puts an end to life more suddenly and painlessly than by any method of destruction ever devised by man. In all the carnivorous reptilia, this same habit appears to prevail; they never make an attack while the prey is motionless, but wait till it comes fairly within reach, and prefer to strike when it is in full activity. Even a slow-worm or ringed snake follows the rule; and, though I have often attempted to deceive them when in a domesticated state, by giving artificial motion to a dead frog, the *ruse* never succeeded, and the morsel was refused. My boa could probably gorge a sheep or goat without difficulty, and though the great python at the gardens is usually fed with rabbits and ducks, it could with great complacency make an end of any one of the pretty antelopes that occupy the pens hard by. But the point of interest here is the alleged act of lubrication. The pythons swallow their ducks without even moistening the feathers, but there is a copious flow of saliva within the horrid jaws, and those jaws undergo a distension, which is in effect a dislocation of the dentigerous bones, which return slowly to their original positions when the act of deglutition is completed. The female python when hungry, and especially after a change of skin, will make an end of a dozen rabbits in rapid succession, but her male companion is generally contented with two or three. Though the act of feeding is not to be counted among the elegant exhibitions of a menagerie, and our little British snakes follow the example of their vaster congeners in creating a sense of disgust in the spectator, there is system in it, over and above the immense muscular force displayed. The victim is invariably taken by the head, so that, in its passage down the gullet, the limbs yield to the pressure of the passage; and, as the bones are already crushed by constriction, there is much less tension of the integuments than would be supposed by any mere comparison of the respective dimensions of the gullet and the prey, the dislocation of the jaws being accompanied with a distension of the œsophagus, while the muscular action conveys the prey to the stomach.

Anxious to afford us a good view of the mass of eggs, about which the python has coiled herself immovably, the keeper proceeded to the back of the den, and gently removed the blanket. There she lay in magnificent coils, the rich mottlings of the scaly skin shining as if oiled, and not a crevice perceptible between the folds, so regularly had she disposed herself to maintain the temperature of her eggs. The keeper gently placed his hand against her a few inches below the head, and she turned aside reluctantly, brandishing her forked tongue, and showing a few of the eggs. He then placed the other hand on one of the great folds; and by gentle pressure in the opposite direction caused her to uncoil slightly, and display the greater portion of the nest. As she now began to raise her head, and assume a menacing look, her small eyes sparkling with a fire that at least suggested the idea of offended maternity, the blanket was carefully replaced, the door was shut, and Mrs. Python shrunk down again until the blanket lay flat and smooth, as if she nestled yet closer to her unhatched progeny. During the brief view thus obtained, it was evident that there was system in the hatching process. The eggs appeared to be somewhat larger than those of a goose, of the same colour, and the exterior shell, instead of being hard and calcareous, is leathery and elastic. Some of them are green and putrid, but it would be equivalent to a sentence of death to require the keeper to remove them, though their presence may be fatal to the young pythons, should any be hatched. They are connected together by a membrane, and are evidently arranged with care in concentric layers, so that the greater part of them have the full influence of maternal warmth.

The temper of the python when thus slightly disturbed, and her persistency in her work of incubation, severally contradict and confirm the statements of scientific authorities. The Rev. L. Guilding, describing the transportation of a boa to the island of St. Vincent says, "A noble specimen of the boa constrictor was lately conveyed to us by the currents, twisted round the trunk of a large cedar tree, which had been previously washed out of the bank by the floods of some great South American river, while its huge folds hung on the branches, as it waited for its prey. The monster was fortunately destroyed, after killing a few sheep, and his skeleton now hangs before me in my study, putting me in mind how much reason I might have had to fear in my future rambles through the forests of St. Vincent, *had this formidable reptile been a pregnant female,* escaped to a safe retreat." The pythoness is evidently in no temper to be disturbed while waiting in instinctive expectation for a happy issue to her tedious incubation, and very few who have witnessed this spectacle will agree with Mr. Waterton that "the pythoness herself would comprehend nothing of what was going on"!

Previous to the extrusion of the eggs, this python exhibited evidence of uneasiness. She had a plethoric look, and it began to be questioned whether she might not have swallowed a blanket. Fearing the loss of so valuable a creature, it was determined that, on Monday, the 13th of January, an emetic should be administered, when lo! on that very morning the keeper found his pet engaged in incubation, the eggs having been laid on the night of Sunday, Jan. 12th. Once she left them for a few moments, and then it was estimated there were upwards of a hundred, but the precise number will probably never be known.

On this matter of incubation authorities differ. The author of the *Treatise on Reptiles* in the *Encyclopædia Britannica* says, "No reptile is known to hatch its eggs." In the *Gardener's Chronicle* of February 22, Mr. Waterton says, "The body of a snake is hard and cold, and scaly; qualities quite useless in hatching eggs, which require warmth and softness, and pliability when birds sit on them; and the heat of the sun and dryness, when the atmosphere acts the part of a parent." On the other hand, the *English Cyclopædia* says, "They (the pythons) are distinguished by placing their eggs in a group, and covering them with their bodies. This statement, which was made by Mr. Bennett, and afterwards confirmed by M. Lamare-Picquot, has been doubted; but its truthfulness has been confirmed by the proceedings of a python in the Garden of Plants at Paris." (Vol. i. Boidæ, c. 540.)

On the 13th of February last, the pythoness had fasted for twenty-five weeks, and then disdained food, and thrust from her the rabbits which were allowed to skip about her cage unsuspectingly as a temptation. She drinks freely; and there is a large tank close at hand, so that she can obtain water without quitting her eggs. The temperature of her den averages 70°, and the temperature of the eggs may be estimated at 80°. As numerous broods of serpents have been artificially hatched at the Gardens, the temperature favourable to the process is a matter of importance. The time usually occupied is sixty days, in a temperature of 80°. It is anticipated that the incubation of the python will be at an end, for better or worse, on the 20th of this month, which will be seventy days from the deposition of the eggs. Opposite the den of the pythoness is a viper, which was hatched from an egg in the Gardens in 1860, and at the rear of the den is a cage full of little viperines (*Tripodonothus viperinus*), which I had the pleasure of playing with, which were hatched artificially; they now average from ten inches to a foot in length, and are lively, interesting creatures that change their garments frequently, and eat a prodigious number of mice and frogs.

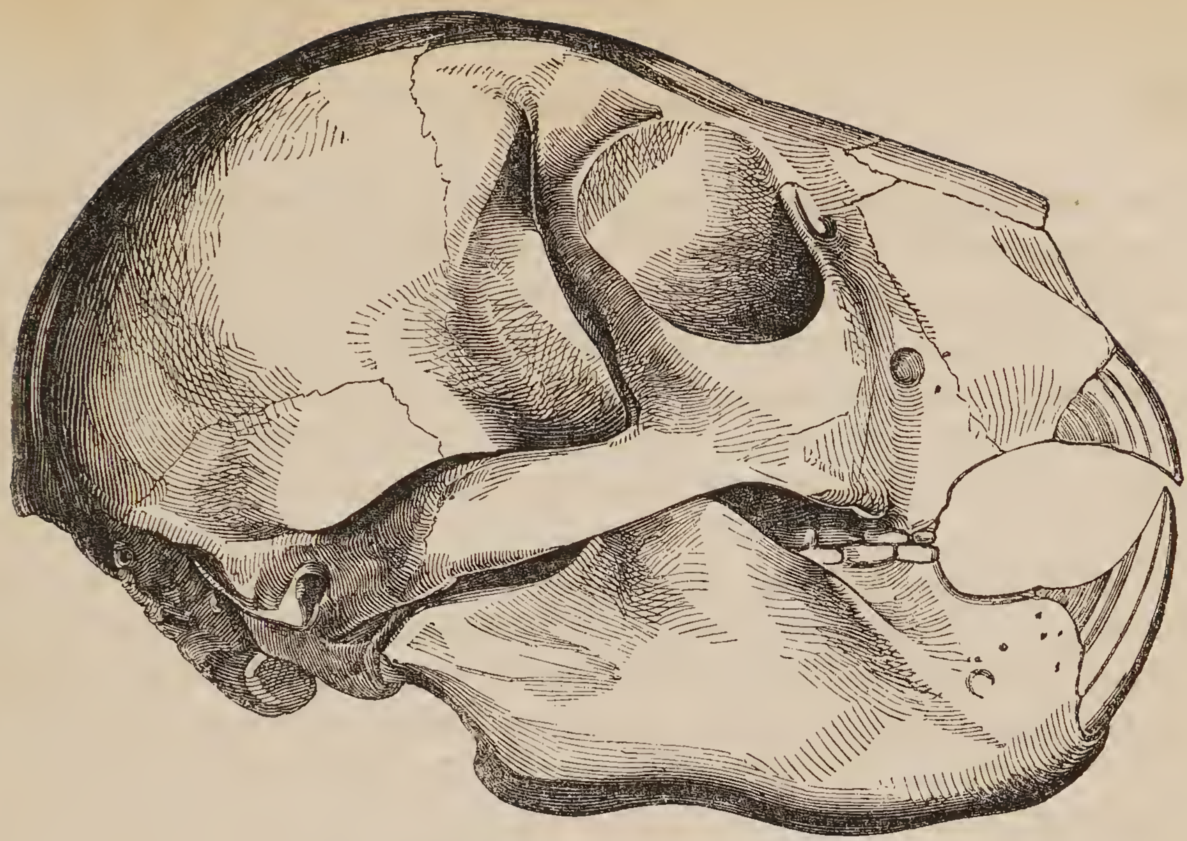
The age of the pythoness is not known. She is supposed to be about thirty years old, and if we may assume that her magnitude has not increased at the rate it would have done had she been free instead of caged during the past eleven years, the measurement in feet will afford a near approximation to the number of years of the existence of such a creature. She may bring out a few little pythons from her mound of eggs, and a new attraction will thereby be offered to the sightseers who will haunt London during the coming summer. In the year 1841 a similar circumstance took place with a pair of pythons in the menagerie of the Jardin des Plantes at Paris. The phenomena of the reproduction of the young pythons in this case were accurately watched by Professor Valenciennes, and the results of his observations published in the *Comptes Rendus* of the Academy of Sciences of Paris. The number of eggs in this case was only fifteen, and the mother sat bravely on, until, at the length of two months, eight young ones were produced. Professor Valenciennes has attempted to show, by careful thermometrical experiments, that this female python, during her incubation, developed heat to the amount of ten or twelve degrees (centigrade) above the temperature of the surrounding objects. But it has been considered by other authorities on the subject, that there is some doubt whether this increase of heat was really caused by the incubative action, and there is still much uncertainty upon this point. Experiments made at the Regent's Park Zoological Gardens go to show, according to the report of Dr. P. L. Sclater, "that the heat of the incubating female python is not greater than the heat of a non-incubating boa in an adjoining compartment."

THE AYE-AYE.

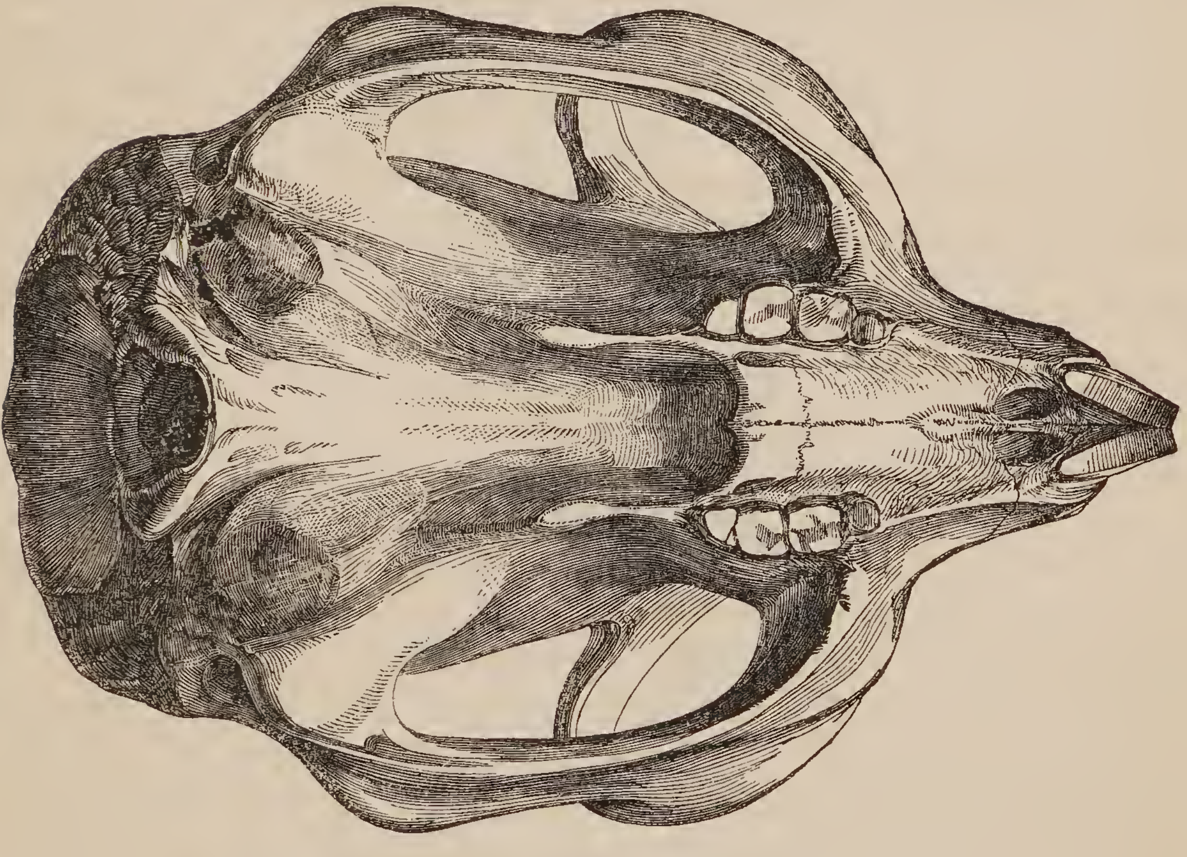
BY W. B. TEGETMEIER.

The Aye-aye of Madagascar, the *Chiromys Madagascariensis* of Cuvier, is one of the most anomalous of living mammalia. In consequence of the exclusion of Europeans by the tyranny of the late queen, but little information has latterly reached Europe respecting the productions of that island, so that one of our best known naturalists has stated, in a book published within a few weeks, that "not a specimen of the aye-aye has, as I believe, been seen since Sonnerat's day, so that if not actually obliterated, the species must be on the verge of extinction." Fortunately, this conjecture is not borne out by the facts of the case; the recent throwing open of Madagascar to Europeans has made known that the natives regard the animal with interest, and Dr. Sandwith has availed himself of his opportunities, as Colonial Secretary at the Mauritius, to obtain these animals in a living state, and to study their actions and habits.

A specimen, most carefully preserved in spirits, has also been recently forwarded to Professor Owen, who has studied its structural peculiarities, so that at the present time we are in possession of much fuller details regarding this extraordinary quadruped than heretofore, and are enabled to arrive at



SKULL OF AYE-AYE.



BASE OF SKULL OF AYE-AYE.

LOWER JAW OF AYE-AYE.

a somewhat more satisfactory conclusion as to whether it is to be regarded as a gnawing animal with the grasping hands of a monkey, or a monkey with the rat-like teeth of a rodent. On consideration of the most important peculiarities in its structure, we cannot fail to observe their extraordinary adaptation to the habits, food, and mode of life of the animal, as recently made known by the peculiarly interesting observations of Dr. Sandwith.

The aye-aye is about the size of a small cat. The head is peculiar, the eyes being directed forwards, and not laterally as in rodents. The ears are of large size, and also directed to the front. The trunk is large, the chest being well developed; the

FOREHAND OF AYE-AYE.

body is clothed abundantly with hair, and terminates in a long bushy tail, which does not possess any power of grasping. The great peculiarity of the outward form of the animal is in the fore limbs, which somewhat resemble those of a lemur. The fore-hand, like that of man and the quadrumana generally, is capable of being turned either into the prone or supine position. The first digit is readily opposable to the others, and so constitutes a true thumb. The index finger, as shown in our engraving of the fore-hand, is very short; the middle finger is long, and so singularly attenuated as to appear withered or deformed, whereas the other fingers are of the ordinary thickness. The palm is naked, and the whole hand looks not unlike the miniature of a deformed and paralyzed human limb. The hinder hand has a powerful grasping thumb, and resembles closely that of the lemur, and other nocturnal quadrumanous animals.

The teeth of this animal, however, offer a remarkable departure from the monkey type. The fore teeth, as shown in the views of the skull, are truly those of a rodent or gnawing animal. having sharp, cutting edges, and are furnished with a layer of enamel on the front surface, which, like the steel facing of an iron chisel, keeps them constantly keen and in cutting order. Like the teeth of a rodent, they are continually growing during the life of the owner. They differ, however, somewhat from the incisors of our common gnawing animals, in being very narrow in proportion to their great depth from front to back.

The grinding teeth are much more vertical in their position than those of rodents, and instead of being formed of alternate transverse vertical ridges of bone and enamel are capped with smooth crowns of enamel, as in man and the quadrumana generally; their number is unequal, being, as shown in our engravings, four in the upper, and three in the lower jaw. The skull compared with that of the squirrel, is larger, the brain-case being well developed, and the brain itself resembles that of a lemur, and not that of a rodent. This wonderful combination of the structure of two groups of animals, so widely removed as are the quadrumana and the rodentia, has hitherto proved exceedingly puzzling, especially to those naturalists who imagine that all animals should be constituted with reference to some given type. To those, however, who are intent upon tracing the intimate relation that exists between structural peculiarities and habits, the aye-aye is one of the most interesting of all animals, but until the exact nature of its habits were made known by the communication of Dr. Sandwith, this relation could not be accurately traced.

The aye-aye is a nocturnal animal, sleeping during the day and becoming active at night, as might be inferred from its large circular eyes, wide iris, and great expanse of pupil. Its food, as indicated by its simple molars, consists in great part of fruits and soft vegetable substances, such as dates; that it is a climber is evidenced by the grasping character of its extremities. It was not until Dr. Sandwith accidentally placed some branches for the living animal to climb, that the true co-relation of its organs to its habits was noticed. These branches had been perforated by some wood-boring larvæ. On being placed in the cage of the aye-aye, the animal was observed to direct the large expansive ears towards them; when its acute sense of hearing gave evidence of the working of some concealed insect in a larval state. The long attenuated finger, that even Buffon himself could now no longer regard as a deformity, was employed as a probe; it failed to reach the intended prey, so that the slender hooked claw, with which it is armed, was for a time useless, but the powerful gnawing teeth of the animal were instantly put into requisition; sufficient of the wood was rapidly bitten away to enable the probe-like middle-finger to be inserted with success, and the slender claw transfixed and drew forth a large luscious larva, which was devoured with the greatest relish.

The peculiar configuration of the aye-aye is no longer a mystery; its grasping hinder hands, leaving the fore limbs free, its long attenuated probe-like finger, with its slender hook-like claw; its enlarged ears, its gnawing teeth, are all evidently adapted to the habits, instincts, and food of the animal, and although they may not enable closet naturalists to locate it with unerring certainty in this or that artificial group; they, nevertheless, prove what is of much more importance to be determined, that there is a co-relation of structure with external circumstances, which proves, as far as such evidence can prove, that the organs of the animals are formed with special and direct reference to the objects upon which they are to be exercised.

THE IDOL HEAD OF THE JIVAROS.

BY WM. BOLLAERT, F.R.G.S.

On the eastern side of the Republic of Ecuador, formerly known as Quito, live a tribe of Indians called Jívaros, a strange, wild people, dwelling in the midst of a most beautiful mountainous country rich with tropical vegetation, and dense forests, and including in its wild grandeur the by no means inconsiderable volcano of Macas. There, may be found, among other valuable vegetable productions, the handsome mahogany, sandal, and ebony trees, the cinchonas, india-rubber, copal, storax, indigo, guayusa, canelo, etc., most of them well known to civilized life, and all of them deserving to be so for their useful properties and capacities. The laurelo or wax palm is very abundant, the wax being obtained by merely scraping it off the bark. Cotton, of a long fibre, strong, and of a fine quality, grows there indigenously; no limits could be put to its cultivation, and the Amazon affords an easy shipment to Europe. Coffee and cacoa grow freely. The guayusa, a plant which the Indians cultivate near their huts, might probably compete with tea from China in the English market, as it has a similar aromatic flavour without bitterness. Canelo is a species of cinnamon; the ishpingo is the calyx of its flower. It is equal in flavour to the best East India cinnamon, and 3000 to 4000 lbs. of it are annually gathered. A wholesome and nourishing drink is made from the *Jatropha manihot,* and this valuable root is of almost universal use as food, and for many other purposes throughout Ecuador, New Granada, and Peru. The Torquilla palm is most abundant, and yields the beautiful straw used in making the Panama hats.

In addition to all this vegetable productiveness and wealth, this favoured district is rich in gold, and may boast of having the famous auriferous mountain of Llanganate within its boundaries. The natives are not slow in turning this to their own account, and quickly collect for the traders an ample supply of the precious metal to exchange for their much coveted goods. The fertility of the soil is, in a great measure, to be attributed to its plentiful irrigation, not only by the smaller rivers, Chinchipe, Pastasa, and Marañon, but likewise by the mighty Amazon, of which they are tributaries; and it is in the forests among these rivers that the Jívaro Indians now make their homes. They are an ancient and warlike people, and their history is given by Velasco, the historian of Quito, together with an account of their conspiracy against the Spaniards in 1599, an outbreak which procured for them the title of Araucanos of the North. At that period they made the governor of Macas prisoner, and killed him by pouring molten gold down his throat; afterwards they destroyed the Spanish settlements in their part of the country in one day, killing the men, but taking the women into captivity. In modern times many expeditions have been organized to punish them, but all have failed.

The Jívaros are a warlike, brave, and astute people; they love liberty, and can tolerate no yoke. Their bodies are muscular, they have small and very animated black eyes, aquiline noses, and thin lips. Many have beards and fair complexions, most probably arising from the numbers of Spanish women they captured in the insurrection of 1599. They have fixed homes, cultivate yucas, maize, beans, and plantains, and their women wear cotton cloth. They live in well-built huts made of wood, and sleep in fixed bed-places instead of hammocks. Their lances are made of the Chonta palm, the head being triangular, thirty to fifty inches long, and ten to fifteen inches broad. They are accustomed to take a strong emetic every morning, consisting of an infusion of the guayusa, or tea plant, for the sake of getting rid of all undigested food, and being ready for the chase with an empty stomach. Their hair hangs over their shoulders, and they wear a helmet of bright feathers. Velasco, in 1789, divided them into three branches; Villavicencio, in our own times, divides them into ten, all speaking the same language, which is sonorous, clear, and harmonious, easy to learn, and energetic. Their branch tribes are constantly at war with each other, but readily unite against a common enemy. Their dissensions are frequently caused by their good living; the abundance of fish and game makes them saucy to each other, which often leads to serious quarrels.

At each village they have a drum called *Tunduli*, to call the warriors to arms, and the signal is repeated from village to village. When engaged in war, their faces and bodies are painted; but during peace they wear breeches down to their knees, and a shirt without sleeves.

One of their prominent customs is to deify the heads of their prisoners. This fact has been known for some time, but only lately have any specimens been obtained. The first was brought to Europe by Professor Cassola in June, 1861, and was exhibited to a few persons in London. This had been stolen from a temple on the river Pastasa. At the latter end of the same year another specimen fell into the hands of Don R. de Silva Ferro, Chilian consul in London, with an explanatory document, which has been translated by Mr. Bollaert, and communicated to the Ethnological Society, together with some account of the Jívaros themselves.

The Idol Head from which our sketch is taken, was obtained through a baptized Indian, who persuaded a Jívaro, notorious for ill luck, that this was occasioned by the imprisonment of the idol, who was desirous to travel. The Jívaro handed it over for this object, when it was taken to the governor of Macas, who sent suitable presents to the Indian in return for his interesting gift.

These curious trophies are thus prepared: after a war the heads of the victims are cut off, the skull and its contents removed, and a heated stone (it is said) is introduced into the hollow of the skin; desiccation goes on, and it is reduced to about one-fourth, retaining some appearance of the features.

A feast ensues, when the victor abuses the head roundly, to which the head is made to reply in similar terms—the Indian priest being the spokesman for the head, or *chancha* (an Indian name for a sow), and he concludes his part thus: "Coward! when I was in life, thou didst not dare to insult me thus; thou didst tremble at the sound of my name. Coward! some brother of mine will revenge me." The victor at this raises his lance, strikes, and wounds the face of his enemy, after which he sews the mouth up, dooming the idol to perpetual silence, excepting as as an oracle; questions being put to it when the inquirer is under the spell of a narcotic.

When the Jívaro is pressed by the enemy, and has not time to cut off the head of a victim, the ceremony is performed on the head of a sow, which is adored as a real Idol Head. Should the fruits of the earth not be in abundance, the women hold a feast of supplication to the head, and if their request is not granted, the hair is shaved off, and it is thrown into the woods.

A double string is attached to the top of the head, so that it may be worn round the neck. The lips are sewn together, and a number of strings hang from them, the use of which is not apparent.

MEDIÆVAL ENGLAND.*

Among the aids to the philosophical study of history, a high place must be given to the labours of the modern archæologist, who has collected and arranged an innumerable array of facts, by the help of which it is possible to reconstruct the society of

* *A History of Domestic Manners and Sentiments in England during the Middle Ages*, by Thomas Wright, Esq., M.A., F.S.A., Corresponding Member of the Imperial Institute of France, etc., with Illustrations from the Illuminations in contemporary Manuscripts and other sources, drawn and engraved by F. W. Fairholt, Esq., F.S.A. Chapman and Hall, 1862.

the past. It is no longer fancied that to learn by rote a few score of names and dates, to get up "tables of kings," and long lists of battles, is to become a historian. In looking back to any particular period, we want to know something more than the external facts of public and political transactions. We desire to gain an insight into the conditions of the people, the relations in which the various classes of society stood towards each other, and to understand the nature of the impulses by which retrogression was compelled, or progress was achieved. The ideal of social development is the substitution of enlightened opinion for brute force, the enlargement of the total quantity of the means of well being, and their more equitable diffusion, so as to realize Bentham's grand desideratum of the "greatest happiness of the greatest number." Keeping this in view, we are especially interested in those movements by which mediæval ideas and institutions were gradually replaced by modern arrangements, destined in their turn to give way before that increase of intelligence which promises to be the great characteristic of the next epoch in the civilization of man.

An enlightened study of history is alike fatal to a superstitious reverence, or a self-sufficient contempt of the past. We discover no "good old times" that we would exchange for our own, and in the sense in which Tennyson exclaims—

"Through the shadow of the globe we sweep into the younger day;
Better fifty years of Europe than a cycle of Cathay,"

we value a year of the present more than a generation of a barbarous age. And if such a comparison tends to puff us up with pride, the very study which suggests it, supplies the corrective of which our vanity has need. We select, for example, a period in our own history many centuries ago; we see the action of the upward struggle which was then going on, and we find that, notwithstanding our inheritance of the victories which our forefathers won, the work which remains to be accomplished is far larger than that which has already been achieved, and we are made to feel that, although our days may be hereafter "good old times" to our posterity, on account of the serviceable materials we shall leave behind us, they will likewise be "bad old times" when a wiser generation looks back upon the ignorance, crime, pauperism, and suffering by which our condition is so sadly marred.

A work like Mr. Wright's *History of Domestic Manners and Sentiments in England during the Middle Ages*, furnishes a store of delightful reading bearing upon the preceding remarks. Aided by his laborious, but gracefully employed learning, and assisted by the hundreds of curious illustrations copied from authentic sources by Mr. Fairholt's pencil, we can make a morning call upon the Anglo-Saxons, dine with the Anglo-Normans, or pay a familiar visit to the early Englishman, when the conflicting races were fused together, and a single national appellation became the grand name of all. We find the Saxon, so far as the upper class was concerned, in a higher condition than has often been supposed, and after Roman influence had been felt, his mode of life was not wanting in the elegance that is compatible with a rough iron age. Although stone was occasionally employed, the chief material for the construction of habitations was wood, and the carpenter was the builder in those simple days. The principal apartment was the hall, or public living room for the family and their guests. Internally it was covered, by those who could afford the luxury, with "wall clothing," or hangings, either of plain cloth, or richly ornamented with embroidered patterns, or pictures of historic scenes. So early as the seventh century, Mr. Wright tells us, that Aldhelm observed that if the tapestries were of "one colour, uniform, they would not seem beautiful to eye." These hangings, together with arms, armour, and trophies of the chase and war, constitute the most noticeable decorations of the abode; but we find ornamental tiles covering the roof, and variegated or tesselated pavements not unknown for the floor. The vessels of domestic use were not without a fair share of beauty and constructive skill. The bowls with double handles were of graceful form, and buckets, probably used to hold ale or mead, were decorated with bronze handles and hoops, exhibiting considerable knowledge of design. Very characteristic also were the drinking vessels, especially the "tumblers," rounded or trumpet-shaped glasses which would not stand, and which the topers of both sexes emptied at a draught. One of them, sketched by Mr. Fairholt, is elegantly fluted, while another exhibits a "twisted" pattern often mentioned by Beowulf, and evidently highly esteemed by the fashionables of his day. Separated from the hall were the "bowers," or private sleeping rooms, in which very little luxury was displayed. The bed was a sack of straw, the bed-clothes of a primitive character, and night-gowns (as was the case for many centuries) consisted merely of the natural covering which Nature provided when she benevolently furnished our progenitors with a skin. The table in the living room, or hall, was, for the most part, literally a "board," which tressels supported when its services were required for the rough but hospitable meal. Very harsh were the distinctions of class, but, nevertheless, certain elements of equality prevailed.. All halls were open, and any stranger, however lowly his condition, was at liberty to enter, and take his place even at the "board" of a noble or a king. The dinner must have been a very clumsy and dirty affair. In an old picture, given by Mr. Wright, we see a table covered by an ornamental cloth, but destitute of plates, and although some rather good-looking vessels are in use, the meats are presented by kneeling domestics upon the spits with which they were prepared, and the guests cut off the tit-bits with clumsy knives. The treatment of servants, even by ladies, was very brutal; fetters and flagellations being freely employed. Mr. Wright thinks it probable that the early babies of our country were swaddled, but whatever may have been their treatment in this respect, maternal tenderness was not sufficient to prevent the common occurrence of gross negligence, and Archbishop Theodore, who lived in the latter half of the seventh century, found it necessary to enjoin a special penance to mothers who left their children on the hearth, exposed to the unfortunate influence of an over-boiling pot. Nor could the matrimonial system be considered quite perfect, when a law of Ethelred provided that any gentleman who was guilty of over fondness for his neighbour's wife should buy him another as compensation for the wrong.

At a very much later period it is surprising to find how deficient our ancestors were in what we should call the necessaries of life. Thus the *Ménagier de Paris*, a work written about the year 1393, informs us, that the servants who had charge of candles used to accompany those valuable articles to the bed-rooms, and hold them in their hands until the would-be sleepers had undressed and gone to rest. Similar adventures repeatedly occurred to Mr. Olmsted, in his recent travels through the semi-barbarous Slave States of America, and, indeed, as we read his *Cotton Kingdom*, the details of brutality and discomfort often remind us of the dark ages in European lands. The coarseness of those times has been thought by superficial observers to have been consistent with moral innocence. Mr. Wright, estimating them more profoundly, asserts that the "whole tenor of contemporary literature and anecdote will leave no doubt that mediæval society was profoundly immoral and licentious." Of course it was. Nothing else was possible, unless in exceptional cases, when the rights of individuals were very imperfectly recognized, when the mind of the people had no rational employment, when ignorance was universal, and gross superstition exercised an almost unbroken sway.

The position of woman is a sure index to the condition of society, and some old books which our author cites are very instructive on this head. Thus we find a social moralist, the Chevalier de la Tour-Landry, instructing his daughters in matrimonial obedience, by telling them what happened to a lady who ventured to contradict her lord and master, and was thereupon knocked down and kicked, so as to break her nose, and thus disfigure her for life—a punishment which the chivalrous narrator thought justly warranted by the offence. Another reformer of domestic manners, Robert de Blois, who furnished young ladies with a code of instruction in verse, entitled the *Chastisement des Dames*, does not make us in love with the ways of feudalism in the fourteenth century. Many of his directions point to practices of gross indecency, and the believers in the so-called "ages of faith," which preceded the Reformation, may be astonished to find it was necessary to recommend the daughters of noble families not to get drunk, and not to use the table-cloth for a pocket handkerchief when they went out to dine!

It is customary to talk of the refined cookery introduced by the Normans, but when the luxury of feasting was at its height, we do not discover any rational principles of culinary art. The dinners were elaborate and costly, consisting of many courses, prepared with great trouble and expense, and yet scarcely a dish would be tolerated by the palate of modern times. In the fourteenth and fifteenth centuries there seems to have been a rage for highly-flavoured compositions, in which the ingredients were mingled with little regard to what we should consider their natural affinities. Perhaps equally disagreeable combinations might be selected from the records of Roman feasts; and there is scarcely anything, however nauseous, to which habit and fashion will not reconcile the accommodating stomach of man. Here is a specimen of a delicacy in the days of Richard II.; it is called a *farsed browet*, or *browet farsyn*:

"Take almonds, and pound them, and mix them with beef broth, so as to make it thick, and put it into a pot, with cloves, maces, and figs and currants, and minced ginger, and let this seethe: take bread, and steep it in sweet wine, and 'draw it up,' and put it to the almonds with ginger: then take conyngs (*rabbits*) or rabettes (*young rabbits*), or squirrels, and first parboil, and then fry them, and partridges parboiled: fry them whole for a lord, but otherwise chop them into gobbets; and when they are almost fried, cast them into a pot, and let them boil altogether, and colour with sandal-wood and saffron; then add vinegar and powdered cinnamon, strained with wine, and give it a boil; then take it from the fire, and see that the potage is thin, and throw in a good quantity of powdered ginger."

During the thirteenth and fourteenth centuries a desire for education exercised a beneficial effect, and Mr. Wright artributes this movement to the rise of an industrial class. It was, as he tells us, the merchants in the towns who made the first step in advance, and founded the most important local schools. We could have wished he had devoted more space to tracing the growth of the intellectual element in English society, and exhibited the enormous difficulties it had to encounter, and the causes of its very slow success.

Even in the fifteenth century, notwithstanding the augmented wealth of the middle class, and the importance assigned to a more private apartment than the hall, the conveniences were so few as to indicate that very little talent had been exerted in contriving the arrangements of domestic life. Thus the "parlour" was thought well furnished if it had a hanging of worsted, a cupboard of ash board, a table and a pair of tressels, "a branch of latten with four lights;" a pair of andirons, a pair of tongs, one form, and one chair. Looked at as a social institution, the "parlour" was a grand invention. Life then acquired the possibility of privacy, with some share of comfort, and the morals of the ladies were improved by having a convenient room to receive their visitors, without taking them, whether male or female, to the retirement of the bedchamber or "bower." Domestic discipline was, however, still founded upon "laws" analogous to those of which Canning represented Mrs. Brownrigg to have dreamt, and the wife of Sir William Paston, in 1454, probably did not depart far from the general custom, in beating one of her daughters one or twice a week, and sometimes twice a day. As vice and brutality were common qualities, demure propriety of outward demeanour was rigorously enforced while the sons and daughters were under the parental eye. We have a sketch of a little party at which all present sit with their hands crossed before them in solemn state. There were, however, redeeming features; music was commonly cultivated, and women began to distinguish themselves in literary acquirements, or through the practise of the painter's art. In the sixteenth century, progress became more rapid, and with the emancipation of intellect from mediæval bondage, we notice a wider departure from the ancient ways.

The growth of a nation is no more an accident or a combination of accidents, than the growth of a flower from its seed. We are to this day what our forefathers made us, modified by our own energies, and the circumstances of our time; but as society moves onward, the scope for individual exertion becomes enlarged. It may be more difficult for a single great man to tower above the rest, but whoever can think a good thought or suggest a valuable course of action has the many to listen to him, instead of the few. Society is not an aggregation of independent units, but a vital whole, so bound together that its highest advances, are possible only when the interests of all are cared for and sustained. Our life is richer than that of the past, because it is compounded of more varied elements, as both our exertions and our speculations take a more extended range. It is richer also through the improved condition of social relations, and the larger proportion of persons who share with us the advantages of civilization, and contribute their mental and moral forces to the common stock. We love to trace the past through the pages of a delightful work like Mr. Wright's *Domestic Manners of the English*, which will commend itself to all readers, but in proportion as his admirable descriptions bring the old times home to us, not like the figures on a faded tapestry, but with the vividness of actuality, we are glad that we are workers in the present, and, as we trust, servants of the future, by sowing seed that may hereafter bear serviceable fruit.

DOUBLE STARS,

BY THE REV. T. W. WEBB, F.R.A.S.

If on some transparent night, when the moon is absent, and "the firmament glows with living sapphires," we take our stand in the open air and gaze around us and above us, as silent worshippers in the great Temple of Creation, our first impression will probably be, as it was with Abraham in the plain of Mamre, that of the presence of multitudes innumerable. A more concentrated attention to any circumscribed portion of the sky will reduce our estimate, and we shall find that the number of stars which we can actually reckon will be but moderate, or even few in proportion; but a general view, in restoring liberty to our gaze, will bring back our first impression in all its strength. When the eye is relieved from the immediate effort of counting, and especially when we can give our attention to those oblique pencils, to which, as astronomers know, the retina is peculiarly sensitive, we shall detect unnumbered glimpses and sparklings over the whole ground of the firmament. If now we take some common telescope, even of the smallest dimensions, and point it to those twinkling regions, we shall find our surmise converted into certainty by the distinct appearance of stars in many places where we had only suspected them; if we lay aside our instrument for larger ones, we shall perceive that every successive increase of aperture brings fresh discoveries into view, till at length, in using the great reflectors and achromatics of the present day, we find that the faint points of light, revealed in their space-penetrating fields could literally be numbered by millions.

Amid such inconceivable profusion, it must of course be a frequent occurrence that two stars are found in very close proximity to each other, constituting the objects so well known as a double, or, in some cases, triple, quadruple, or multiple star. If, however, their mutual distance is sufficient to admit of their being separately distinguished by the naked eye, they are seldom classed under these titles, which are, generally speaking, reserved for those too close, as well as in many cases too minute to be seen without a telescope. Of such it has been computed that there may be about 6000 in the heavens (including of course both hemispheres), and as many of them are especially interesting objects of telescopic research, it is intended in the present paper, and others which will form its continuation, to give some plain directions which may enable amateurs to find them readily, and view them to advantage.

But in the first place it may be asked, what peculiar interest do stars acquire from being thus brought into juxtaposition? In many cases it may be answered, that the mere comparison of magnitude, or contrast of colour, thus brought out, is both singular and beautiful, and will well repay the slight trouble of the search. But others possess a higher claim upon our attention. In many instances they are not merely supposed, but ascertained to be systems of connecting suns, bound together and revolving round each other by the same combined action of gravitating and propulsive force which governs the motions of our solar system, and is thus proved to pervade the nearer regions, and must by analogy be supposed co-extensive with the whole domain of the starry universe. Such pairs of stars are called *binary*, to distinguish them from those whose duplicity is only optical or apparent; the mere accidental consequence of their lying behind each other in a line passing nearly through the observer's eye. This distinction cannot be demonstrated by a single observation, however accurate, but may be effected in two different ways, by examinations repeated after sufficient intervals of time. In many instances, as experience will readily show, the very aspect of a pair is enough to point out the probability of its physical relation. The components are frequently so curiously alike in physiognomy, if we may so apply the term, that their family connexion is all but self-evident; and the chances are exceedingly small that in such a case one object should be found almost exactly in a line with another, whose difference in size is so precisely balanced by a corresponding difference in distance, as to produce the effect of equality. Still this, though a very high probability, does not amount to actual demonstration, which can only be obtained, as we have said, in one of two ways. Either we may observe such a change from time to time in the relative position of the two stars, as actually to exhibit their revolution to the eye; or we may find them, after the lapse of years, though sensibly unmoved with respect to each other, get both gradually displaced through equal distances from their former position, and travelling in company on an unknown and mysterious way through the vast expanse of creation. It is well-known that the term "fixed" is most incorrectly applied to the stars, a great proportion of which are found to change their places in the sky year after year, with a slow but steady progress, the combined result, it is believed, of their own movement, and a similar motion on the part of our sun. How this "proper motion," as it is called, can affect a pair of stars equally, and thus show their comparative nearness to each other, while yet they exhibit no appreciable motion of revolution round each other, is wholly unknown, though it may perhaps point to an extraordinary deficiency in mass, as compared with magnitude or luminosity; but who can wonder at our ignorance of the nature of those distant suns when we know so little of the constitution of our own? It is of course possible that a progressive motion in the sun may cause the apparent movement of a double star in the opposite direction; but it is obvious that such an illusory displacement would betray its cause by the inequality of its amount in the two stars, unless they were nearly at the same distance from the eye, on which supposition we are brought round to the same point again, by this proof that they were actually adjacent, a real *pair*. It is then by the one or the other of the these two ways—by displacement relatively to each other, in such a manner as to show revolution round a common centre of gravity, or by displacement relatively to the ground of the heavens, and common to both individuals, that a very large proportion of double stars are ascertained to be mutually dependent systems.

The study of these interesting objects has been advancing with rapid steps. Only about four double stars had been noticed, or at least recorded, when the elder Herschel began to turn his powerful reflectors upon the heavens. He soon perceived the importance of his research, and in 1782 published the first of a series of catalogues containing in all about 500 stars; but it was not till the beginning of the present century that, in seeking for the parallax of the stars in order to determine their distance, he obtained unquestionable evidence of the mutual relation of some of these pairs. His son, and other observers, followed in the same track, and at length W. Struve, then at Dorpat, but subsequently Director of the Imperial Observatory at Poulkova, near St. Petersburg, produced a catalogue of 2787 double stars, lying between the North Pole and 15° of south Declinations, which has since been universally regarded as the great authority for that portion of the sky. According to him there were, in 1837, fifty-eight systems within his limits, known to be undoubtedly binary, thirty-nine probably so, and sixty-six suspected. In 1849, Mädler, his successor at Dorpat, considered that 650 pairs throughout the heavens were certainly of binary character; and the subsequent period, if, in some instances, it may have thrown doubt upon hasty inferences, has on the whole added materially to the number. The chief increase, however, has not been due to the discovery of fresh objects, for the superiority of the Dorpat telescope, which has 9·43 inches of aperture, and the unwearied zeal of Struve, who carefully examined with it in two years about 120,000 stars, left comparatively little to be done in the northern hemisphere; it is the interval of time, which by enabling the slower movements to be recognized and measured, has developed a new character of connexion in many pairs previously known.

The amateur who is impressed with the extreme sublimity and beauty of these distant exhibitions of the Creator's glory, will not be satisfied with a cursory glance, but will like to see, and see carefully, all that his instrument can show him. It will be, therefore, well to specify the following as the points of interest in double stars.

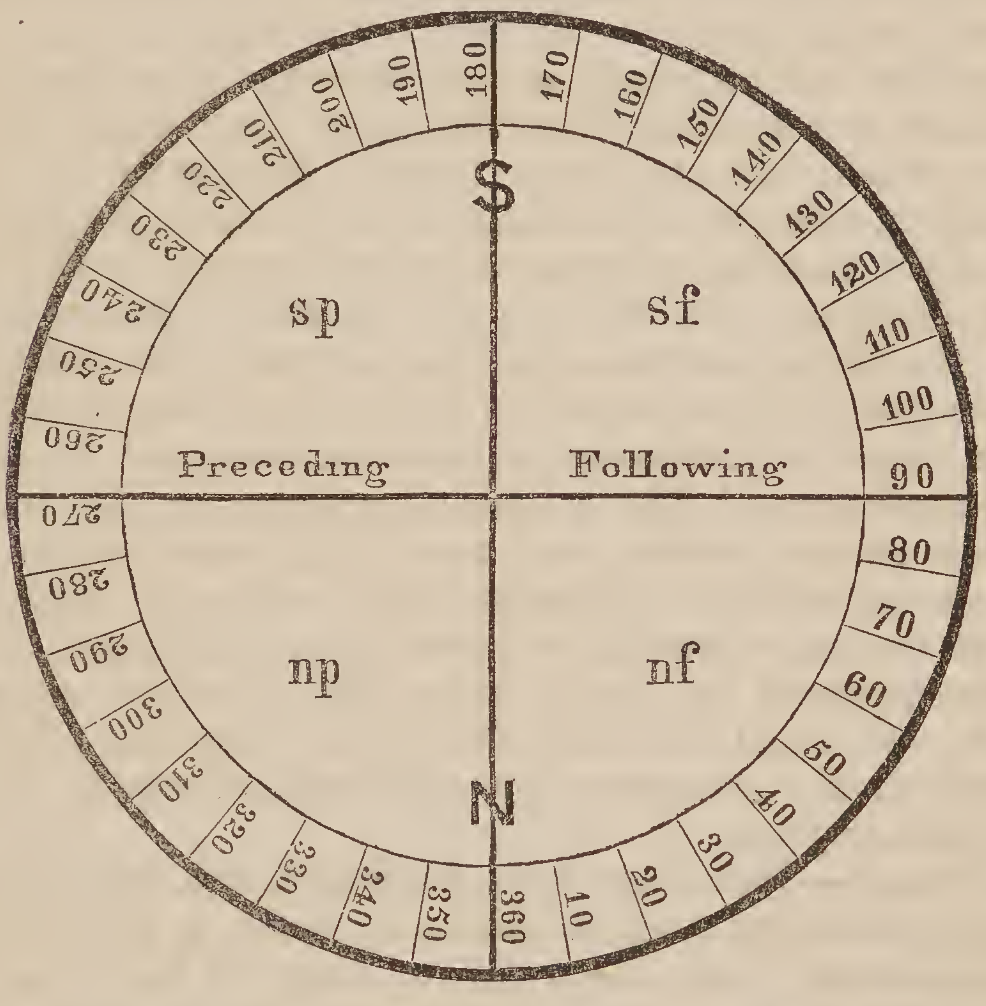
1. *Magnitude.*—It is to be regretted that on this head there is much that is very arbitrary and uncertain; the magnitudes of stars as given by different authorities varying sometimes to a surprising degree. Sir J. Herschel, Argelander, and others, have indeed done much in the very difficult inquiries of stellar photometry, but the results are either not fully satisfactory, or have met with a very limited application. In the present series of papers the data of Admiral Smyth's most accurate and valuable *Bedford Catalogue* will be adopted as the standard, in this as well as all other respects, with occasional additions from other quarters.

2. *Distance.*—This is one of the most important elements of observation, and gives more especially its character to the aspect of a pair of stars. It is always measured from centre to centre, and expressed in seconds and decimals of arc (on space). We often find the decimals carried to three places in these measures, but it is of course not to be supposed that instruments exist capable of marking, or eyes of discriminating, such subdivisions; they merely express a mean deduced from many observations. In Smyth's measures such refinements are not employed. The Dorpat Catalogue terminates at 32″ as its exterior limit, but from a calculation of chances it appears that there is a possibility of mutual relation even as far as 15′; that is to say, between stars, double, even to the naked eye.

3. *Position* of the components with respect to each other.—This deserves the more attention, as being one of the elements which would vary on the supposition of orbital motion, and by

which it would be most easily recognised. It is always determined by measuring the angle between two lines, one, the parallel of declination passing through the larger star, or in other words, its apparent course through the field of the telescope; the other, a line drawn from the larger to the smaller star. Astronomers estimate the positions of all objects near one another in this way, and amateurs, unprovided with the convenient apparatus, called a *position micrometer,* will do well to master thoroughly the accompanying diagram.

It represents the field of an astronomical eye-piece, in which objects being inverted, the N., where the measures commence, will be found at the bottom, the S. at the top: the line joining



them is a portion of a meridian; the one at right angles to it is a parallel of declination, along which (or parallel to which) all objects move across the field from right to left, or from the word "Following" towards "Preceding." The initials *n. p, n. f, s. p,* and *s. f,* which are constantly used in astronomical works, stand for *north preceding, north following, south preceding,* and *south following,* and characterize the quadrants in which they are respectively placed, so as to show at once, and in a most convenient way, the general bearings of objects, where accuracy of measurement is not required. In describing a double star, the larger of the two, if differing in size, is supposed to be placed in the centre of the field, and the position of the lesser one, which, if very small, is often called a *comes,* or attendant, is given, if roughly, by the quadrant in which it stands; if accurately, by the degrees included in the angle already referred to, which is called its *angle of position.*

In estimating angles of position, for the purpose of tracing orbital motion, or knowing in what direction to look for very minute attendants, the inexperienced observer may at first be much puzzled, and frequently misled, by the varying situation of the N. point, or zero of the diagram, according to the quarter of the sky in which the object is situated at the time. From the amount of elevation of the pole in our latitudes, the transits of stars through the field may be performed at angles of every degree of inclination in one part or other of the sky, and the line which stands horizontally in our diagram will be sensibly horizontal in the heavens only when the object is in, or near, the meridian of the place; in the circumpolar regions of the sky it may even become perpendicular to the horizon: in addition to which, the observer's head is frequently so twisted, especially in using an achromatic telescope, that all accustomed ideas of the position of objects are thrown into confusion. It will be necessary, therefore, for the student to attend carefully to the course of the principal star through the field, which gives the parallel of declination; to estimate the position of the smaller object by referring to the diagram; and to compare this estimation with the measured angle: the eye will thus require a training which will prove very serviceable. If he possesses the habit of observing with both eyes open (a very desirable one, as producing less uneasiness and fatigue), a glance with the unarmed eye at the polar star, if within convenient distance, will help to fix the line of the meridian; from the inversion in the eye-piece, the pole will of course stand at 180° in the diagram.

4. *Colour.*—This, when fully developed, and especially when strongly contrasted, adds a charm to many a pair otherwise less interesting from the relative fixity of its components. There is, however, a good deal of uncertainty about it, as there is some diversity in the pictures in different instruments, and much discrepancy in the estimates by different observers. The achromatic, from its inherent defects, the uncorrected or "outstanding" colours, which cannot be united with the rest, necessarily gives an image whose tint is *minus* that outstanding colour; thus, as the latter is usually blue or purple, a white star will be found to have a yellowish or slightly orange cast. Reflectors are in theory exempt from this imperfection, but unless the speculum is of perfectly white metal, and free from tarnish, they are apt to give a smoky hue. From this cause, or from some peculiarity of vision, Sir W. Herschel was so partial to ruddy tints, that his observations, in this sole respect,

do not afford so good a starting-point as might be desired; and it is well known that certain eyes, perfect in other respects, fail, more or less, and some even altogether, in their appreciation of colour. These circumstances throw an unfortunate impediment in the way of a curious inquiry, and one well adapted for general prosecution—whether stars are liable to any change of colour. The wonderful New Star of 1572 passed through various tints in its diminution, and there is sufficient evidence to prove that Sirius, now of so brilliant a white, was once decidedly red, Seneca says even redder than Mars; and other similar suspicions have been entertained. Upon what such alterations may depend, or what corresponding changes they may indicate in the constitution of those far distant suns, is of course wholly unknown, but they form a point of great interest. It is here that a multiplication of observers may be of much service, as the combination of the impressions of many eyes is the most probable way of eliminating individual peculiarity, and testing suspected changes; and it is here that amateurs, with eyes sensitive to colour, and provided only with telescopes of adequate size, may afford assistance as effectual as could be derived from all the appliances of a regular observatory.

When a large star is of any decided hue, it may be naturally expected that its feebler companions may from contrast assume the complementary colour; just as the moon, viewed near, or just after, a powerful yellow artificial light, will appear decidedly blue, or as Schmidt saw it, of a lively green, among the ruddy clouds of volcanic smoke and steam, which encompassed his observatory upon Vesuvius during the great eruption of 1855. In such cases the accidental colour of the smaller star will disappear when its overpowering neighbour is hidden behind the edge of the field, or a thick wire introduced into it. But in many instances the colours, though complementary, as red and green, or yellow and purple, or orange and blue, are proved, by the same means, to be independent; and it is a curious and suggestive sight, to behold the whole light of the spectrum thus divided in unequal proportions between two companion suns. As a general rule, Struve found that when a pair of stars are not both of the same colour, the larger verges towards the red end of the spectrum, the smaller towards the blue. He gives the following result of his observations:—375 pairs of the same colour and intensity; 101 of the same colour, but different intensity; 120 of different colours; 295 both white; 118 both yellowish or reddish; 63 both bluish. In cases of great inequality of magnitude, when the smaller star is blue, he found the larger, white in 53 pairs, light yellow in 52, yellow or red in 52, green in 16. He assigns no colour to very minute stars, but such were frequently seen by Smyth of a beautiful blue tint. Instances of a ruby colour are to be found in the heavens, but only in solitary and not large stars.

5. *Variation* of light.—The experience of later times has shown the wide extent of this marvellous phenomenon, and every year is adding to the probability of the worthy old Hanoverian astronomer Schröter's idea, that variable light is present throughout the whole creation. It will be readily seen how favourable an opportunity is offered for its detection in nearly equal pairs, where juxtaposition gives an admirable test of change. But a more surprising and still more unintelligible development of this peculiarity comes out of the Dorpat observations. Struve has discovered what he thinks satisfactory evidence of alternate variation, each component taking precedence in turn, in 23 pairs, and has suspected it in 42 more. It may be remarked that it must be difficult to ascertain, in many cases, whether this variation is extended to both individuals, or is confined to one, as the relative effect would be the same upon either supposition; and it remains to be seen whether these alleged changes are equally apparent to other ages; all of them, at any rate, have not been so, but the subject is too interesting to be passed by lightly, and, as in the case of colours, it is from an average of not only many observations, but many observers, that these very delicate and almost evanescent data can be determined. The amateur who is not provided with a telescope equal to those of Struve and Smyth, need not despair, as, from some cause not yet clearly explained, but connected probably with the sensitiveness of the retina, inequality of light is found to be more perceptible when its absolute quantity is diminished in the use of a smaller aperture.

To this enumeration of the principal points to be noticed, we must add that the observer should record the *epoch of his observation.* This may prove not merely interesting to himself, but of more general value. Even a negative statement—as of apparent permanency—is of use if followed by positive change. Our readers may not have the means of executing those delicate measurements which decide the periods of revolution, but they may feel much interest in watching, year by year, the diminution or increase of distance, or progressive change of angle, which attests the fact; and memory, in such cases, is seldom to be fully depended upon. Astronomical dates are frequently given in decimals of a year, rather than in months and days; thus 1862·49 signifies June 30 of the present year. This mode of reckoning may be found in the *Nautical Almanac;* it has the advantage of conciseness, and ranges much better in column.

It may be well to remind the commencing student that as few, comparatively, of the planes of the orbits of these binary stars lie at right angles to our line of vision, they are for the most part foreshortened in perspective; and hence circular orbits (if there be any) will usually be projected on the sky as ellipses, and ellipses will be thinned off till in some cases they are seen edgeways as straight lines, and the stars will appear, twice in every revolution, to close up into one, at least, with such optical means as are at our command. A true occultation is, however, probably extremely infrequent, as we have reason to think that the real discs of the stars are too minute to be perceived—the merest points conceivable. They have never yet been seen by mortal eye. The circular appearance which, in a fine state of atmosphere, a star exhibits in a telescope, is not its real image, but what Sir W. Herschel termed a "spurious disc," arising partly from peculiarities in the original constitution of light, and partly from unavoidable imperfection in the instrument. With low magnifying powers, indeed, this little disc is not to be distinguished from a point, but these are in general inadequate to the purposes of sidereal astronomy; as we employ higher magnifiers, we shall find that the point will expand into a little luminous circle, surrounded by one or two faint rings, which are present in every good telescope; one great test of goodness being the perfect circularity of the disc and rings; by increasing our aperture, we shall diminish the proportional diameter of the disc, and hence it is that the same magnifying power in a small telescope will fail in separating the discs of close double stars, which are readily divided by a larger one; but we have never yet succeeded, and have little hope that we ever shall, in contracting the disc to so minute a point as to be a true representation of the star. The progressive diminution of the discs, as telescopes attain greater magnitude and perfection, is at present but a remote approximation to the real image, as is conclusively shown by the instantaneous disappearance in occultation of a star even of the first magnitude, behind the slowly advancing limb of the moon; and hence it is highly improbable that a real eclipse of one star by another has ever been observed. In such a case, as Sir J. Herschel has remarked, the fact would become evident to the naked eye, from the diminution of the total amount of light emitted jointly by the pair.

The possessors of small telescopes will be glad to find that a considerable number of interesting double stars, and even binary systems will be within their reach. They will, of course, not expect to distinguish the closer pairs, or to pick up the minuter *comites;* nor will they succeed very well in the discrimination of colour, which becomes more distinct and full in proportion to the quantity of light. But they may gain such a glimpse into the interior of the temple as may give them some slight idea of its grandeur and glory, and in these days, when excellence and costliness are no longer inseparably associated in the optician's workshop, they may be induced, by what they see imperfectly, to arm themselves with the means of seeing to more advantage. We shall in future papers indicate to amateurs a wide and interesting field in which their labours will find abundant scope.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*January* 22.

Discovery of Bone and Flint Arrow-Heads, etc., in Hyæna Cave, at Wookey Hole, Somerset.—In a ravine at the village of Wookey-Hole, near Wells, the River Axe flows through a canal cut in the rock. In cutting this passage, a cave, filled with ossiferous loam, was exposed, and its entrance cut away. In 1859, Mr. W. Boyd Dawkins and Mr. Williamson began to explore it by digging away the red earth with which the cave was filled, and continued their operations in 1860 and 1861. They penetrated 34 feet into the cave, which is hollowed out of the Dolomitic Conglomerate, from which have been derived the angular and water-worn stones scattered in the ossiferous cave-earth. Its greatest height is 9 feet, and the width 36 feet. Remains of *Hyæna spelæa* (abundant), *Canis Vulpes*, *C. Lupus*, *Ursus spelæus*, *Equus* (abundant), *Rhinoceros tichorhinns. Rh. leptorhinus* (?), *Bos primigenius*, *Megaceros Hibernicus*, *C. Bucklandii*, *C. Guettardi*, *C. Tarandus* (?), *C. Dama* (?), and *Elephas primigenius* were met with; remains of *Felis spelæa* were found when the cave was first discovered. The following evidences of man were found in the red earth of the cave—chipped flints, flint-splinters, a spear-head of flint, chipped and shaped pieces of chert, and two bone arrow-heads. Mr. Dawkins believes that the conditions of the cave and its infilling prove that man was contemporaneous here with the extinct animals whose remains were found, and that the cave was filled with its present contents slowly by the ordinary operations of nature, not by any violent cataclysm.

Natural Formation of supposed Flint Arrow-Heads.—Immediately beneath the surface-soil at Croyde Bay, North Devon, at the mouth of a small transverse valley, Mr. Whitley found broken flints in considerable number. About ten per cent. of the splintered flints at this place have more or less of an arrow-head form, but they pass by insensible gradations from what appear to be perfect arrow-heads of human manufacture to such rough splinters as are evidently the result of natural causes. Hence great caution should be used in judging what flints have been naturally, and what have been artificially shaped.

[We regret that we cannot, in the present number, lay before our readers such a summary of the remarkable address read by Professor Huxley (in the absence of the President) to the Geological Society, on the 21st ult. It was in every respect a striking paper, calculated to exert a powerful influence upon the thoughts of scientific men. We can only now advert to its masterly analysis of the negative evidence by which palæontologists and others have built up many of the assumptions on which too much of recent geology has been based. Mr. Huxley shows that we have no reason to assume that similar formations in different parts of the world were deposited at the same time, or even in the same age or era. What we know is the order of superposition in stratification, and something of the order of succession in the plants and animals which fossil remains present to our view; but we do not know, and have no right to infer, that chalk formations or Silurian formations in different countries, bear to each other any relation of contemporaneity; nor have we any justification for assuming that we can discern the beginnings of life in the oldest rocks in which organic remains have been discovered.

From this branch of his subject the learned Professor passed to a consideration of the arguments that support prevalent theories of development, either regarded as a progress from a general to a specialized structure, or as an advance from embryonic to adult forms during the long course of ages. Here, as in the former case, he demonstrated the insufficiency of the data on which broad assertions are very often made; and showed that the extent of changes in the organic world during past geological eras was much less than is commonly asserted, and not brought about in such an abrupt and violent way.—Ed.]

ROYAL SOCIETY.—*January* 23.

Influence of Physical Agents on the Development of the Tadpole.—It is usually believed, in consequence of a statement by Dr. Edwards, of Paris, in his work, *On the Influence of Physical Agents on Life*, that the presence of light is necessary to the development of the tadpole into the frog. In a paper read before the Royal Society, Mr. Higginbottom has demonstrated the fallacy of that opinion. His experiments were performed in cellars in Nottingham cut out of solid rock, not subject to any great change of temperature, and into which no solar light ever enters. The lowest cellar is 30 feet deep, and has a mean temperature of 51° Fahrenheit. Ova just deposited were placed in the cellar on the 11th of March, and on the 31st of October the first was fully developed in the form of a frog; whilst ova placed in the dark in a room at the temperature of 60° Fahrenheit were fully developed on May 22nd, twenty-three weeks earlier than those in the cellar; proving that the development of the ova depended on temperature, and not on light. In fact, an excess of light retarded the development.

Mr. Higginbottom attributes the failure of Dr. Edwards's experiments to the fact of the ova being placed deep in the water, as they will not develope even when submerged a few inches.

Dr. Edwards also stated that light was essential to the metamorphosis from the tadpole to the frog, stating that tadpoles deeply submerged in a perforated box in the river Seine do not become transformed. Mr. Higginbottom maintains that the arrest of development is to be attributed to the seclusion from the atmospheric air, and not from light, as the tadpoles, both of the frog and triton, obtain their perfect development in the dark rock-cellars of Nottingham, the rapidity of the change varying with the temperature. He states, that "The situation in which Dr. Edwards placed the tadpoles, 'some feet below the surface of the river' in his experiment, would inevitably prove unsuccessful in the full development of the frog. I have always found the transformation, both of the triton and of the frog, equal, in the same temperature, both in the light and in the absence of light, if placed in shallow water; but during their metamorphosis they must be allowed to rise to the surface of the water to obtain air, or they become asphyxiated. To prevent this, I placed stones in the vessel, and allowed them to leave the water for the purpose of atmospheric respiration. The metamorphosis of the tadpole, when at its *full* growth, requires about fourteen days to bring it to the condition of a frog. About the termination of that period, the diminution of the body is so great, and also the absorption of the expanded caudal extremity is such as to diminish cutaneous respiration. Respiration by the lungs becomes absolutely necessary to prevent the animal from becoming asphyxiated, which would be the case if it remained in the water; requiring then not an aquatic, but an atmospheric medium of respiration. It may be observed that after the tail is partially absorbed, leaving only a portion of the solid part, the asphyxiated state has commenced; the little animal, with open mouth, gasps for breath; but if removed into atmospheric air, the mouth is directly closed, and respiration is effected through the nostrils with perfect freedom; the animal is restored directly, jumps about and is lively."

ROYAL GEOGRAPHICAL SOCIETY.—*January* 27.

Ascent of Kilimandjaro.—Mr. Thornton's paper on the Ascent of Kilimandjaro was read. The journey of the Baron von Decken and Mr. Thornton, from the coast to Kilimandjaro and back again, occupied 101 days. The mountain was ascended to the height of 8000 feet; and was seen to be incontestably snow-capped. The scientific confirmation of the statements of Mr. Rebmann is satisfactory, in the first place as settling what has long been a doubtful point, viz. the existence of snow-covered mountains in Africa at so short a distance from the equator; and, in the second place, as proving the truthfulness of the Missionary reports. Mr. Thornton states that, considering the imperfection of the instruments for making calculations which they possessed, the observations and maps of the Missionaries are wonderfully accurate. The Kilimandjaro mountain was observed from various points. It is said to rise very gradually from the surrounding country. The summit, from one point of view, presents the appearance of a great dome, and from another that of a cone with a small plain on the top. Two other high peaks, belonging to the same group of mountains as Kilimandjaro, have been observed. One of these, at a distance of about 15 miles N., appears to have a height of 17,000 feet, and the other, apparently 60 miles W., seems to be 18,000 feet in height. The explored peak is decidedly volcanic; and Mr. Thornton considers that it may be merely the remaining peak of a vast volcano, by far the larger part of which has subsided to a lower level. The central axis of the mountains appears to run from N.E. to S.W.; and it is thought probable that, when this is reached, granite will be found.

Sir Henry Rawlinson read a letter from Colonel Pelley, H.B.M. Consul at Zanzibar, stating that Baron von Decken intended to continue his explorations, and that the river Ozee, which flows into the Indian Ocean, not far south of the Equator, and is supposed to rise in the northern prolongation of the Kilimandjaro range, was beginning to attract attention.

Ascent of the Ogun (the Abbeokuta River), by Capts. Burton and Bedingfield and Dr. Eales.—Captain Burton recorded his ascent of this river, and his opinion that the whole country, from the Niger to the Volta, is well suited for the growth of cotton. He thinks that the population of the district has been under estimated, and that, instead of being called 100,000, it ought to be 150,000. He rather scoffs at the King of Dahomey's Amazons, and thinks that their number is less than previous travellers have stated.

Captain Strickland made some remarks with regard to the Abbeokutans. He said that they displayed great aptitude for trading, and might be called the Jews of Africa. Abbeokutans taken as slaves to Brazil, soon purchase their freedom, and also that of others who are brought to that country as part of cargoes of slaves. They are intelligent, and appear to preserve the remains of an ancient civilization.

THE ROYAL SOCIETY.—*January* 30.

Absorption and Radiation of Heat by Gaseous Matters.—Dr. Tyndall described the results of his continued investigations on the absorption of heat by gases and vapours. The absorption of radiant heat by atmospheric air in a short tube, and at a tension of thirty inches, being taken as 1; Chlorine would be 36; Hydrochloric acid, 62; Carbonic acid, 90; Sulphuretted hydrogen, 390; Olefiant gas, 970; Ammonia, 1195. The absorption of radiant heat by vapours was also found to be very considerable, and even small quantities of perfumes, when diffused through common air, increase its power of arresting heat to an extraordinary degree; thus the absoptive power of air charged with the perfume of patchouli is 30 times greater than that of pure air; lavender increases the power to 60 times; and aniseed 372 times the natural amount: hence the perfume arising from a bed of flowers increases the temperature of the air around them by rendering it more absorptive of radiant solar heat. The vapour of water, when present, increases the absorption of heat by the air in a very extraordinary degree; during the month of October last Dr. Tyndall found that the atmosphere was 60 times more absorptive than dry air, owing to the continued moisture. Dr. Tyndall infers that as the amount of vapour diminishes rapidly at a distance from the earth's surface, the sun's rays are not sensibly arrested until they reach our atmosphere, but that, on the other hand, the heat of the earth is prevented from being radiated into the free space and lost, by the existence of vapour in the air; and owing to the influence of this action, he thinks that even those planets most distant from the sun may have a temperature sufficiently high to render them inhabitable.

CHEMICAL SOCIETY.—*February* 6.

Formation of Siliceous Minerals.—Several interesting communications were made to this Society. Professor Bloxam, of King's College, read a paper on the presence of arsenic in sulphuric acid, and the great difficulty of obtaining chemical substances absolutely free from that element. Mr. Dugald Campbell, in the discussion which followed, made an interesting statement relating to the almost invariable presence of arsenic in hydrochloric acid, and traced its origin to the sea-salt used in the manufacture of that acid: arsenic, as is well known, being, in common with silver, copper, etc., an invariable constituent of the waters of the ocean. In all the above cases the arsenic exists in a proportion far too minute to be discoverable except by the most delicate tests. Mr. A. H. Church then gave the results of some experiments on the aqueous solution of silica, which chemists are now able to prepare of considerable strength by means of the dialytic process of Professor Graham. He found that a solution containing three per cent. of dry silica, or flint, was as transparent and nearly as mobile as water, when freshly made, but that it soon became of the consistency of glycerine, and finally, after six days, gelatinized completely. A very large quantity of the pure aqueous solution of silica may be changed from the liquid into the solid state in the course of ten minutes by the fifteen-thousandth part of a grain, or less, of carbonate of lime; the process of the transformation into a firm jelly of several ounces of the limpid solution by means of a few minute particles of the carbonate of an alkaline earth being very remarkable. Mr. Church pointed out the important geological effects which might have had their origin in an aqueous solution of silica, referring more especially to the formation of an interesting mineralized fossil known as "Beekite." This substance, originally coral or shell, has been transformed into chalcedony or flint, having lost nearly all its carbonate of lime. Mr. Church had succeeded in effecting a similar transformation in recent coral by means of the infiltration of an aqueous solution of silica.

He pointed out the almost constant presence of silica in the waters of the earth, as enhancing the probability of his views. The tendency to circular or globular arrangements often observed in siliceous minerals was compared by the author to certain minute rings observed to form during the evaporation of an aqueous solution of silica. A second paper relating to silica was also read at the same meeting. In it several springs in New Zealand, very rich in silica and alkaline silicates, were reported on, and the beautiful quartz-sinter described, with which they rapidly incrust surrounding objects, such as leaves, flowers, buds, and fruits. A singular crystallization of large quantities of phosphate of lime occurring in cavities in teakwood was also brought under the notice of the Society by Professor Abel.

ROYAL INSTITUTION.—*February* 7.

On the Fossil Remains of Man, by Professor Huxley.—The brain-case of man has many varieties of shape and proportion among the different races of men.

The *skull of a Negro* was shown; its breadth was small in proportion to its length—in fact, was only six-tenths of it. The *skull of a Turk*, on the contrary, was, in breadth, nine-tenths of its length. All skulls come under one or other of these classes. Taking eight-tenths of the length as a standard from which to classify skulls according to the proportion between their length and breadth, all that have for breadth a less proportion than eight-tenths of the length are termed *dolichocephalic*, or long-headed; all that have a greater proportion, or even that proportion (eight-tenths), of the length in the breadth, are termed *brachycephalic*, or round-headed.

Skulls which are of the second class generally have the jaws *orthognathous*—nearly or quite in a perpendicular line with the forehead. Those of the first class have the jaws *prognathous*, or more prominent than the forehead.

If a line be drawn on a map from the centre of Russian Tartary to the Bight of Benin, it will be found that north and east of this line the heads are of the brachycephalic type; south and west of it they are dolichocephalic; north and east the faces are orthognathous; south and west, prognathous. This, however, is a very broad statement of fact. Near these points may be found heads of all varieties of breadth; but, as a rule, the round headed races, Mongols, Tartars, Turks (modified Tartars), are north of this line, and long-headed, Negro races are south and west of it.

These great changes are doubtless influenced by, and may be, in great measure, caused by difference of physical condition. So great are the differences, that these points may be called the ethnological poles. At the northern end are cold, barren, treeless plains; at the southern, the warm, rank fertility of the tropics. As we go away from these ethnological poles, we find, in going from Tartary, the Chinese become longer-headed and more prognathous; the Greenlanders are long-headed, so are the Esquimaux, so are the

North American Indians. In fact, all heads vary as we depart from the ethnological poles.

A line drawn from the British Isles, through Europe and Western Asia to Hindostan, represents the Ethnological Equator, along which the skulls are found to be *oval.*

The question arises whether the same varieties of the human race have always inhabited the regions of the earth in which they are now found. In Asia, in Africa, all remains that are found are of races similar to those now dwelling in the countries. In North America, in the valley of the Mississippi, are found, however, the remains of a race entirely different from those who now live there—a race whose remains are the great earthworks found in that region.

When we come to Europe, however, we find, first of all, everywhere the remains of the great Roman people. In northern Europe we find the remains of a long-headed people, acquainted with the use of iron; the ancestors of the present Germanic races. These, however, were preceded by a race smaller of stature, long-headed, like the Hindoos, unacquainted with the working of iron—workers in *bronze* —and traces of them are found all over Europe.

But *behind these*, and earlier than these, come the remains of an earlier race still—a ruder race—who possessed weapons of *stone* ground to an edge. These were a rounder-headed people—the transverse measurement of the skull was eight-tenths of the longitudinal—but the forehead was flat, the supra-orbital ridges were extremely prominent, and the jaws were prominent, though *not* decidedly prognathous.

At what distance from our epoch was this Stone Period? It is impossible to state in years. In Denmark, there are vast peat-bogs. In the upper layer of these are found *beech* trees, the trees which which now form the forests of Denmark; and in these bogs are found the remains of the *iron age.* Deeper than these is a layer of peat, in which are imbedded *oaks* of enormous size—oaks, whose circumference speaks of centuries of growth. With the oak trees are found the implements of bronze.

Deeper yet, is another stratum, in which are found pines, which show by their long stems that they have grown up in dense forests, into which the light could hardly penetrate; and at the very bottom of these pine bogs are found the stone weapons; under them, again, is found peat, in which are found no weapons of any kind, or any remains of man.

It is not possible to make any calculation of the years that have elapsed between the stone period and the present day—the consideration of the immense length of time which must have been occupied in the formation of these bogs can alone furnish us with any idea on the subject. But before even these bogs were formed, there was a time when the physical features of the country were totally different from what they now are, when the urus and bos primigenius, the fossil elephant, hyæna, and cave bear roared over the land. The question has arisen, was man contemporaneous with these animals? The recent numerous discoveries of stone weapons, chipped to an edge, and fossil bones acted upon by instruments, tends to the conclusion that man was co-existent with these animals. The question then arises, what races of men? This has been answered by the discovery of a well-developed dolichocephalic human skull, in a cave at Engis, in Belgium, associated with the remains of the animals enumerated above. Since that, a skull has been discovered at Neanderthal, near Düsseldorf, very different, and much lower in type than that of the Engis cave. It is a flat-topped skull, so much so that there was a question whether or not its shape had been produced by artificial means, and the supra-orbital ridges are extremely projecting.

An interesting question arises as to the relations which existed between the possessors of these skulls. Could they be all of one race, or were they of entirely different races? This question was settled by an examination of skulls which belonged to Australian aborigines—the purest existing race of human beings. In a large collection of these, there were found skulls which almost exactly matched both the Engis and the Neanderthal skulls, in actual dimensions; and which certainly differed as much from each other in relative proportion as did these. A remarkable fact is, that the present aboriginal Australians resemble these ancient people in modes of life as well as in development of skull. Like them, they use stone weapons; like them, they use the bones of the kangaroo, as they did the bones of the deer and *urus;* like them, they make mounds of refuse skulls; and like them, they build their huts on piles in the water.

The Engis skull can, however, be paralleled in proportions even by English skulls.

Far back as is the age of the men who made and used the flint implements, still farther removed is that at which must be placed the commencement of the human race.

ROYAL HORTICULTURAL SOCIETY.

The Artesian Well at South Kensington.—Mr. Nesfield's bold and original design for these gardens was characterized by the extensive series of water scenes, canals, cascades, fountains and ponds, as much as by its grand architectural accessories. The plan was adopted without any consideration being given to the question how the immense body of water that would be required for the fountains was to be supplied. The council knew that by payment of a certain rent the resources of a water company would be available, and to fill the canals, and work the fountains, was a matter of no immediate concern. When this question came to be considered seriously, it appeared that there was every probability of a sufficient supply being obtainable by the sinking of an artesian well in the garden, the first outlay for which would be as nothing compared with the large yearly rent for a supply from a water-company. Messrs. Easton, Amos, and Sons, were so confident that the chalk would yield water in abundance, that they undertook the work of boring on the condition that if unsuccessful they should receive no pay. The work has been completed, and in spite of all the risk attending such operations, has proved successful beyond all previous undertakings of the kind within the London basin. The engineers guaranteed a supply of seventy-five gallons per minute, but the well is capable of supplying ten times that amount; it can, in fact, supply a million of gallons in twenty-four hours, and will apparently be wholly unaffected by local circumstances, and but slightly by the changes of the seasons. The total depth sunk and bored is 401 feet, a well having been sunk to the depth of 226 feet, and a bore thereafter carried down 175 feet farther. In boring this well, it was found the London clay forms a much thicker stratum at Kensington than usual. Below it the strata are successively mottled clay, pebbles, greensand, grey-sand, flints, and lastly the chalk. But there is a circumstance of peculiar interest in connection with the enormous capabilities of this well. Whilst boring through the chalk, the instrument came upon a fissure, and dropped down a space of several feet, indicating that the boring had penetrated into one of those subterraneous streams which are known to occur in the chalk, and which when met with appear to be incapable of exhaustion. This, and the well at Trafalgar Square, are the only two in which this fortunate correspondence of the bore into a fissure has occurred, of the many wells bored by Messrs. Easton and Amos; all other in the metropolis being dependent on the supplies which percolate through the chalk into the well. This running stream, or natural main, may be the same as that hit upon in boring the well at Trafalgar Square, but at present there are no evidences of identity. Fortunately too the water from this well is fit for garden purposes, and the cost of the undertaking will prove to be one of the best investments of the funds of the Society, both for the maintenance of the garden and the interests of the fellows. It is unquestionably the finest well in the metropolis, a triumph of engineering, and an important contribution to our knowledge of the characteristics of the London basin.

NOTES AND MEMORANDA.

Physiological Effects of Milk.—Mothers have long been aware of the fact that their infants were affected by any changes in the composition of breast-milk, brought about by particular kinds of food, medicine, or other disturbing causes; and a French doctor, M. Labourdette, takes advantage of this circumstance by administering to the mother the physic he wishes to operate upon the child. M. Flourens also has made divers experiments with pigs and other animals. He coloured the maternal food with madder, and in twenty days found the bones of the little sucklings tinged with that dye. At the meeting of the British Association in 1860, Mr. Gibb, referring to Vogel's discovery of vibrions in human milk, stated that a child had been brought to him in a state of emaciation. The mother appeared in good health, and her milk was rich in cream and sugar, but it contained numerous vibrions. Subsequent observations confirmed the opinion that milk containing infusoria reduced the children who were suckled upon it to skin and bone.

Fertility of Hybrids.—M. J. G. St. Hilaire, after collecting facts from various sources, and making numerous original experiments on the reproductive powers of hybrids formed by the alliance of species of the same genus, arrived at the conclusion that there were a great many sterile hybrids, and also a great number that were imperfectly fecund; but that there were others which possessed the faculty of reproduction either with stock species or among themselves. It would be of the highest importance to ascertain under what circumstances the fertility takes place, and to what extent hybrids are formed by animals in a wild state. M. St. Hilaire considered such commingling of species occurred much oftener than is usually supposed.

Antiquity of Bones.—M. J. P. Couerbe has proposed to the French Academy of Sciences a clever, but uncertain mode of ascertaining the date of human bones discovered in tumuli or similar situations. He analyzed portions of skeletons dug up at the Château of Vertheuil. The bones were friable, but well preserved; and from part of an arm-bone he obtained carbonate of lime, 15·50; phosphate of lime, 67·17; phosphate of magnesia, 3·16; oxides of iron, manganese, and aluminium, 1·50; silica, 2; organic nitrogenous matter, 10·47 per cent., and traces of chlorides. Berzelius obtained 33 per cent. of nitrogenous organic matter from fresh bones, and M. Couerbe considers that it is possible to discover the rate at which this matter disappears from buried remains, and consequently that the age of any fragments could be ascertained by the results of analysis. He tells us that Vogelsang could only obtain traces of organic nitrogenous bodies in bones which had been eleven centuries under ground; and hence he concludes, with perhaps more haste than judgment, that these elements disappear at the rate of three per cent. per century. He admits that difference of soil and other conditions would materially affect the question to be solved, but nevertheless considers that if the loss of organic matter experienced by any bone be divided by three, an approximate age will be obtained in centuries.

Embryogeny.—M. Ch. Robin observes: "Under the name of 'mucous globule,' 'hyaline corpuscule,' etc., most embryogenists have distinguished a translucent globule which appears on the sides of the embryon. Once produced, it remains, under the vitelline membrane, a stranger to the phenomena which take place around it, and it is abandoned, with the aforesaid membrane, when the hatching (*éclosion*) takes place. Becoming useless as soon as formed, its production has prepared the way for the segmentation of the vitellus." He proposes to call these agents in generation "polar globules," because their appearance "marks some hours in advance the pole of the vitellus which is about to be depressed." After various details, he remarks: "It is by germination, and with the aid and at the expense of the substance of the vitellus, that the polar globules are produced. Among all the vertebrate and most of the invertebrate animals, their appearance is followed by the segmentation of the vitellus. But there are animals, such as gnats (*Tipulaires culiciformes*), among which the vitellus does not undergo segmentation, and the cellules of their blastoderm originate by germination, as the polar globules do in other creatures."—*Comptes Rendus.*

Growth of Coral.—M. de Lacaze du Thiers, having been directed by the Governor-General of Algeria to report on the reproduction of coral, devoted himself to the requisite observations, and communicated the results to the French Academy. He found coral branches to contain male polyps, females, and hermaphrodites, the latter being the least numerous. One or other sex usually predominated in a particular branch, and when fecundation was not the result of hermaphroditism, the currents of the water carried the male seed just as the air carries the pollen of diœcious plants. In lively specimens, the male polyps may be seen to emit a white fluid, which produces a milkiness in the water, and diffuses the spermatic elements. He found some difficulty in distinguishing the seminal from the ovigerous capsules under a hand magnifier, but the microscope revealed egg appearances in the latter, and spermatozoa in the former. The incubation takes place in the digestive cavity, the coral is viviparous, and its young resemble little worms, which move with agility. They swim backwards, and after becoming fixed, experience curious transformations in reaching the form of the perfect animal.—*Ibid.*

Adulteration of Tin-foil.—As many experimenters might be under the delusion that tin-foil was really composed of tin, it may be as well to cite the analyses of Mr. Baldock, who found various specimens to contain lead, the purest having rather more than 34 per cent. of that metal, and the worst 86 per cent.

Carbolic Acid.—Dr. Crace Calvert calls this substance the most powerful preventive of putrefaction with which he is acquainted. By its aid he succeeds in preserving gelatine solutions, and preparations of starch, flour, etc. It prevents the conversion of tannin into carbonic acid and sugar, and arrests lactic fermentation. Diluted with from two to seven parts of water, it is found useful in putrid ulcers and sloughing wounds. The non-chemical reader may be reminded that carbolic acid is very similar to creosote, and obtained from coal-tar.

Divisibility of Matter.—A writer in the *Chemical News* proposes, as an illustration of the mechanical subdivision of matter, that a film of gold leaf reduced by Faraday's plan, through the action of cyanide of potassium, so as to be quite transparent, and about 1-3,000,000th of an inch in thickness, should be divided by cross-lines 1-80,000th of an inch apart, like those in Norbert's test-plates, belonging to the highest series which the microscope will revolve. By this means squares of gold might be obtained so small, that three billion eight hundred and forty million of them would occupy no more than a single square inch; and yet each one would be distinctly visible under the best objectives of modern microscopes.

The Comet of 1861.—The *Comptes Rendus* of the 13th of January contains an elaborate paper by M. Faye on "the Figure of the Great Comet of 1861," in which he first comments upon what he terms the "cyathiform," or "nucleated cup-shaped anterior emission." He alleges various reasons for considering this emission to have the shape of a cup, with reversed edges. He remarks that in attempting to compare theoretical figures with the forms naturally observed, it is necessary to remember that the former represent geometrical surfaces without thickness, while the latter exhibit considerable thickness, and are not homogeneous in substance. He further compares the cometary emission forms to the conical or spherical sheets of water in wide-spread fountain jets, which after a certain limit lose their regular shape, and are resolved into torn and divided streams (*lambeaux*) and drops. M. Faye states that these details may be conveniently studied by causing the flame of a spirit-lamp to be deflected by an obstacle held in a horizontal plane. He also describes "a posterior conoidal emission," which he finds prolonged far into the tail, following its curvature, and gradually enlarging itself until it presents the perspective appearance of two distinct branches.

Intra-Mercurial Planets.—The same number of the *Comptes Rendus* contains an extract from the *Annales de l'Observatoire* on the theory of Mercury, detailing various objections to the hypothesis of a large planet comparable with Mercury in size, and circulating within its orbit, and suggesting the belief in a series of asteroids, whose joint action might produce the disturbance which has to be accounted for. The writer urges the importance of noticing every regular spot that may appear on the disk of the sun, in order to ascertain whether it possesses the character of an asteroid.

Velocity of Bolides.—M. Petit estimates the velocity with which the bolide of the 9th of December, 1858, passed over the communes of Muret, Longage, etc., at 5200 mètres per second, and its height above the earth during the explosions at 5000 mètres. A previous meteor (13th September, 1858) had an elevation of 220 kilomètres, and a velocity of 29 kilomètres. The mètre is 39·37100 English inches, and the kilomètre 4 furlongs 213 yards 1 foot 10·2 inches. M. Petit observes that the last-named meteor exhibited a brilliant light, far beyond the limits usually assigned to our atmosphere.

Photography and Ethnology.—The Russians have taken photographic portraits of the various inhabitants of the Steppes of the Oural, with a view to ethnological studies. One view gives a profile, and another a full face; and the subjects of the operation were shaved, so as to exhibit the true form and dimensions of the skull.

A New Volcano has appeared in the Planeito de los Vaqueros, Chili, in a region of perpetual snow, and about twenty leagues from the Baths of Chillon, known for their hot sulphurous springs.

The Petroleum Springs of North America.—Dr. Abraham Gesner communicated to the Geological Society an account of these extraordinary springs, and an abstract of his paper will be found in the *Quarterly Journal*. The oil region comprises parts of Lower and Upper Canada, Ohio, Pennsylvania, Kentucky, Virginia, Tennessee, Arkansas, Texas, New Mexico, and California, reaching from the 65th to the 128th degree of longitude west, and there are likewise outlying tracts. The oil is believed to be derived from silurian, devonian, and carboniferous rocks, and is conjectured to be a product of the chemical action by which ligneous matter is transmuted into coal. Dr. Gesner also suggests that in some cases animal matter may have been the source of the hydro-carbon. To obtain the petroleum, borings are made through various strata to the depth of 150 to 500 feet. As a general rule, these borings pass through clay, with boulders, sandstones, and conglomerates, shale, bituminous shale, and then the oil, underlaid by the oil-bearing stratum of fire clay, containing fragments of stigmaria and other coal plants. As soon as the oil stratum is reached there is an escape of carburetted hydrogen gas, often violent enough to blow the boring-rods into the air. When the oil comes it is ejected with much force, sometimes rising to the height of 100 feet. Some wells have at first given 4000 gallons in six hours, and the average daily yield of mineral oils in the United States is estimated at about 50,000 gallons.

Land Animals in the Coal Measures of Nova Scotia.—Dr. Dawson has obtained numerous animal remains from the cliffs of the South Joggins, Nova Scotia, among them some reptilian skeletons, one of which, the *Dendrerpeton acadianum*, he considers the most perfect carboniferous reptile hitherto discovered. These were obtained from a tree trunk fossilized *in situ*, and it also contained, amongst other treasures, many remains of insects, the most interesting being a compound eye, with the facets perfectly preserved. Further details are given in the *Quarterly Journal of the Geological Society*.

New Volcanic Island in the Caspian Sea.—In August last, the crew of the steamer "Turkey" discovered a new island in the middle of the Caspian, 23 fathoms long, 12 fathoms wide, and the height above the water about 6 feet. The soil is very loose, and smells strongly of petroleum. The new isle is in a line of volcanic action, from the mud eruptions of Kertch to the fires of Bakou. An account of its discovery appeared in the Russian *Naval Review*, a translation of which by Lieut. Lutke was communicated to the Geological Society, through Sir R. Murchison.

Bakewell's Copying Telegraph.—We understand from Mr. Bakewell that he considers Bonelli's telegraph, noticed in our last Number, to be an imitation of his copying telegraph, to which a Council Medal was awarded at the Great Exhibition of 1851. The latter effects with a single wire what Signor Bonelli's telegraph does with twenty; and it was at once evident, when the method of copying writing by the means of electricity with one wire was shown, that a greater number would do the work more quickly, if cost were no object. We are informed that with eight or ten wires copies of writing may be transmitted with Mr. Bakewell's instrument at the rate of 3000 letters per minute.

Heliochromy.—M. Niepcé de St. Victor has communicated to the French Academy an important step towards the fixation of heliochromic tints, which increases the hope that before long coloured objects may be successfully photographed. He states that he "obtains the heliochromic colours on a film of chloride of silver formed on a metallic plate." In preparing this plate he employs hypochlorite of potash, and he remarks, "this alkaline bath, although very variable in its composition, generally gives fine colours, only the bottom of the image remains somewhat dark, and divers causes occasion certain colours to dominate over the rest." Continuing his description, he observes, "it is known that to obtain the colours on a white ground it is necessary to heat the plate, before exposing it to the light, until the chloride of silver assumes a rosy tint, or to substitute for the action of heat that of light, in the manner indicated by M. C.

Becquerel. I conceived the idea of covering the chloride film, before exposing it to the light, with a layer of a saturated solution of chloride of lead mixed with enough dextrine to form a varnish." He found that the colours were produced with greater brilliancy on a plate thus prepared, and after their appearance the plate was heated over a spirit-lamp, not raising the temperature high enough to carbonize the varnish. "Under the influence of heat, the colours usually grow more intense, especially if the light has influenced the whole thickness of the chloride of silver; but if otherwise, the blues are turned into violets, and the blacks to reds." The result of the process is, "that the destructive action of light upon the plate is retarded, so that ten or twelve hours are necessary to destroy the colours, which, under ordinary circumstances, would disappear in a few minutes. Such is the state of heliochromy to-day, and if the problem of fixation is not yet solved, we may at least hope for a solution." M. Chevreul remarks that the discovery of the dextrine and chloride of lead varnish is a great advance, and he compares the sensitive films of M. St. Victor to the retina of the human eye.

A Living Skeleton.—Under this title a very remarkable monstrosity is exhibited at Lima, in Peru. The individual, whose name is Montaos, appears about thirty-five years of age, but he says he is only twenty-eight. He seems to enjoy good health, his complexion is rosy, his cheeks full, and his eyes bright. His arms are long and fleshless, his body flattened, the legs dried and bent up like those of a Peruvian mummy, and terminating into two small half-bent feet. He has never been able to stand, and presents himself for exhibition seated on a three-legged stool. Notwithstanding his unfortunate organization, he contrives to play the violin and accordion with considerable taste. His body has a slight power of motion backwards and forwards, and he is able to use one hand and arm. To play the violin, he fixes one end of the bow between his legs, and steadies the other with the upper part of his body. He then takes the instrument in his right hand, fingers the strings, and at the same time draws them across the bow. The accordion he manages by securing the loose portion between his body and left leg, his mouth seizes the upper part, and the fingers of the right hand touch the keys.—*From the " Camercio de Lima," January* 3, 1862.

Curious Effect of Vis inertiæ.—M. Tardiret states that if a perfectly smooth and polished plate of glass, ivory, or metal is caused to rotate with great velocity in a horizontal plane, it does not communicate its own motion to a highly-finished ball which may be placed upon it.

Action of Iodine on Tin.—In the *Comptes Rendus* (January 27th 1862) will be found a paper, by M. Personne, on the iodides of tin. To obtain a direct combination of the two substances, he placed 21 grammes of iodine and 10 grammes of powdered tin in a sealed tube. At about + 50° cent. (122° Fahr.) a violent action took place, accompanied by the evolution of light. After cooling, the tube was broken, and there was found in it a metallic button of tin, and a red substance highly fusible and volatile. This was the bi-iodide of tin SnI^2. This substance crystallizes in octahedra of a red-orange colour. It melts at + 146° cent. (294·8° Fahr.), and emits yellow vapours; at + 142° cent. (287·6° Fahr.) it solidifies. After vaporization, it condenses on cool bodies in beautiful needles, resembling in form those of sal ammoniac. It is decomposed by water, into hydriodic acid, and binoxide of tin. It dissolves in bisulphide of carbon, chloroform, and benzine, and likewise in anhydrous alcohol or ether; but, like bichloride of tin, it can enter into combination with these last solvents. It absorbs ammonia, and forms three compounds. The protoiodide of tin is obtained by dissolving powdered tin in concentrated hydriodic acid, or by a double decomposition produced by pouring a solution of protochloride of tin into a moderately strong solution of iodide of potassium. In concluding his paper, M. Personne observes that it results from the experiments which he details that the action of iodine on tin is precisely similar to that of chlorine or bromine on that metal, and the iodides of tin are analogous in composition and chemical properties to its chlorides and bromides.

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THE INTELLECTUAL OBSERVER.

APRIL, 1862.

BEES AND THEIR COUNTERFEITS; OR, BEES, CUCKOO-BEES, AND FLY-BEES.

BY H. NOEL HUMPHREYS.

No insect is so well known to our unentomological public as the hive-bee of North-Western Europe. All the habits, peculiarities, and interesting social arrangements of this insect have been popularized in a series of works, the public appetite for which never seems satiated, and so, new volumes upon this never-failing theme, always possessing more or less merit, are continually issuing from the press; but although the natural history of our common hive-bee (*Apis mellifica*) has been thus rendered so familiar, the other members of the bee family have found but few popular historians, and less is generally known about them—except to entomologists—than about other far less interesting insect families.

Yet there are many interesting peculiarities connected with different species of the bee tribe which would amply repay the cost of a little study. I may, therefore, within the limits of the present paper, call attention to a few remarkable kinds of British and foreign bees, more especially with reference to certain extraordinary resemblances which exist between some of the honey-collecting kinds and those belonging to the parasitic or cuckoo class; which will lead to the notice of still more curious resemblances that exist between bees and certain insects belonging to a distinct order, *Diptera*. These last, though only furnished with two wings, while the bees and the whole order (*Hymenoptera*) to which they belong have four, yet bear such a striking resemblance to the bees, in company with which they are found, that an untrained observer would not, at all events on a first glance, perceive the existing difference.

The bee family was termed by the great French naturalist, Latreille, *Mellifera* (honey gatherers), or *Anthophila* (flower lovers), both terms being characteristic of the general habits of the family. One of the most remarkable features in those kinds of bees which live in societies, as is well known in the case of the hive-bee, is the existence of a third sex, the neuter or worker; and there are other singular peculiarities of this kind in less known species, such as the existence of two distinct kinds of females. The material of which the egg-cells are composed is very various. The comb of the hive-bee, as is well known, is formed of wax, secreted in a peculiar manner, as described in hundreds of popular works; but other species, though forming a comb almost identical in appearance, make it by the manipulation of certain substances which they reduce to a material more analogous to common manufactured paper than anything else; while others, again, make cells with sand, moistened with a glutinous secretion, which reduces it to a kind of tenacious cement. Some of these species, again, collect an inferior kind of honey, while others only collect pollen, of which they place a small mass or ball in each cell in which an egg is to be deposited, so as to form a supply of food for the grub or larva to subsist on till full grown. The exactly sufficient quantity is prepared by the instinct of the parent; and, in fact, when that is consumed, the young grub bee has no choice but to subside at once into the torpor in which his change of organization is to take place. This is a necessity, as he has no powers of locomotion, being a clumsy maggot-formed larva, which, placed at the bottom of a smooth-sided cell, would have no means of seeking food for himself. The tribes of parasitic bees which do not make cells to contain honey or pollen for the separate use of each infant bee, visit the nests of their more industrious cousins, and surreptitiously place an egg of their own in the cell containing the honey or pollen, as the case may be.

It was formerly believed that the egg of the parasitic bee was placed in the same cell with the egg of the honey-bee, and that being hatched first, the young parasite devoured all the food, leaving the infant of the honey-bee to find himself born to an empty larder, and consequently speedy starvation; but more recent observation has led to the conclusion that this is not the case, but that the parasitic bee, on entering the nest, selects cells already furnished with honey or pollen, but in which no egg has as yet been laid. While the unsuspicious female proprietors of the nest, finding an unexpected egg deposited in the cell they first visit, exhibit no sign of surprise, but pass on to the next, not seeming to be at all disturbed by the presence of the uninvited deposit; just as small birds make no attempt to exclude the egg of the cuckoo, but hatch it, and rear the young intruder along with their own offspring.

This occurs in the nests of wild bees constructed in different situations, some kinds making an excavation expressly, others adopting the deserted work of some other insect, or taking advantage of an accidental hollow. For instance, *Anthidium manicatum*, one of our summer bees, generally uses the holes bored in willow stumps by the *Cossus ligniperda;* but a nest of this species was once found, as described by Mr. F. Smith, in the keyhole of a garden door. Some of the humble bees, on the other hand, carefully construct their own burrow. A beautiful exotic species, a large and powerful bee, has received the specific name of *Latipes*, from the singular broadening and strengthening of the front pair of feet. These broadened feet assume somewhat of the character of the front feet of the mole, or rather those of that curious insect the mole cricket. These enlarged feet, with the thick brushes of strong hairs with which they are furnished, are evidently excavating implements, and no doubt the works produced by their agency are of a very interesting kind; but entomological discovery has not at present

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made us acquainted with the nest architecture of this handsome insect. A pretty little English bee, one of the solitary kinds, often makes its burrow in sheltered parts of hard gravel walks, an affair evidently of very great labour, as the female bee, who is the sole architect in this instance, frequently comes to the opening of the burrow to rest, when the male commences flying rapidly round and round his mate with great rapidity, as though to encourage her to renew the task.

I am not aware whether the nest of the little bee of the gravel walk is subject to the visits of a parasitic cousin, but among those most subject to intruders of this kind is that of the common garden humble-bee, *Bombus hortorum*. In the engraving above, this pretty bee (Fig. 1) is engraved side by side with its parasite, *Apathus barbutellus* (Fig. 2). These bees bear such a generally close resemblance to each other, that one may easily be mistaken for the other, even by the initiated, till after a close examination, as colour, size, and general form are almost identical. There is, however, one marked difference, which is easily perceived when the trained eye has been taught where to look for it: the hind legs of the honey or pollen collector are invariably furnished with an enlarged tibia, the flattened and somewhat hollowed breadth of which serves as a reservoir, in which the pollen collected from flowers is carried to the nest. This peculiarity of formation will be observed in the engraving, Fig. 1, whilst in Fig. 2 the same part of the hind leg will be found simply rounded, and entirely without that broadened, flattened, and hollow character which distinguishes the hind leg of the honey collector. This parasite, having neither the instinct to collect food for its expected progeny, nor, in fact, the means of carrying it home even if the will existed, has been deemed by naturalists to be entirely devoid of those parental and home instincts which distinguish the recoltant or harvesting kinds. It is on that account that it has, like the genus to which it belongs, received the name of *Apathus*; apathy in regard to the providing protection or food for their young being the leading characteristic of parasites. It will be observed that the light band on the thorax, near the head, is less distinct in the *Apathus*, and also that the abdomen is not quite so profusely furred. Latreille termed these parasitic bees *Cuculinæ*, or cuckoo-bees, the term *Apathus* having been substituted by an English naturalist.

The resemblance of the third insect figure in the group above is still more curious. Although, at a glance, it so much resembles both the bees represented in the engraving as to cheat the careless observer, it will on closer examination prove itself not only far from being identical, but will be found so radically different as at once to show that it belongs to another and distinct order of insects, the *Diptera*, or two-winged order. It is, in fact, merely the general size and the colouring which deceive the eye untrained to appreciate anatomical form with accuracy. On examination, almost every part of the structure will be found to be exceedingly distinct from that of the bee: the eyes are differently placed and different in form, while their size and colour are nearly identical; the antennæ, instead of being horny and robust, like those of the bee, are delicately slender and feathered, like some kinds of moths—but these are not conspicuous appendages, and escape the attention of the ordinary spectator. The thorax, or fore part of the body, is, however, furred with orange hairs next the head, which become yellow near the abdomen, leaving the centre of the thorax black; the segments of the abdomen nearest the thorax are clothed with yellow fur; the central segments are black, and the last segments, or tail, are white—this is precisely the colouring of both the bees (Figs. 1 and 2); but then the single pair of wings, the legs have not the enlarged or honey-bearing tibia, and even the anatomical structure of the body itself, though under the disguising fur mantle of identical colour, is of itself amply sufficient to denote that the insect belongs to another and very distinct class.

Still, the close general resemblance of this insect, *Volucella plumata*, is indisputable, and as it passes into the nest of the bee, in order to deposit its eggs (one to each) on many of the living larvæ of the bees, it might certainly, to a casual observer, pass for one of the family, while entering the bees' nest on its mission of murder to the infant bees in their cell-cradles. The egg of this parasite being deposited in the warm folds of the soft skin of the bee-larva is rapidly hatched, and it at once proceeds to its unnatural feast, slowly devouring the foster parent whose breast had warmed it into life; the bee-larva, as I have stated, being a soft, legless grub with no powers of escape. The engraving below (Fig. 4) is the larva of one of the solitary bees; very closely resembling that of the humble-bee, and indeed of the hive-bee also. The larva of the *Volucella* is represented at Fig. 5. This odious-looking creature, with its broad tail, armed with sharp spines, and its muscular body tapering to the head, and furnished with rigid serrations along each side, forms a striking contrast to the soft, helpless larva of the bee. Like all the larvæ of the *Syrphidæ*, to which the genus *Volucella* belongs, it is blind; but resting attached by the broad tail, it moves its head rapidly about as a feeler, before changing its position. The spikes at the tail may be adapted to enable it to raise itself up the smooth sides of the cell of the bee larva, in case that one infant bee should prove insufficient, and that it might require to pass on to the next cradle. But it may be as well to describe the progress of the parasitic larva on the supposition that one baby bee will prove enough for its purpose. The devoted larva of the bee, then, is gradually eaten alive by the parasite; which, with seemingly horrible instinct, spares all the actually vital parts, taking only the more fleshy portions, until the carnivorous young *Volucella* feels itself full fed and ready to undergo its torpid state of change. Then, the last remains of the wretched infant bee are greedily consumed, and the parasite passes into its sleepy chrysaline stage, taking its long *siesta* in the comfortable cradle whose infant tenant it has devoured, and from which it eventually comes boldly forth in all the pride of its winged and perfect state, walking out of the bee home as from its own proper

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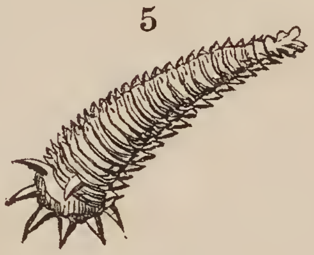

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abode, and attracting no notice whatever from the bees, in whose nursery it has performed the odious act of eating a baby bee, and appropriating its comfortable cradle cell. The stolid unconsciousness with which the bees allow this insect vampire to pass out and escape from the scene of his horrid proceedings with impunity, has induced some naturalists to believe that the carnivorous *Volucella* owes its safety to its complete disguise in the colouring of the bee, which is supposed to be so perfect as to deceive the bees themselves into the belief that these strangers are members of their own fraternity. Mr. Westwood, quoting Messrs. Kirby and Spence, in their admirable work, in which the habits and instincts of British insects were first classified and grouped together in a pleasantly readable form, makes the following statement on the likeness of the *Volucella* to the bee:—"This similarity to the humble-bee is of eminent service to the insects which deposit their eggs in the nests of those bees, an admirable provision of Nature, since, as Messrs. Kirby and Spence observe, 'did these intruders venture themselves among humble-bees in a less kindred form, their lives would probably pay the forfeit of their presumption.'" This statement, however, though appearing so plausible, is not borne out by analogy, there being many parasites on bees which do not bear the slightest resemblance to the insects whose nests they invade. Not only are some of the *Diptera*, who deposit their eggs in the nests of bees, very unlike the bees whose homes they infest, but even the parasitic bees themselves do not always resemble the bees whose nests they appropriate. For instance, the species *Eucera longicornis* has a *broad* brownish body, without any conspicuous mark, while its parasitic relative, *Nomada sex-fasciata*, has the *narrow* body of a wasp, and, as its name implies, six conspicuous yellow bands on the abdomen, which with the intermediate black spaces, make it a very distinct-looking creature indeed.

In some of the exotic bees more especially, the distinct aspects of the harvesting bee and the parasite are very striking; they are, in fact, so much so, that the insects might be thought to belong to entirely different families. The beautiful Brazilian bee, *Euglossa dimidiata* (No. 3 in the coloured plate), has an attendant parasite as totally unlike it as it is possible to conceive of insects of the same order. *Euglossa dimidiata* is one of the most beautifully and variously coloured of the whole bee tribe. The specimen from which our representation is taken, was captured by Mr. Bates, at Para, in the Brazils; and it is found in other tropical parts of South America. Latreille described this handsome species in Schomberg's Fauna of British Guiana; but it had been previously described by Fabricius, from specimens taken at Cayenne, and named by him *Apis dimidiata*; subsequent divisions of the family having rendered another generic name necessary, this beautiful species was attached to the genus *Euglossa*. It forms its nest by boring tubular hollows in large reeds, and there is a specimen of a reed in the British Museum bored in this manner by this bee, or by a bee belonging to a closely allied genus.

Into such a tube the parasite bee penetrates, for the purpose of depositing its egg in the cells which have been furnished with honey or pollen by *Euglossa dimidiata*.

In this case, in order to support the theory of Messrs. Kirby and Spence, it would be more than usually necessary that the intruder should be furnished with a very complete disguise, as he must, in such a narrow tubular home, necessarily come to very close quarters with the master of the house. Yet, on the contrary, the whole aspect of the parasite of *Euglossa dimidiata* is not only extremely different, but its appearance is of that striking character calculated to excite immediate attention. Instead of being soft and furry after the fashion of the humble-bee tribe and their allies, he is entirely hard, smooth, and glittering—the entire body, thorax and abdomen, and also the legs, being of a light vivid metallic green like that of our rose-beetle. It might be urged, on the other hand, that although not provided with a security in the form of a disguise, a defence of another kind has been substituted, in the suit of impenetrable plate-armour, of magnificent green bronze, in which this insect is incased. But I feel convinced that it is entirely futile to attempt to explain the nature of providential arrangement, and point out the secret purposes for which either apparent analogies or discrepancies were devised. The best explanations offered, indeed, are too full of contradictions to be for a moment seriously accepted as revelations of intended purpose. As a ready example of the contradictions to which such speculations must be liable, I may mention here, that although the parasitic bee, which infests the nests of *Euglossa dimidiata*, is entirely unlike the harvesting-bee, whose home he invades, yet the doubly-unfortunate *Euglossa* has a second enemy, in the form of a gigantic diptera, whose similarity to the bee is most curious. This enormous fly-bee, *Asilus fasciatus*, has, it is true, only two wings, but those being of deep brown to half their length, and transparent for the remainder, bear an extraordinary general resemblance to those of the bee; while the colouring of this handsome insect being nearly identical with those of the bee, and the size and shape of the markings being almost identical, the general resemblance becomes very remarkable; hence the conspicuous appearance of one enemy is rendered utterly useless as a defence, while the seemingly perfect disguise of another apparently favours his fatal entrance to the nest. There is another instance of a likeness so very extraordinary between a large exotic bee and its parasitic diptera, that I have represented them in the engraving below, in order to allow of careful comparison (Figs. 6 and 7).

The handsome bee figured above (Fig. 4, and No. 2 in the coloured plate), is *Xylocopa nigrita* (the female); it is a native of Sierra Leone, and is remarkable for the full deep velvety black of the greater part of the body, while the sides of the abdomen are conspicuously fringed, and partly

Fig. 6.

Fig. 7.

covered, with milk-white furry hairs; the effect of which call to mind the appearance of an aged negro, of the same part of the African coast, whose woolly hair has become white with age. The legs, also, are thickly fringed on one side with a similar white fur, and the "face" is white, with large, brown eyes. The wings are nearly opaque, and of deep, dull purple, with a metallic gloss, bronzy-red towards the extremities. The Diptera, or two-winged counterpart of this insect (Fig. 5), has all the characteristic contrasts of black and white, similarly disposed, even to the white face and brown eyes; while the opaque, iridescent wings are precisely similar in tone and colour. The somewhat longer legs, the single pair of wings, and the different structure of the antennæ, at once prove to the entomologist that these two insects are not only not the same, but that they belong even to different "orders." They are, however, in all probability, found together, like the other bees and diptera which so strongly resemble each other—the larva of the diptera, no doubt, preying upon the larva of the bee. In proof of this hypothesis, it may be stated that both specimens were brought to England from the west coast of Africa, the bee, from Sierra Leone, the bee-fly from Port Natal, and probably both will eventually be found in the same district. The last, the bee-fly, is at present an entomological novelty, and has not yet been named. The bee exhibits, in an unusual degree, a peculiarity common to many of the family, namely, a marked difference in the general aspect of the two sexes. The individual engraved above is the female bee, the male being of a light tawny brown colour, and having a much longer body, a characteristic which generally distinguishes the female rather than the male. The two sexes of this remarkable insect are both figured in the coloured plate, No. 1 being the male, and No. 2 the female. It would be interesting to know, whether in the bee-fly, which bears so extraordinary a resemblance to this fine bee, an equal disparity of appearance exists between the two sexes; but, as we have at present only a solitary specimen of this insect, that is a point which cannot be decided; but other specimens will, doubtless, be captured, which may may enable us to solve this interesting entomological problem.

The other exotic bees figured in the coloured plate are, the pretty little *Euglossa cordata* (No. 5), a native of the Brazils; *Anthophora elegans* (No. 6); and *Crocisa picta* (No. 7), are also from South America.

In concluding my remarks on curious resemblances between "bees" and various kinds of two-winged "flies," I may mention a curious instance of a resemblance between a dipterous insect and one of the wasp tribe (*Vespidæ*). *Eumenes esuriens*, a small Indian wasp, found in Bengal, has its counterpart (the resemblance being truly extraordinary) in *Cesia eumenoides*, the specific name of which has been conferred upon it in consequence of this singular resemblance. I ought also to mention, as a case in point not the least singular, that a British dipterous insect of the *Syrphus* tribe, belonging to the genus *Eristalis*, is so like the common hive-bee, that it would, at a glance, deceive any observer untrained as an entomologist.

THE SHELL OF THE CUTTLE FISH.

It is not generally known that the internal shell of the cuttle fish (*Sepia officinalis*), so commonly found by the sea-shore, and likewise having its place among the miscellaneous items of the chemist's shop, affords one of the most beautiful objects for microscopic examination by polarized light. All that is required is to scrape a little of the soft part of the shell with a penknife, taking care not to reduce it to too fine a powder, and then mount it in Canada balsam. The slide is thus easily prepared, but to view it requires some little nicety. If exhibited without a selenite stage, the polarizer and analyzer should be so adjusted as transmit their least amount of light. When they are in this position the cuttle shell slide may be placed on the stage, and there will be seen a number of irregular shaped masses of a dull golden hue, variegated with numerous points of a brighter aspect, and likewise many more or less oblong fragments, glowing with rich purples, crimsons, yellows, emerald-greens, and shades of golden-brown. The colours or tints are arranged in numerous horizontal bands which, under an inch or two-third object-glass, show symptoms of crystallization in the shape of thousands of minute needles, an aspect that is strengthened if a higher power, such as a quarter or a fifth, is employed. Revolving the analyzing prism produces no good effects, nor does a similar process with the polarizer, the object presenting no beauty except in the one position we have described. While the prisms are in such relative positions as to transmit little or no light, the selenite stage may be introduced beneath the slide, and the colours will appear somewhat more brilliant, but pretty much the same. Revolving the analyzer still exhibits only one good view, namely, that with the dark ground, on which the fragments glisten like jewels upon black velvet. But if the polarizer is made to take a quarter turn, and the selenite is of the right thickness, a revolution of the analyzer will then exhibit two new effects, one exhibiting brilliant colours on a rich sky-blue ground, and the other on a ground of an amber tint. The blue one is exceedingly fine. A thin slice of mica, about the thickness of writing paper, placed under the slide and on the selenite, affords further changes of extreme richness and beauty, the grounds assuming, as the analyzer revolves, crimson, violet, and green hues, with corresponding alterations in the colours of the particles of the shell.

If the experimenter is successful in adjusting the prisms, and employing the right thickness of selinite or mica, this object is quite equal in splendour to the most esteemed crystals, such as salicine or asparagin; but greater care is required for the cuttle shell than for them, and even an experienced microscopist may not immediately hit upon the right way. Perhaps no polariscope slide is better adapted to assist the artist-designer in devising patterns for shawls, carpets, and other ornamental goods, and the effect may be varied not only by the methods we have indicated, but also by the degree of fineness of the powder employed, and by determining, as we shall presently explain, the proportion which the amorphous dull golden particles bear to the most brilliant and crystalline portions of the display. But to make this intelligible we must, at all risks of offending very learned readers, say a few words on the structure of the cuttle shell, and the mode of examining it.

The first step is to cut a little block of the soft brittle substance of which what may be called the inside of the shell is composed. If such a block is viewed in vertical section as an opaque object, it will appear to consist of a great many tiers of columns of a white glittering semi-transparent substance, about one-fortieth of an inch high, and between each tier of the tiny pillars a flooring of somewhat similar material will be seen to run. Thus the first idea of construction would be that of dozens of floors supported by millions of columns, and many sections may be made and viewed in various directions without the real principle of the fabric being found out. A horizontal view, when one floor has been cut away, may perhaps disclose the secret; but the apparent columns are so brittle, that enough of them may not remain after the knife has passed through them to show the true form. By beginning at the back of the shell the chance of success is greater. First, a rough brittle layer of carbonate of lime is removed, then comes a transparent glassy-looking substance, and behind this the pillars begin, and a portion of the flooring may be taken away without materially disturbing the order in which they stood. If this does not readily yield a good horizontal section, a cube of the shell may be saturated with the colourless varnish used in photography, and when this is dry the brittle part will be strengthened sufficiently to bear rougher usage without harm. However it be accomplished, if the horizontal slide is well made, it at once becomes obvious that the columnar appearance was an optical mistake, and that instead of the floors resting upon thousands of separate pillars, they are supported by the sheet of carbonate of lime, corrugated just as a sheet of paper would be by folding it alternately backwards and forwards across a square-edged ruler. The chemical nature of the several parts may be readily ascertained by acetic acid. If a few minute fragments from different portions are placed in a drop of dilute acid, covered up with thin glass, and placed under the microscope, the pillars or fragments of the corrugated sheet dissolve first; while the portions of the floors do not change their form, for although much carbonate of lime is removed, the animal membrane remains. The back of the shell dissolves quickly, and the glassy-looking film behind it is converted in a few minutes into a tough transparent material like gelatine paper.

Our polariscope object was composed of the floors, which furnished the amorphous fragments of dull speckled golden hue, while the corrugated supports supplied the portions that glowed with the rainbow lights. If mere splendour is required, the particles of the flooring should be rejected, and pieces of the corrugations mounted alone, taking care not to spoil the effect by breaking them up too small.

It is interesting to find the vital and chemical processes by which the cuttle shell is formed, combining to produce upon the principle of corrugation that strength associated with lightness, which man, in his recent inventions, seeks to obtain in precisely the same way. Hundreds of similar illustrations might be given, of reason obtaining by slow degrees, and manifold experiments, to methods of construction which abound in the organic world. Sometimes the human contrivance is assuredly an imitation, but oftener it is reached by an original method, and when this is the case it is impossible not to be struck with the evidence thus afforded of the unity of plan in creation, as displayed in the intimate correspondence, or relation, that exists between the tendencies of human thought and the processes, consciously or unconsciously, carried on in the lower spheres of material existence, or of subordinate animated being.

ALUMINIUM.

BY J. W. M'GAULEY.

There is no subject connected with chemistry of more importance than that of the metals: nor is it an exaggeration to assert, that they have been the principal agents in civilization. We are chiefly indebted for the latter, however, not to those which are costly and rare, but to that which, by a beneficent dispensation of Providence, is the most common of them all: since iron has been of far more value to mankind than gold.

The ancients were acquainted with but few metals. In very remote antiquity, metallurgical knowledge was almost confined to copper and tin, which were more easily reduced than iron. And, as it was soon discovered that some of their alloys were extremely hard, they were employed in the manufacture of axes, swords, and other weapons, after still ruder materials were discarded: hence, warlike and domestic instruments of bronze, are found among the oldest relics of distant ages. But iron at length obtained its fitting place among the substances useful to man; and its abundance, its extreme softness when softness is required, its extreme hardness when that quality is desirable, its elasticity, its malleability, ductility, tenacity, and other admirable qualities, have caused it to acquire and maintain the very first rank among the useful metals. Gold and silver, it is true, have been known from the earliest times; but their use, like their supply, has always been limited; and much of the value attached to them is due to their scarcity. Lead, also, and zinc—at least as an ore, and as one of the ingredients of brass—were familiar to the ancients. But we have now enumerated all the metals with which they were acquainted; and, in truth, all that to any great extent have yet been utilized.

We are, on this occasion, specially to treat of a metal which has been a source of great expectations: and, fortunately, there is no reason to consider that these have been disappointed; their complete realization is only deferred, and most probably for but a short period: and one of our objects in directing attention to it, is to excite a more general inquiry regarding it. The establishment of aluminium among the most important of the metals, is a mere question of the cheapness of its production: and as, up to this time at least, it is most conveniently obtained by means of sodium, investigations regarding it, resolve themselves into a determination of the most economical method of obtaining that metal. On this point, our knowledge has already progressed considerably, and hence the price of aluminium has greatly fallen. Not long ago it was £3 per ounce, it is now only about 5*s.*: and it will, no doubt, be far less, if we are to judge by the extraordinary improvements always made, after a time, in chemical processes. How much lower in price are the most useful substances at present than they were a very few years ago, because the methods of manufacturing them have been simplified. But, even at its present cost which, by *weight,* is the same as that of silver, aluminium is really only one-fourth as dear, *bulk* for bulk: and this, after all, is the test, since bulk for bulk, it is as strong, and even stronger than silver. When there is question, however, of its application to domestic purposes, we must compare its cost with that of pewter or copper: it would chiefly supersede these, which, among other disadvantages, are productive of very noxious compounds, particularly the copper.

The qualities of the precious metals are quite distinct from those of the more common: nor have the two classes hitherto been connected by any intermediate metal—that is, by one possessing the most characteristic properties of each; but it is hoped that aluminium may supply such a connection. Like the precious metals, it is brilliant, and little alterable by chemical agents—scarcely at all, under ordinary circumstances. Like the common metals, it is very abundant, constituting one-fourth, by weight, of the most widely diffused bodies. It is malleable, ductile, hard, and tenacious; its compounds are harmless—which is true of scarcely any other metal but iron: and, unlike both the precious and the common metals, it has the advantage of being extremely light. It is admirably suited to all ordinary purposes: and is one of the best that can be used for those which are artistic and ornamental. M. Christofle, in 1858, exhibited before the Academy of Sciences a group in aluminium, which had been cast and chiseled: and which afforded an excellent example of its capabilities, though it was its first application to such a purpose.

Davy, soon after he had discovered the metallic bases of the alkaline earths, in 1807, proved the existence of aluminium, from potassa being produced when the vapour of potassium was brought in contact with alumina heated to whiteness; and he even obtained it, in combination with potassium. It was procured by Wöhler, in 1827, as a grey powder; and in 1845 in the form of very minute globules: but probably from being more or less impure, it did not exhibit the same properties as when in a massive state. On account of the high price of potassium, at the time he made his experiments, and other obstacles, he did not obtain it in particles larger than a pin's head: and he succeeded in uniting these, only by great chance, and after many trials: since the presence of minute quantities of other substances, or a slight coating of oxide, would prevent their coalescing. M. Degousse, a gold-beater of Paris, succeeded in preparing it in the form of very thin plates: and he found that, in beating them out, it was necessary to re-heat them more frequently than other metals in similar circumstances. M. Deville has been the most successful of all those who have made experiments upon it. We shall first describe the most convenient methods of obtaining aluminium, particularly on the small scale: and shall then examine its properties and combinations—omitting nothing of any importance, that has yet been discovered regarding it. As to the mode of procuring it on the large scale, it does not concern the object we have in view: but it may, in a great degree, be conceived from what we shall say.

When we attempt to get aluminium directly from alumina, with potassium, or sodium, we do not succeed: most likely from its being necessary that the potash, or soda, which would then be formed, should unite with some of the undecomposed oxide —which does not seem to occur, though aluminates of the alkalies are very easily made. But M. Chapelle, in 1854, procured it by introducing pulverized clay, sea salt, and powdered charcoal, into a common crucible, and heating the mixture with coke, though not to whiteness, in a reverberatory furnace. When the crucible was cold, a considerable quantity of minute globules of aluminium were found at the bottom. It must be admitted that the simplicity of this method, if it could be rendered economical, would make it deserving of preference: and it is not improbable that it may hereafter be so improved as to supersede all others. To obtain aluminium through the medium of a troublesome metal, seems at best a clumsy process. It is, however, the most successful that has been yet devised; and we are indebted for it, in its present improved state, to the ingenuity and researches of Deville, whose method is a modification of Wöhler's. He received from the present Emperor Napoleon the funds necessary for making his experiments on a large scale, and in a satisfactory manner: and he first published an account of them in 1854.

It occurred to him that, on account of its smaller equivalent, and the commercial value of its salts, sodium would be better for the purpose of obtaining aluminium than potassium, which had been employed by Wöhler. Other advantages, besides, were found to follow from its adoption: the manufacture of sodium is easier, and even safer, than that of potassium: and when the process goes on well, those carbon compounds which are so annoying with potassium, do not make their appearance: nor is its reduction accompanied by the explosive substances—probably compounds of hydrogen—which are so dangerous in the reduction of potassium. Moreover, the use of potassium in obtaining aluminium is not very safe, it inflames so easily, and often produces such violent explosions: while sodium can be employed without fear, since it may be raised in the atmosphere to a higher temperature than its point of fusion—indeed, we have reason to believe that it is inflammable only in a state of vapour, though still at a temperature below its boiling point; and, if it is kept very carefully from water, there will be little likelihood of its taking fire.

To get pure aluminium by Deville's method, we require pure alumina, pure chloride of aluminium, and metallic sodium: for any impurities present in these will be concentrated in the aluminium, and affect its properties very much: nor, if once combined with it, can they ever be entirely removed. We shall first, therefore, describe how these are to be had.

To obtain *pure alumina.*—Eight and a half parts, by weight, of the sulphate of alumina of commerce, for every required part, by weight, of pure alumina, are dissolved in an equal weight of water, and precipitated by a concentrated and boiling solution of acetate of lead in slight excess; and the smallest possible quantity of tartaric acid, is added to the liquor which is separated by decantation, to prevent the precipitation of alumina. The acetate of alumina is then supersaturated with ammonia, and the ammoniacal solution, after being treated with hydrosulphuret of ammonia, in a closed vessel, is placed in a stove having a temperature of from 122° to 140° Fahr.: this determines the precipitation of the sulphurets of iron and lead, which are removed, first by decantation, and then by filtering —but without washing the filters. The clear and slightly yellow liquor, which consists of acetate and tartrate of alumina combined with ammonia, and some hydrosulphuret of ammonia, is rapidly evaporated and carbonized in an earthen crucible. The residual mixture of alumina and carbon is made into a paste with oil, and strongly calcined to expel the sulphur—due to a little sulphuric acid which remains in the alumina, the whole of it not having been separated by the acetate of lead.

To obtain *pure chloride* of *aluminium*.—Some of the mixture of alumina and carbon, just mentioned, is introduced into a porcelain tube that has been fitted with another tube, and is heated to redness in a current of dry chlorine. Chloride of aluminium sublimes, and is removed from the tubes in compact masses, which are composed of very beautiful crystals, that are either colourless or slightly tinged with yellow. If, however, from the impurity of the materials, this chloride is not found to be quite pure, it is heated with nails or iron-turnings, in an earthen or cast-iron vessel, which, when the permanent gases have passed off, is closed: after which, the heat being continued, a slight pressure results, that causes the chloride of aluminium to melt and come in contact with the iron. This changes the volatile *per*chloride of that metal into the *proto*chloride, which is comparatively fixed: and the chloride of aluminium, completely purified, crystallizes in the vessel itself in large transparent and colourless prisms: and a distillation in hydrogen finishes the process.

To obtain the *sodium*.—Its preparation is founded on the reaction of an alkaline carbonate on carbon; and carbonate of soda, wood charcoal, and carbonate of lime are required in the following proportions—

Carbonate of soda	717
Wood charcoal..................	175
Chalk	108
	1000

The carbonate of soda should be obtained from crystals dried and pulverized fine: the carbon and chalk should also be reduced to powder; and the whole, as soon as possible after having been mixed, should be made into a paste with very dry oil, and then calcined at a red heat in an iron mercury-bottle, that it may occupy a small space—and thus a larger quantity of potassium be obtained by the subsequent process. The calcined mass is subjected to a high heat in an iron mercury-bottle, which is not so rapidly destroyed as might be expected, and ought to last for three or four operations; it is kept comparatively cool by the resulting oxide of carbon, and by the sodium assuming an æriform state, and the heat required is not near so great as might be supposed. An iron tube leads from the bottle which is inside the furnace, to a receiver, which is outside, and has an aperture for the escape of the gases. The carbonic oxide formed from the chalk, assists in carrying the vapour of sodium rapidly into the receiver, and thus prevents it from decomposing any of the gas by which it is necessarily surrounded—an effect that would be facilitated by its finely divided state as vapour; the receiver also is thus kept hot enough to unite the metallic globules, without a wasteful after process. One-seventh of the weight of the mixture which has been used, or one-fourth of the weight of the carbonate of soda, should be obtained in sodium. If the mixture employed has been such as to melt, it will have prevented a free disengagement of the gases.

To obtain the *aluminium*.—From 3000 to 5000 grain of chloride of aluminium are placed in a tube of glass or porcelain, about one and a half inches interior diameter, and are insulated by two plugs of asbestos. Hydrogen, purified and dried, by being transmitted through sulphuric acid and chloride of calcium, is sent through the tube: and, while it is passing, the chloride of aluminium is gently heated by a few coals, to drive away any hydrochloric acid which may have been formed by the action of the air on the chloride, and also the chlorides of sulphur and silicium which are invariably present in small quantities. Sodium, previously crushed between two pieces of dry filtering paper, and placed in a boat, is then introduced into one end of the tube while it is still full of hydrogen, and is melted; the chloride is at the same time heated so as to make it rise in vapour, that it may come in contact with the sodium, and be decomposed; and when the sodium has disappeared, and the chloride of sodium that has been formed is saturated with chloride of aluminium, the process is complete. An incandescence which occurs is easily regulated. The boat, being taken from the tube, the mixed chlorides, in which the globules of aluminium are suspended, are removed, by dissolving in water: and the globules, covered up in a porcelain crucible either with mixed chlorides of aluminium and sodium, or with common salt, are fused together by a strong heat.

This process answers still better on the large scale; but, instead of the porcelain tube and boat, two cast-iron cylinders connected by a smaller tube of iron are employed. The anterior cylinder contains the chloride of aluminium; the posterior, sodium in a tray; and the iron tube, kept at a temperature of from 400° to 500° Fahr, scraps of iron to separate any of that metal which may rise with the vapour of chloride of aluminium, by changing it from volatile *per* to fixed *proto*-chloride.

Œrsted, who was the first to form chloride of aluminium, is said to have obtained that metal, by heating the chloride with an amalgam of potassium, rich in the latter, and driving off the mercury from the resulting amalgam of aluminium, by heat.

Aluminium may also be procured from *Cryolite*, a mineral which exists abundantly in Greenland, though it is found only in small quantities elsewhere. It is a double fluoride of aluminium and sodium: and may be produced artificially, by adding hydrofluoric acid in excess to calcined aluminium and carbonate of soda, so as to produce

Fluorine	54·5
Aluminium	13·0
Sodium	32·5
	100·0

then evaporating, and fusing the result. Both the native and factitious cryolite give aluminium with sodium, and with the galvanic current. The latter, with a mere *mixture* of aluminium and fluoride of sodium, would afford only sodium and fluorine. It occurred to Rose that, on account of the deliquescence and volatility of the chlorides of the alkaline metals, and the necessity, when they are employed, of preventing any access of atmospheric air, it would be better, in the reduction of aluminium, to use a fluoride of that metal combined with an alkaline fluoride; and he proposed to use cryolite, but was deterred by its scarcity at that period. To obtain aluminum in this way, finely powdered cryolite and sodium are placed alternately in layers, in cast-iron crucibles, the whole being covered with a good thickness of chloride of potassium as a flux. The crucible is then carefully closed with a porcelain cover, and raised to a red heat for half an hour. After which, the calcined matter having been softened with water, it is broken down in a porcelain mortar. The larger globules of aluminium are easily separated mechanically; the smaller, by dissolving away the mass in which they are imbedded, with nitric acid, without heat. The globules are fused, as before, under the mixed chlorides, or common salt; without this, the slight coating of oxide on their surface would prevent their union. When common salt alone is used, a higher temperature is required. The aluminium obtained from cryolite almost always contains silicium, and even iron: and the product is not abundant, since 10 of cryolite and 4 of sodium give only 0·5 of aluminium. Rose attempted also to procure aluminium, by placing the mixed chloride of aluminium and sodium, in alternate layers with sodium; but the results were not satisfactory.

Bunsen proved, in 1854, that aluminium may be obtained by means of the galvanic battery, in the same way as magnesium. But, as chloride of aluminium cannot be used for the purpose, since, instead of fusing, it volatilizes, he employed the double chloride of aluminium and sodium, which is not volatile except at a higher temperature than the fusing point of aluminium. The apparatus also must be somewhat different from that used in reducing magnesium. For the electrolysis, two parts chloride of aluminium, and one part common salt dried and pulverized, are mixed in a porcelain capsule, and heated to about 390° Fahr.; after a while the mixture becomes a clear liquid.

The apparatus, in which the decomposition is to be effected, consists of a glazed porcelain crucible, placed in another of earth; the latter is closed with a cover having one opening, at the side, sufficient to allow a thick plate of platina to pass down through it for the negative electrode, and another in the centre, to admit a porous vessel, which has been well dried, and in which is placed the positive electrode—a piece of gas-retort graphite. Both the crucible and the porous vessel—which is of less depth, are filled to the same height with the melted double chloride: and the latter is kept hot, but not sufficiently so to melt the aluminium. A battery of about five circles is connected with the electrodes; and the aluminium and common salt, which will be deposited on the platina plate, is occasionally removed. Chlorine and a little chloride of aluminium will separate in the porous vessel, unless prevented by a small quantity of common salt, thrown into it now and then, in a dry pulverulent state. The mixture which has been detached from the platina plate, is melted in a porcelain crucible protected by another of earth; the fused mass is dissolved in water, and the particles of metal obtained from it, are melted several times under the double chloride of aluminium and sodium.

The battery does not give so pure a metal as the sodium process, which removes the silicium, sulphur,—and even the iron, from the materials; but these impurities are found only in the first portions detached from the platina plate. On account of the small atomic weight of aluminium, compared with that of zinc, the mode of obtaining it by electrolysis is too expensive for ordinary purposes.

The *properties* of aluminium are very remarkable, and many of them are highly important. It is white, with a bluish tinge, but when its surface is quite clean, its appearance differs very little from that of silver; its splendour is not indeed quite so great, but lasts much longer. A very white and beautiful, though not a polished surface, may be easily given to it, by plunging it for an instant into a very dilute solution of caustic soda, washing it with water, and then digesting it in strong nitric acid. This removes everything that can soil it, except silicium if in considerable proportion. Aluminium takes a fine polish, and preserves it for an indefinite period; but to render it as brilliant as possible, a mixture of stearic acid and spirits of turpentine must be used, between the rotten stone and finishing powder; and the polishing process must end with spirits of turpentine. Its characteristic blue tint is more perceptible when the surface is polished than when it is dull. It often assumes a crystalline form, if cooled slowly. When pure, it has not any taste. If it contains a large portion of silicium, it has a slight smell of siliciuretted hydrogen; otherwise it is inodorous. Hot or cold, it is as malleable as gold or silver, and is reducible to as thin leaves. It differs from all other malleable metals, by being deprived of malleability if alloyed with any other metal. It is so ductile, that it may be drawn into an extremely fine wire: but its ductility also is affected by admixture. Its tenacity, and elasticity, are nearly the same as those of silver. When cast, it is as hard as pure silver; but when hammered, it is as hard as soft iron. It seems to be one of the best known conductors of electricity; its conducting power is eight times greater than that of iron: but this also depends very much on its purity. Since metals generally conduct heat in about the same proportion as electricity, it is, as we might expect, an excellent conductor of heat—probably a better one than silver. It is slightly magnetic. When pure, and in the form of a bar, it is remarkably sonorous: and if suspended by a thread, it emits a sound like that of a glass bell: but in other forms, its tones have not been found agreeable. Its specific gravity is only 2·56, and when hammered 2·67; no other metal of small density has been found malleable, tenacious, sonorous, and a good conductor. Iron is nearly three times as heavy, copper nearly four times, lead nearly five times, and platina nearly nine times. Even though prepared to find it very light, we are astonished on handling it. This property causes it to answer admirably for spectacles, the beams of delicate balances, sextants, etc. It is well adapted for small chemical weights: the increased size of which causes them to be more easily moved, and less easily lost. M. Dumas exhibited to the Academy of Sciences a helmet of aluminium, which was very brilliant, had been gilt by the battery, and was joined by solder with great solidity; it weighed less than twenty-five ounces avoirdupois. If of brass, it had weighed nearly sixty ounces, and would not have been so strong. Aluminium cannot easily be adulterated, because even small quantities of other metals deprive it of malleability and ductility. Nor can it be imitated by other metals, for their weight would betray them. All the other less oxidizable metals are heavy, and have a much greater atomic weight. Its point of fusion is somewhat higher than that of zinc, and lower than that of silver. It flows readily into moulds of metal, or sand; any flux would be injurious to it, but it requires none. It fuses very slowly, for its specific heat is very high, and therefore its latent heat is considerable—it exceeds all ordinary metals in this respect. It therefore keeps warm for a long time, which may be found a useful property. If pure, it is scarcely affected even by the oxyhydrogen blowpipe, but the presence of oxidizable metals facilitates its oxidation. Though silicium has itself little tendency to unite with oxygen, its presence causes aluminium to burn with great splendour, silicate of aluminium being produced. In the form of a thin plate, it burns with great brilliancy, in the flame of a spirit-lamp; but the light it emits in combustion becomes intense, when the flame is urged with a jet of oxygen. If pure, or nearly so, it is not tarnished by air or moisture; it may be fused in the atmosphere without oxidation, and may even be raised in a cupel to a temperature higher than is required for the assay of gold, without being altered. Water, either as a liquid or vapour, has no effect upon it, though heated to near its melting-point: and at a white heat, produces only a slight oxidation. But if chlorine is present, it acts upon it like a hydracid, hydrogen being disengaged, and a soluble compound formed. If, however, it is in the form of a thin plate, it will cause a small quantity of hydrogen to be evolved, when it is placed in boiling water.

Nitric acid, whether concentrated or dilute, has no effect upon it, at ordinary temperatures; it is slowly dissolved in boiling nitric acid, but the solution ceases if the acid is allowed to cool. Sulphuric acid, whether concentrated or dilute, does not act upon it; nor is it, like zinc, rendered soluble in the acid by contact with another metal. But it is dissolved by hydrochloric acid, whether concentrated or dilute; slowly if pure, but with great rapidity if otherwise. It is the acid, and not the water in which the acid is dissolved, that is decomposed; since hydrochloric acid gas acts upon it at a very low temperature, forming an anhydrous and very volatile chloride; and the more concentrated the acid, the more energetic its effect. Whenever aluminium is tarnished with water, on testing with nitrate of silver, it will be found that chlorine is present. If a wire of aluminium is plunged for an instant into dilute hydrochloric acid, a considerable amount of it will be changed into a white substance, after it has been withdrawn from the acid, and without any absorption of oxygen. Acetic acid, diluted to the strength of strong vinegar, has little or no effect upon it; but it is important to bear in mind that a mixture of vinegar and salt dissolved in water, acts upon it—in accordance with a well-known chemical law, according to which the acetic acid displaces some of the chlorine, and this forms hydrochloric acid, its proper solvent; but the action in such a case is very slow, particularly if the metal is pure. Tin would be more affected in the same circumstances, and would impart a bad taste, which does not occur with aluminium. It is scarcely acted on by tartaric acid—a valuable property, if it is used in connection with wines. Its combinations with the feeble acids are harmless, which is not the case with most of the other metals; and they are decomposed at a low temperature. Solutions of potash and soda act upon aluminium very energetically, forming aluminates of the alkalies, with evolution of hydrogen. But monohydrates of the alkalies, even at a red heat, affect it no further than to remove from its surface any silicium that may be present upon it. Ammonia acts upon it slightly, but only in presence of water—which is decomposed, hydrogen being set free: and the resulting alumina is dissolved by the alkali. Sulphur has no action upon it, even when it is heated to redness: but enters into combination with it at a high temperature. Its utility, as applied to domestic purposes, is increased by its not being tarnished by the sulphur which is in eggs and mustard. Sulphuretted hydrogen does not affect it: hence the air of cities, which always contains that compound, particularly when they are lighted with gas, does not dim its lustre, though it tarnishes silver with great rapidity. It may be used therefore as a reflector, with a jet of gas, even though the flame comes occasionally in contact with it. If sulphuret of ammonia is evaporated from it, there will be produced only a spot of sulphur, which will be driven off by continuing the heat. Polysulphuret of potassium will merely act on any iron or copper that may be united with it: but that substance cannot be applied to its purification, since it would more or less protect these metals, and prevent their complete removal. Metallic salts comport themselves with aluminium according to the acids they contain; thus the chlorides act upon it, the sulphates do not. Aluminium fused with nitre is not affected by it, except at a high temperature, and then aluminate of potash is formed. The chlorides of sodium and potassium do not perceptibly act upon it when pure, and only very slowly when impure. Ordinary metals cannot resist the action of common salt—particularly as it is found in sea-water; even silver is slightly corroded by being boiled in water holding it in solution: and silver articles, which usually contain five per cent. copper, become dangerous when food is allowed to cool in them. Now, supposing silver and aluminium to be even equally affected in such cases, the latter, on account of its low equivalent, will give rise to a much smaller quantity of resulting salt: since a quantity of acid that will dissolve *one hundred* grains of silver, will dissolve only *eight and a half* of aluminium; and the physiological effects of the salts are very different. Other metallic chlorides, including even its own, are decomposed by it: and with a facility dependent on the elevated rank of the metal they contain. It does not combine with carbon: and in this respect has the advantage of platina, in the laboratory.

Compounds containing silicium are decomposed by aluminium, at a high temperature: yet we may fuse it in glass, or porcelain, because they are not in contact with it, unless some fusible substance is present; and hence, when we melt it in vessels which contain silicium, a flux is inadmissible. When aluminium containing silicium is dissolved in hydrochloric acid, siliciuretted hydrogen, a compound not long discovered, is disengaged, and is recognised by its peculiar odour: and the presence of silicium greatly assists the action of that solvent.

Aluminium combines also with boron: and the latter, like silicium, affects it properties. A very interesting compound, the *diamond of boron*, is produced by the intervention of aluminium. Boron assumes three states, corresponding with the three conditions of carbon—amorphous carbon, graphite, and diamond. Boron, in the state of *diamond*, is obtained by causing aluminium to act on boracic acid: it bears a heat sufficient to melt iridium, without change; and unites with oxygen, at the temperature at which diamond burns—but only on the surface, as it is protected by the boracic acid which is formed externally. It scratches the hardest diamond, by which alone it is exceeded in brilliancy and refractive power. It assumes three forms, having somewhat different qualities: one of them is exceedingly hard, and answers well instead of diamond powder, its crystals not being abraded by use: and the least hard is more so than corundum.

M. Hulot, director of the Mint at Paris, discovered that aluminium may be used in the galvanic battery, instead of platina, zinc being employed as the electro-negative element. It had long before been ascertained by Wheatstone, that it is as strongly negative as that metal. It becomes soiled, however, after a while, but may be cleansed by immersion for an instant in nitric acid, and washing with water.

Aluminium unites very imperfectly with lead, and only temporarily with mercury. It combines with small quantities of sodium, which changes its properties, and is with great difficulty separated from it entirely. It alloys with iron, in all proportions: but seven or eight per cent. makes it hard and brittle. Cadmium, tin, and zinc, render it fusible. Two or three per cent. silver, gives it a hardness and colour, equal to that of the silver alloy which is commonly used; a larger quantity destroys its malleability. If any chlorine is present, which, unless it is very pure, will probably be the case, the silver alloy soon blackens. Aluminium containing ten per cent. gold is softer than when pure, but not so malleable. Its most important combinations, however, are those which it forms with copper: if it contains two or three per cent. of that metal, it is aluminium bronze, a material well adapted for artistic, and many other purposes: if it contains ten per cent. it is as brittle as glass. Ten per cent. aluminium, and ninety per cent. copper, gives an alloy which, though harder than common bronze, laminates extremely well—particularly if it is heated, and is very ductile. The last is a definite compound, since it is in the proportion of nine atoms copper to one of aluminium, and great heat is disengaged during combination: hence its constituents do not separate by fusion and cooling. Its colour is that of green gold, which consists of gold and silver: and it is capable of as fine a polish as steel. Its tenacity is very great; and, compared with that of copper and iron, is found to be as follows—

Copper...........................	190
Iron	280
Aluminium Bronze............	434

It answers well for the material of axle-bearings, and similar parts of machinery: after having been used for six months with a steam-engine, it showed no wear; and it lasted eighteen months, in a machine which made two thousand two hundred revolutions per minute, while any other substance, in the circumstances, was found to last only three months. Possessing hardness without brittleness, it sustains shocks uninjured: and is well adapted for artillery, or the barrels of firearms.

It is difficult to gild or silver aluminium: baths of acid sulphuret of gold, and hyposulphite of silver containing excess of sulphurous acid, have, however, been employed with tolerable success for these purposes. Other processes have been found to answer better, but their details are not known. Plates of copper or brass, and aluminium, strongly pressed together at a dark red heat, will unite; if it is attempted to treat gold and aluminium in the same way, the temperature required for cohesion will cause the two metals to combine. In depositing metals on aluminium, by means of the galvanic battery, we must not use acid solutions in which hydrochloric acid, or combined chlorine is present; nor must alkaline solutions of the metals—so useful in other cases, be employed. Pure aluminium may be easily coated with copper, by a bath of sulphate of copper. A patent was taken out some time ago, for plating with aluminium. The solution used was obtained by dissolving alum in water, adding ammonia as long as any alumina was thrown down; then filtering, adding distilled water, boiling with cyanide of potassium, and filtering when cold. And the article to be coated was suspended in it, by copper or brass rods connected with the zinc pole of a battery; a bag of alumina, or a piece of platina, being connected with the other pole.

It is difficult to solder aluminium, on account of our not knowing a flux that cleanses without altering it, or protects the solder without acting upon it; and a thoroughly strong joint has not yet been made in this way, although various methods have been adopted. Some persons deposit copper on the surfaces, and then apply the solder to unite them. With the process of M. Mourey, which is probably the best that has yet been used, the surfaces to be united are smeared over with a mixture of turpentine, balsam of copaiba, and lemon juice; they are then placed on hot coals, and the flame of a gas lamp, or of a self-acting blowpipe, is directed between them; after which, small pieces of an alloy containing six parts aluminium and ninety-four parts zinc, are placed in contact with them, and, when melted, are pressed upon them with tools made of aluminium. The surfaces thus coated, are next brought close together, and kept so by wires; after which, an alloy containing twenty parts aluminium and eighty parts zinc, is applied, in bits, to the points in contact outside, and is melted in with a lamp. When cold, the article bears filing and re-working.

We have now brought under the notice of the reader, almost everything of importance yet known regarding this interesting metal: and we do this the more willingly, because its general adoption is assuredly but a question of time. This must be greatly shortened, through the labours of ingenious and persevering experimentalists, who may be induced to give their attention to the subject, by the reasonable expectation of benefitting the community, and at the same time deriving considerable profit from success. The method of obtaining it, by means of sodium, is the best that has yet been proposed; but it is more than probable, that one far less troublesome and expensive will hereafter be discovered.

HUNTING FOR DIATOMS.

Let us suppose the diatom collector and his friends to be setting forth, properly equipped with the necessary apparatus for securing and preserving the gatherings they may meet with. Here it will be as well to describe the arrangement of apparatus used by the writer of this paper in his expeditions after Diatomaceæ.

First of all, is a morocco leather bag, with a strap to go over the shoulders. This bag contains several pockets, to carry a dozen or more wide-necked bottles of say two-ounce capacity. A smaller leather case, with six narrow one-ounce phials, with wide necks, the phials slipping into partitions. This case is carried in the pocket of the shooting coat when out on a trip.

Next comes a box with small tubes and a camel-hair pencil, for painting off pure gatherings, or when it is inconvenient to bring home a larger quantity of the material.

In addition to the bottles and tubes some pieces of gutta-percha paper, or waterproof macintosh cloth, nine inches square, are very useful to wrap up Algæ, masses of Confervæ, and other diatom-yielding plants, into bundles, after slightly pressing out part of the water. These bundles, kept from unfolding by an elastic ring, are put at once into the bag. For scraping the surface of mud, the sides of jetties, etc., the writer uses a copper spoon, with a screw clamp, to fasten to the end of a walking-stick when used. On one side of the neck of the spoon is riveted a small knife blade, which forms a convenient means of cutting away portions of aquatic plants covered with diatoms, and lifting them out of the water.

The only lens necessary to the diatomist when out collecting is a Coddington; but the writer has found a small compound hand microscope very useful occasionally. This, with some slips of glass, are carried in a separate compartment of the leather satchel.

We will now suppose all these arrangements made, and the diatomists, who live in some large sea-port town, are sallying forth, as mentioned in the commencement of this paper.

A knowledge of the most likely places to look for Diatomaceæ is only to be gained after some experience, and it is the wish of the writer to give the result of his experience in the matter, which has induced him to pen these lines. In mentioning the various species of Diatomaceæ in connection with given habitats and localities, it may be as well to say that the writer has in most cases found the species named in such localities; not necessarily in one particular district, but at various times and in different parts of the country.

We will now suppose the collectors are commencing their imaginary collecting tour, and, before leaving the town, let us take a stroll round the Docks—for here we may meet with material in places where such might be the least expected. For instance, let us examine the logs of Baltic or American timber as they come from the vessels. If the timber has remained for any length of time afloat before shipping, the logs are almost sure to have traces of Conferva, either fresh-water or marine, growing on them, and these, on being carefully scraped off, will, in all probability, yield diatoms to reward the collector. Some of the logs from the St. Lawrence or the Ottawa will yield us American forms, while logs from Dantzig will give us interesting gatherings from the Vistula and the interior of Poland.

Should a vessel be unloading "Kaurie spars," from New Zealand, or some of those gigantic "sticks" which have lately been imported from Vancouver's Island, we may, probably, be rewarded by finding beautiful Antipodean forms of Diatomaceæ on the former, and the exquisite *Arachnoidiscus* or *Triceratium Wilkesii* from the latter, perhaps even *Aulacodiscus Oregonus*.

Let us not go past these mahogany logs landing from Mexico or Honduras, as the case may be, without casting an eye over them, for these may have been rafted for some time in the sea before shipment, or may have brought down new or little known forms from the interior of Central America. Here, on the first log we examine, is a copious incrustation of a form, either identical with or closely allied to *Melosira nummuloides*, abundant likewise in our Docks. The gathering is so copious that it fairly glistens in the sun.

Let us also scrape away some of the shelly incrustation of *Balanus*, which completely covers some of the logs, for possibly among this we may find that exquisite American form *Terpsinœ musica*, so called, I suppose, from the costæ appearing like so many musical notes.

Here are some fishermen just coming in. Let us examine their nets, for these men are trawlers, and have been fishing in deep water, aud the meshes of their nets may still have diatoms bearing Algæ attached to them. On such Algæ we may probably find *Rhabdonema arcuatum* or *Adriaticum*, *Grammatophora serpentina* and *marina*, with species of parasitic *Synedras*; possibly the singular *Synedra undulata*, may reward our search.

Some of the oyster shells from deep water are worth examining for marine Algæ, or, what is even better, the greenish, leathery-looking ascidians attached to them. The ascidians are regular feeders on diatoms, and their stomach contents often yield a rich harvest of deep-water forms difficult to obtain in any other way. Perhaps we may be securing the rare *Biddulphia regina*, at any rate, *Bidd. Baileyii* and *aurita*. We will take some for future examination, for the curious *Rhizosolenia styliformis* is almost sure to be there.

Let us step into a boat and examine that ship's bottom and sides, which look so brown with a growth of conferva and barnacles. Here the spoon becomes of use. Scrape very gently where the deposit is the darkest in colour, and let us see what we have got—*Achnanthes longipes* and *brevipes* in abundance. These are common enough elsewhere in the timber ponds, so we will only secure the little thing in zig-zag filaments, for this is probably *Diatoma hyalinum*, or, perhaps, the rare *Hyalosira delicatula*.

Is it not singular that such delicate filaments, hanging together by the angles of the frustules, should be able to withstand the rushing of the vessel through the water during the long voyage she has just completed?

The ballast heap must not be passed without examining. Here are stones densely covered with marine Algæ and Corallines, which we will scrape off, and store away for after examination. *Biddulphia pulchella*, *Amphitetras*, *Grammatophora serpentina*, or possibly some of the beautiful foreign species of *Aulacodiscus*, may reward our trouble, for this ballast is brought from all parts of the world. The only matter of regret is the difficulty in ascertaining the exact localities.

Let us now take some of the *Zostera* which is being landed on the quay in large bales; it is extensively imported from the Baltic as *Alva marina*, for stuffing chairs and mattresses. *Cocconeïs scutellum* and *diaphana*, with *Epithemia* and a medley of other forms, are generally found parasitic on the *Zostera*, and may be easily separated by maceration in weak acid.

But what are those brown bundles landing from the steamer? These are "Dutch rushes," for coopers' purposes and chair-bottoms, and are well worth examining, for, growing as they do in brackish water in Holland, the sheath at the base is often completely coated with diatoms, *Coscinodiscus subtilis*, for instance, with other good things, such as *Eupodiscus argus* and *Triceratium favus*.

Nor must we pass these cargoes of bones discharging into lighters. See, some of the larger bones have evidently been lying in the water some time, for they are covered with a green incrustation. Let us scrape away the incrustation, for we may find among it the fine *Synedra crystallina* or *undulata*, together with valves of *Coscinodiscus* and *Eupodiscus*. Many good gatherings have been procured from this source, especially from cargoes coming from Constantinople, Smyrna, and the Black Sea.

Ask this sailor if he has any foreign shells still in the rough state; if he has any for sale, they are certainly worth securing for the small Algæ and Corallines found growing on them. These, on being cleaned, often yield splendid results. Many of the most beautiful and rare species of *Campylodiscus* have been obtained from this source. The Californian *Haliotus* shell is almost certain to yield the fine *Aulacodiscus Oregonus*, *Arachnoidiscus*, *Hyalodiscus cervinus*, and *Biddulphia Roperi;* while the *Haliotus* from New Zealand will probably furnish the rare *Aulacodiscus Beeveriœ* and *Macraeanus*.

The West Indian *Strombus* shells invariably yield beautiful forms, such as *Campylodiscus-ecclesianus*, *ambiguus*, and *imperialis*.

Vessels with guano are worth visiting. The Peruvian guano, when properly prepared, yields the magnificent *Asterolampras* and *Aulacodiscus scaber;* while the Bolivian is even richer in fine things, such as the superb *Aulacodiscus formosus* and *Comberi*. Californian guano yields, among an infinite variety of forms, many of great beauty and rarity, such as *Aulacodiscus margaritaceus* and *Biddulphia Tuomeyii*. Algoa Bay is frequently rich in *Aulacodiscus Petersii;* and, finally, the Ichaboe guano, *Eupodiscus Ehrenbergii*, and other good things.

The old mooring anchors and cables which are now lying on the quay are covered with a marine incrustation, which on examination will be found deserving of notice.

We will now take a stroll towards the timber ponds, where the timber often remains afloat for years. Here we see ample traces of the objects of our search. The sides of the logs seem quite covered with a tangled mass of the filamentous forms; but before we bottle up any of them, let us collect with the spoon some of the brown pellicle which covers the surface of the water. This proves to be a very pure gathering of *Amphiprora constricta*. Then let us collect some of the green *Ulva* and *Enteromorpha*, growing on the sides of the timber, which seems so brown and furry. With the Coddington lens we find the brown tint is owing to a dense parasitic growth of *Achnanthes longipes* and *brevipes*. The long brown filaments are principally *Melosira nummuloides* and *Borrerii*, with *Schizonema crucigerum* and *Dillwynii*, mixed with *Bacillaria paradoxa*, shooting into long filaments, then suddenly retreating until the filament is closed again, one frustule sliding past the other in a most marvellous manner. By the way, this species will live, and even thrive, quite well in perfectly fresh water. Mixed with the *Bacillaria,* we find *Nitzschia sigma,* and other free forms.

The wooden piers running out into the river are brown with a covering of *Homœocladia sigmoidea, Pinnularia Johnsonii,* and *Navicula ellipsis.* On another wooden breakwater we find *Pleurosigma scalprum* and *Navicula mutica.*

Leaving the immediate vicinity of the docks we come to a maze of ditches, to which the salt-water has access during spring tides, and these ditches are often very rich in Diatomaceæ. Let us commence operations here by collecting this brown covering from the mud. Here we have *Pleurosigma angulatum, Fasciola, Strigilis, Hippocampus, Nitzschia sigma,* and *Surirella gemma.* Such gatherings may afterwards be entirely cleaned from the mud by covering the outside of the bottle with black cloth, and letting it stand for some days in the sun. The diatoms by this time will have worked themselves to the surface, and the thick brown layer will be found quite free from impurities. This plan, if carefully carried out, rarely fails. The brown floating scum must by no means be neglected, for on bottling some we find we have secured a good gathering of *Pleurosigma Fasciola, macrum,* and *delicatulum,* with, perhaps, *Navicula ambigua,* and other good things.

Proceeding to another ditch, we will take a dip from the mass of brownish stuff which coats the weeds. Well, here indeed is a capital haul, for we have *Nitzschia bilobata, Brebissonii, vivax,* with *Tryblionella gracilis, Navicula amphisbæna, Pinnularia peregrina,* and *Cyprinus.*

Further on we pull out some of the weeds which are covered with brown furriness, and we have a gathering of *Synedra fulgens* and *Amphipleura Danica;* while on the mud we obtain a copious one of *Stauroneis salina, Nitzschia dubia β,* with *Navicula minutula.*

But what can this brown hair-like mass be, growing parasitically on the reeds and floating pieces of stick? On examination it will prove to be pure *Melosira Borrerii,* which we will bottle up with great satisfaction.

Further on we come to a large lagoon, and find therein some plants very promising in appearance, and well worth gathering. These yield us afterwards a fine mass of *Amphiprora alata* and *paludosa, Pleurosigma Strigilis, Amphora salina,* with *Surirella Brightwellii.*

Mind how you step over this boggy ground, with the ink-black mud, smelling so unpleasantly of sulphuretted hydrogen. In spite of the smell, we shall probably get something to reward us. Collect carefully the brown covering from the mud, and you may find *Navicula elegans, tumens, Nitzschia dubia,* *Epithemia musculus, Amphora affinis,* with *Pinnularia Cyprinus* and *peregrina.*

We now approach the banks of a canal, into which the brackish water sometimes gains access. Let us hook out some of the *Potamogeton* and other weeds. Well done, we have here something that will reward us for our fatigue. Examine it with the Coddington; the circular discs are valves of the rare *Cyclotella punctata.* Mixed with these we find *Campylodiscus cribrosus, Bacillaria paradoxa,* with a host of other both fresh and salt-water forms.

With the tweezers let us now carefully pull off some of the brown tufts growing on the clay banks of the river. This looks like some stunted Conferva. On examination with the lens, the filaments are found crowded with rows of little sigmoid things, for all the world like miniature specimens of *Pleurosigma Balticum.* This is a prize again, being no other than the rare *Colletonema eximium.*

Leaving this locality, let us proceed a few miles down the river towards its embouchure, and where the water is salter. Being low tide, we see for miles the mud is coloured of a dark chocolate-brown tint, owing to the presence of millions of *Navicula Jennerii.* In the large lagoon, formed by the salt-water getting over the embankment during spring tides, we shall probably find an abundance of good things; among these many of the filamentous *Schizonemas, Rhipidiphoras,* and *Podosphenias,* and even *Licmophora flabellata.* Proceeding even further down the river, the mud gradually disappears, sand takes its place, and afterwards we come to the open sea, where the coast is in places guarded by rocks. Here is a fine field for the purely marine forms. Let us gather some of the wiry green tufts of *Cladophora rupestris,* one of the best of the diatom-bearing Algæ. The tips of the *Cladophora* are quite brown with a parasitic growth of *Grammatophora marina* and *macilenta,* together with *Rhabdonema arcuatum, Cocconeis scutellum,* and *Gomphonema marina.* On the other Algæ, growing among the rocks, we find masses of *Podosphenia,* and perhaps the easily-overlooked *Hyalosira delicatula.* The brown hair-like mass floating about, but attached to the stones, is *Fragillaria striatula,* and some of the filamentous *Schizonemas.*

In the rocky pools left by the tide are some masses of *Corallina officinalis,* growing in dense tufts. This Algæ is an excellent diatom trap, collecting the floating frustules among its tangled branches. We must, therefore, select a good stock of the *Coralline,* lifting it out of the water with as little violence as possible, for fear of washing off the diatoms.

Washing afterwards in acidulated water will liberate the frustules, and then we have probably a fine gathering of the beautiful *Eupodiscus Ralfsii*, with *Eupodiscus subtilis;* perhaps also *Amphiprora lepidoptera*, and other good forms.

The sand in sheltered places, you will observe, is brown in the hollows of the ripple marks. This is caused by millions of diatomaceous frustules, and we must by all means take home a good store of the brown sand which by washing easily yields up its riches.

Having spent so much time on the marine and brackish water gatherings, let us turn inland and proceed where the tide ceases to have any influence. To make sure of this, we will take the rails and go to the rocky hills some ten miles distance. Having arrived there, let us examine, in the first place, this rocky streamlet, for I see traces of a brownish covering on the stones, and also some pretty long streamers. Lift the filaments out gently, or you will get little into the bottle. On examination at home you will probably detect *Odontidium mesodon*, *Himantidium undulatum*, and *Arcus*, with *Tabellaria fenestrata* and *flocculosa*.

Proceeding a little further, we come to a little waterfall trickling down the surface of the rock, and gradually finding its way to the stream. The brown, velvety covering on the stones looks very promising for our purpose, and if I mistake not, we shall be well rewarded for our trouble in carefully collecting a bottle full of the material, for we have a good gathering of the beautiful *Gomphonema geminatum* and *ventricosum* mixed with the minute *Achnanthidium lineare*. The brown mass completely covering the stones in the bed of the stream is *Cocconema lanceolatum*, not often found so pure.

Let us see what causes the green colour on the surface of the mud in the roadside puddle. Ah! this is indeed a treasure, for it is seldom that *Navicula cuspidata* occurs as perfectly free from mixtures. The green colour is also remarkable, being so different from the usual brown endochrome of most diatoms.

Here is another roadside puddle left by the recent rain, and see what a brown coating has grown at the bottom in so short a time. At any rate we have here *Diatomaceæ* in abundance, though small in size, probably *Nitzschia palea* and *Pinnularia pygmæa*.

Proceeding further inland we are supposed to be passing a water-mill, and as the mill race is covered with confervoid growths, let us examine some of the coating from the wooden aqueduct. The brown streamers are in all probability *Diatoma vulgare* and *elongatum*, and the beautiful stellate form is the local *Asterionella formosa*, which, by the way, seems to select its habitat always in some out of the way place, such as the present one in the mill aqueduct, water tanks, and reservoirs.

Having climbed up some distance on the hill sides, let us collect some of the weeds from the sides of the boggy pool, for in such localities we may expect to find some of the rarer alpine forms, *Navicula rhomboides, obtusa, Pinnularia divergens, lata,* and *Alpina,* for instance. The pale green flocculent mass growing in quantities like a conferva, is well worth collecting, for it is a pure gathering of *Tabellaria flocculosa* and *fenestrata.*

In tramping over this quaking bog it is well to roll up a bundle of the *Sphagnum,* for on afterwards squeezing out the water, we may be rewarded by finding some of the rarer species of *Pinnularia,* such as *Hemiptera* and *Alpina.*

Before leaving this rocky part of the country for the flat country below, let us scrape some of the brown mucus from the face of the dripping rocks, for it will probably yield such forms as *Epithemia, Cocconeis Thwaitsii, Navicula Trinodis, Denticula sinuata,* etc.

The weather being warm we will quench our thirst at the little spring in the cavern-like hollow in the rocky roadside. Observe, the roof of the little cavern is quite covered with a chocolate-brown mass, which feels rough and gritty to the fingers. Here is a splendid and pure gathering of *Orthosira arenaria,* and I recommend you to take a good store of it away with you, for it is seldom one finds this fine form so pure and unmixed.

Proceeding towards the low country let us take a scrape from the side of this horse-trough, for it is quite brown. It is well we have done so, for it is a nice pure gathering of *Cyclotella operculata* and *Pinnularia pygmæa.*

Passing a little further on we come to a clump of ash trees, with a crop of moss growing on their trunks. Perhaps you may smile when I proceed to peel off this moss and store it away in a bundle in my satchel. On washing the moss afterwards, however, I may be rewarded with some of our most local and rare species, viz. *Orthosira mirabilis,* mixed with *Navicula tumida, Pinnularia borealis,* and *Orthosira spinosa.*

Having secured a bundle of moss from the tree trunks, we will take another from the roof of this old thatched cottage, the north side of which is quite carpeted with beautiful green moss. This will probably yield *Nitzschia Amphioxys* and *Pinnularia borealis.*

The white-coloured stratum of earth exposed in the cutting on the roadside must now be examined, for it is probably a deposit of fossil, diatomaceous earth, in which case a large piece must be secured.

These fossil deposits are generally composed of a compact mass of Diatomaceæ of recent as well as extinct species. The deposit we are at present examining is several feet thick, and has at some remote period formed the bed of a lake, the diatoms accumulating at the bottom until the present thickness was attained. You will observe that the endochrome has been removed by long rotting, and the entire mass is now composed of the pure white siliceous valves. Pray also observe that this richness in silex suits the cereal crops growing over it, but does not seem to furnish much nutriment to the potatoes and turnips.

The adjacent peat beds may also be examined, for frequently rare Diatomaceæ are found in the turf which is cut for fuel.

The dark, hair-like mass growing on the woodwork of this sluice-gate, is a nice pure gathering of *Schizonema neglectum*, the frustules arranged in regular rows in the interior of the long filaments.

Before leaving this pond let us pull out a mass of the *Myriophyllum*, which seems rusty in colour. Well! here is a medley of forms, but the gathering is worth bottling up, owing to the abundance of *Amphipleura pellucida*.

The clear ditch by the roadside is a likely place for such forms as *Pleurosigma attenuatum*, *Spencerii* and *lacustre*, *Nitzschia linearis* and *tenuis*, *Surirella ovata*, *Navicula elliptica* and *Cymbella maculata*.

The yellow mass attached to plants a little further on is *Cyclotella operculata*, *Amphora ovalis* and *Nitzschia sigmoidea*, while the brown covering on the *Anacharis* is *Gomphonema tenellum*, *dichotomum* and *curvatum*. The stones in the running beck, issuing from the clear spring close by, are covered with long, yellowish-brown streamers, which are well worth collecting. Take them out very gently, for they are very fragile and likely to drop again into the water. The species is the beautiful *Meridion circulare*, with *Melosira varians*.

At the bubbling spring itself, which forms the head of the streamlet, the sand, which is tossed and heaved about by the ascending water, seems tinted of a brown colour. Let us secure some of the sand, when we shall find the brown colour is caused by a dense parasitic growth of *Odontidium Harrisonii* quite pure.

Further on the dark brown streamers must be collected, for here are two species of *Fragillaria*, *Capucina*, and *virescens*, mixed with *Diatoma elongatum*. The stones and aquatic plants are likewise covered with a dense brown coating of *Synedra radians*, and *Ulna*, species found in almost every clear water-ditch.

The boggy place where the plants are coated with a yellow coating of the oxide of iron, is not to be passed without collecting a little of the light flocculent surface mud. This will be almost sure to yield some fine diatoms, such as *Campylodis-*

S. Cobbold del.

Choroid, cornea, [illegible] &c.

cus spiralis, *Pinnularia nobilis*, *Stauroneis Phœnicenteron*, *Surirella splendida*, and *Cymatopleura solea*.

Here we must finish our day's work, having arrived at the railway station, from whence we proceed home with our treasures. The work of collecting has been finished, yet much remains to be done before the material is cleansed and mounted on slides for microscopical investigation.

Let us hope our fatigue has not been in vain, but that the store of riches we have collected together, will furnish us with ample material for much interesting study and instruction.

THE EYE OF THE COD-FISH.

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FROM the earliest periods of physiological inquiry, the organ of vision, especially in connection with man and the higher animals, has uninterruptedly occupied the attention of the anatomist, the physicist, and the philosopher; and yet, notwithstanding the instructive teachings of a most voluminous eye-literature, there remain difficulties to be solved both as regards the visual functions of the organ and the structural elements concerned in the production of its optical effects. In the view, therefore, of contributing something towards our knowledge of the histological peculiarities found to occur in the eye of fishes, I hereby propose to dwell more particularly on the existence of certain parasitic vegetations in the sclerotic coat, on the structure and functions of the so-called choroid gland, and on certain artificially-produced phenomena in connection with the cones of the retina.

Recent discoveries respecting the microscopical anatomy of the vertebrate eye have, in most instances, resulted from examinations of the eyeball after it has been immersed for a greater or lesser period in solutions of chromic acid. This method appears to have originated with Dr. Hannover, of Copenhagen, who published a series of papers on the subject in Müller's *Archiv*, during the year 1845. In 1851, Dr. Hannover came over to this country, bringing with him a number of preparations illustrative of his recorded views as to the structure of the vitreous humour in different orders of mammalia; and at a meeting of the Physiological Society of Edinburgh, I had an opportunity of examining them attentively. These choice preparations unequivocally demonstrated the correctness of the descriptions and figures given by Dr. Hannover; but I then pointed out, and subsequent investigations have confirmed the truth of my statements, that the assumed laminated character of the vitreous body had no real existence in nature, seeing that the laminæ only made their appearance after the eyeball had been steeped in a solution of chromic acid or some other coagulating agent.

During my antecedent investigations into the anatomy of the eye—the results of which were only partially recorded in my graduation Thesis, for which the Edinburgh Medical Faculty awarded me the University Gold Medal in 1851—I had followed out the indications initiated by Dr. Hannover, and had thus satisfied myself as to the danger of drawing hasty conclusions from the occurrence of appearances so palpably the result of chemical action; yet, at the same time, it should be acknowledged that the application of chromic acid solutions has materially assisted us in the determination of the relations and component parts of the retina, especially in the hands of Professor Kölliker and Heinrich Müller. Even here, however, as will be shown in the following pages, the true characters presented by the individual elements of the retina have been either changed or altogether obliterated; and as regards the vitreous body, the fallacy of supposing it to be made up of delicate membranous laminæ is evident from circumstances altogether independent of microscopical inquiry. Thus, if several punctures be made through the hyaloid covering of the vitreous mass in a recent condition, its fluid contents will rapidly escape, and all that we shall ultimately find left will be the external tunic and a few septa or membranous prolongations from the internal wall of the hyaloid, these together constituting scarcely a fiftieth part of the bulk of the entire vitreous body.

I may premise, also, in regard to the so-called *choroid gland*, that the anciently received opinion, supported by John Hunter, as to its muscularity, is still maintained by many at the present day; at least, they aver that this organ is in some way or other concerned in the adjustment of the crystalline lens and vitreous body to different focal distances. At a later period, Sömmering doubted whether it were glandular, vascular, or muscular; whilst Baron Cuvier, who supplied accurate descriptions of its ordinary appearance in various fishes, returned to the still older notion of Haller, that its structure partook more of the character of a gland. Subsequently, I believe, Cuvier took up with the opinion that the choroid gland was to be classed with erectile tissues, but with whom this idea originated I am not able to state. In later times, amongst others, Dr. Arthur Jacob, of Dublin, diligently applied himself to the solution of this question, but at the conclusion of his excellent article, "Eye," in Dr. Todd's *Cyclopædia of Anatomy and Physiology,* he simply observes:—"The organization of the part is certainly not merely vascular, as stated by Cuvier, and undoubtedly bears a stronger resemblance to muscular than any other structure; it also retains the peculiar colour of red muscle after all the rest of the eye has been blanched by continued maceration in water."

On recently consulting Leydig's *Lehrbuch der Histologie,* I was surprised not to find any description of the organ, in question, which is the more remarkable as the author has given a good account of the *processus falciformis* and *campanula Halleri.* It seems, therefore, that the now very generally received opinion as to the erectile character of the so-called choroid gland is still deemed worthy of credit, and further, that in virtue of its erectile properties, it is, to use Dr. Carpenter's words, "concerned in the adaptation of the eye for distinct vision at different distances." To me it appears that a due consideration of the facts and arguments which I shall immediately record, are sufficient to demonstrate the erroneousness of these views.

If the perfectly fresh eye of a full-grown cod be removed from its socket, three large vessels will be seen to enter or emerge from the sclerotic covering; namely, a vein passing out from within the optic sheath, an artery entering immediately behind the sheath, and a vein situated further back, at a little distance from the circumferential border of the tunic. If the loose cellular connective tissues be next dissected off from the sclerotic, the latter will be found to consist of three distinct layers; that is to say, of an outer and inner fibrous membrane which inclose between them the true cartilaginous coat. The first-mentioned layer consists of coarse fibrous tissue closely investing the cartilage, but the internal connective layer is delicate, transparent, and easily separable from the middle coat. A thin verticle section of the latter, or true sclerotic layer, displays, under the quarter-inch objective, a hyaline, ground-glass-like matrix, in which the characteristic cartilage cells are numerous, thickly set, and rather irregularly disposed.

In addition to these ordinary structural characters, it is not uncommon to find, especially in old fishes, milky-white patches partially or entirely embedded in the cartilaginous matrix, and they not unfrequently project considerably from the inner true sclerotic surface. These striking-looking patches vary in size from a pin's head to that of a threepenny-piece, and invariably present a more or less rounded, oval, or semicircular outline, the borders of which are usually cleft and lobed in so regular a manner that the entire mass frequently exhibits a curiously stellate appearance, such as is accurately represented in the accompanying plate (Fig. 1). It is probable that these bodies have been seen by observers in this country, as their contents are evidently referable to the so-called Psorospermiæ described by J. Müller, Creplin, Leydig, and others on the Continent. Some years ago they were brought under my notice by my friend Dr. Drummond, at Edinburgh, when we both endeavoured to ascertain their true character. As then demonstrated, and in accordance with my more recent examinations, the patches in question appear to form a sort of nidus for the lodgement, protection, and development of the minute cells which are found by myriads in their interior. These little bodies are evidently parasitic in their nature, and forcibly remind one of the so-called *pseudo-naviculæ* of *Gregarina*. I think that they are of a vegetable nature; this algous character being also, in my opinion, applicable to the somewhat similar parasitic cells described by Mr. Lubbock, F.R.S., in his valuable memoir "On the Ova and Pseudova of Insects," in the *Philosophical Transactions* for the year 1857. Be this as it may, I have further to remark, that in specimens recently subjected to microscopic analysis, the cellules measured about the 1-4000th of an inch in their longest diameter, and they presented an oval figure, being at the same time slightly pointed at either extremity (Fig. 2). The cell-wall itself is double; but by far the most striking peculiarity consists in the universal presence of two bright, highly refracting nuclei, usually located side by side at one end of the cell cavity. They also exhibit a pale yellow colour, due apparently to a clear fluid surrounding the nuclei. In no instance have I observed any metamorphotic appearances, neither have I seen any altered condition of the cells, such as might indicate an earlier or later stage of growth. On the addition of caustic potass the colour of the cellules quickly disappeared, and they performed a series of peculiar jerking movements, due, it would seem, to the bursting of the outer cell-wall; a little sarcode matter appeared to make its escape, but the oval form of the cells remained unaffected.

Between the internal separable layer of the sclerotic coat and the *marsupium* of the choroid there exists a clear albuminous fluid, which, in the perfectly fresh condition of the eye, is entirely free from blood corpuscles, sarcode globules, and other particles; but this fluid is not uniformly disposed between the two membranes, because at certain spots, and especially in the neighbourhood of the optic nerve, the marsupium is intimately blended with the inner sclerotic layer above mentioned. The fibrous marsupium itself is in great part made up of, or rather contains, numerous cylindrical rods, which offer a decidedly inorganic crystalline aspect, but which do not consist of carbonate of lime. The Neapolitan naturalist, Delle Chiaje, designated them eye-stones, and I have represented a few in the upper part of Fig. 3. When I added acetic acid there was neither effervescence nor disintegration, although, on the other hand, the application of strong caustic potass gradually caused their dissolution. Between the marsupium and the vascular layers of the choroid there exists a fibrous membrane coated with yellow-brown pigment cells, the latter being characteristic of the *lamina fusca* of authors. These coloured cells, shown in Fig. 4, are somewhat irregular both in form and size, and contrast strongly with the true black pigment cells, which are much larger and particularly abundant at the ciliary margin of the choroid. One of the latter and two sarcode globules are represented in the lower part of Fig. 3, magnified about two hundred diameters linear.

The vascular choroid itself consists of two distinct layers, the outer one constituting the true choroid, and the inner being the so-called *tunica*, or *membrana Ruyschiana*, which is partly separated from the former by the intervention of a non-vascular fibrous membrane, containing neither nuclei nor granules. The choroid proper consists of vessels united by connective tissue, the latter element being particularly abundant in the neighbourhood of the vascular trunks before they suddenly divide to form the so-called choroid gland; the inner layer, or *membrana Ruyschiana*, is comparatively thin, becoming intimately blended with the former as it approaches the ciliary circle. To the naked eye the choroid gland of the cod invariably displays the figure of an irregularly horseshoe-shaped band, the incomplete portion of the band occupying the anterior aspect of the eyeball in relation to the longitudinal axis of the fish. In some instances the continuity of the band is interrupted at two or more distinct places, but in this case the lineal arrangement of the independent segments combines to produce the characteristic form above described.

If in another fresh eye of the cod fine injections of vermilion and artificially prepared ultramarine be severally thrown into the vein emerging from the optic sheath and the artery entering the sclerotic immediately behind the latter, both injections, if not too violently forced from the syringe, will be found to have filled the trunks of the choroidal arteries and veins as far as the inner margin of the band; and if, thereafter, the eyeball is laid open by a clean tranverse cut from before backwards, the true choroid being also carefully isolated from all the other membranes, the operator will probably be rewarded for his trouble by the production of a preparation of the posterior half of the choroid very similar to the one depicted in the accompanying plate (Fig. 5). The illustration, however, represents the parts enlarged to twice their natural diameter, the minuteness of the vessels not permitting a clear picture of their disposition had they been drawn of the natural size. In the several instances in which I have thus treated the eye, I have never found the colours to pass into the vascular continuation of the true choroid beyond the band, neither into the band itself, nor even, so far as I can remember, into the *membrana Ruyschiana;* and thus it is seen that naked-eye experiences taken by themselves are calculated to convey the idea of the non-vascularity of the so-called gland. By a series of careful microscopic investigations, however, I have satisfied myself as to the inaccuracy of this inference, and I therefore now proceed to show what is the true character of the structure in question.

If a thin vertical or horizontal section be removed from the choroid band, and placed under a quarter-inch objective, the smaller arterial and venous branches will be seen to divide suddenly into multitudes of minute capillaries, the latter taking their origin at a point precisely corresponding with the clearly-defined line of limitation indicated by the stoppage of the artificially-introduced pigments. These small vessels are closely connected to one another by their own walls, and not by the intervention or extension of any fibres from the connective elements of the choroid. They are all arranged in a simple, linear, parallel manner, and their width does not appear to exceed that of the short diameter of the blood corpuscles, the admeasurements of the latter being about the 1-2500th of an inch long, and the 1-3500th of an inch in breadth. In fresh eyes the capillaries are always found gorged with blood, and when I recently succeeded in isolating, more or less completely, a few of the vessels of the band, one of them was seen to contain blood corpuscles arranged in single file. As shown in the accompanying diagram (Fig. 6), the capillaries are straight and of uniform diameter throughout; moreover, they do not give off any branches or dilatations such as are found to occur in the true erectile structures.

From beneath the external border of the horseshoe-shaped band the outer vascular choroid is supplied with numerous vessels, which for the most part proceed in a radiating manner to the circumferential border of the choroidal membrane. These vessels are obviously a continuation of the reunited capillaries of the band, but their mode of origin is not so easily seen at the outer as at the inner border of the band. As previously remarked, a simple fibrous layer is interposed between the choroid proper and the *membrana Ruyschiana,* the latter being also lined internally by another non-vascular membrane, which is entirely destitute of fibres (Fig. 7). This membrane is applied against the baccillary layer of the retina, and consists of a delicate membrane almost entirely made up of minute, closely-aggregated granules.

Turning now to the consideration of the retina, I may, in the first place, observe that it is well-nigh impossible to obtain a thin vertical section of this membrane, unless the eyeball has been previously immersed in a strong acid solution; at least this is the case with the posterior division commonly described as Jacob's membrane. Very soon after death, the relations of the delicate and complex elements of this structure are lost by disintegration, but a careful examination of the broken-up tissues themselves affords a clearer insight into their true histological character than can possibly be obtained from the artificially consolidated section. Whilst the latter method, therefore, demonstrates the actual relations of the component tissues of the organ, the former conveys a truthful conception of the nature of these elementary particles.

Under ordinary circumstances, when a small portion of the retina of the cod is subjected to microscopic examination, with the one-fourth or one-fifth objective, all that we see is a more or less confused mass of semi-transparent tissues, in which, however, the following elements may be distinctly recognized: a fibrous matrix inclosing oval nuclei, dense layers of granules, nerve filaments with or without ganglionic enlargements (Fig. 8); rod-like fragments which are portions of the well-known *baccillæ* variously twisted, and frequently tapering to a narrow point at one end (Fig. 9); and large oval corpuscular bodies which are neither more nor less than the so-called *cones*, whose character varies considerably in different members of the vertebrata. If the eye be not perfectly fresh, the cones display the utmost irregularity of outline, some being cylindrical, some club-shaped (Fig. 10); many of them split up longitudinally (Fig. 11), and showing a central cavity (Fig. 12); a few perfectly spherical (Fig. 13), and others oval (Fig. 14), in which case the contents of the corpuscles are usually confined within a second investing membrane, the latter being more or less widely separated from the outer covering.

These appearances, though in part abnormal, are not altogether uninstructive; but when the retina of a fish more recently killed is examined, it will then be seen that all the foregoing illustrations represent only the separated halves of the cones which are double in the cod (Fig. 15) and its allies, as indeed has also been shown to obtain in the perch by the researches of Kölliker and H. Müller. Although the twin-cone last referred to does not exhibit the true normal condition of these corpuscles, yet, before going further, I may here remark that these various demonstrations seem to prove the cones to possess a double envelope, the inner one inclosing a dense mass of extremely fine molecules, agglutinated together by an albuminous fluid, which becomes gradually less dense towards the centre of the corpuscular cavity. The half-cone may, therefore, not inaptly be compared to an ovum in which the chorion, yelk-membrane, and granular yelk respectively occupy the same relative position as the parts just described. Such are the appearances ordinarily found on examining the retina of the cod, a small appendage being occasionally visible at one end of the cone (as shown in Fig. 10), which, however, drops off immediately any floating particles strike against it. In the case of the twin-cone (Fig. 15) here represented, there were two appendages adherent, both of which I saw detached in the manner just indicated. Mr. Nunneley, of Leeds, who describes the appendage in question as "the conical leg" of the cone, has noticed similar changes to "occur within a very short time after death;" but notwithstanding the extent of his recent and valuable researches on the retina, the antecedent phenomena which I am now about to detail do not appear to have come under his observation. My attention was first called to a special examination of these cone structures in the cod at a meeting of the Brighton Microscopical Society, held in the evening of the 6th of December last, and as I derived great assistance from the distinguished members of that society who were present, I think it right to allude to the particular circumstances under which certain observations, preceding those I have just recorded, were made; and in doing this I shall describe the mode of occurrence of a series of phenomena in connection with the cones, which I have subsequently and independently confirmed. I had taken with me to the meeting a perfectly fresh cod's eye, with the view more particularly of re-examining the choroid gland under Mr. Hennah's powerful "Smith and Beck" microscope, which is fitted with Wenham's binocular arrangement. After examining the choroid band, without, however, obtaining any other results than such as I had previously acquired from my own instrument (by Ross), I placed a portion of the retina under the one-fifth objective, when the following facts were elicited:—Conspicuous beyond any other histological element were numerous oval corpuscular bodies, or perfect twin-cones, all of which were slightly truncated at either extremity, symmetrical in form, and divided longitudinally by a straight line passing in the middle line from pole to pole (Fig. 16). All of them in the first demonstration exhibited these characters. Following Mr. Hennah's advice, I had in this demonstration only added to the slide a little of the albuminous fluid, which is naturally present in the eyeball, but when this medium was supplanted by the addition of a drop or two of clear, cold, hard water, the effect at once produced upon the corpuscles was as remarkable as it was unexpected. The cones now displayed a series of curious phenomena; all of them began to alter in form, the two halves partly separating from one another, whilst each half at the same time gradually assumed a more or less completely oval outline. Usually the upper poles of the twin-corpuscles retained somewhat of their normally truncated figure, and at this end they appeared broader than at the other. Contemporaneously with these changes, the borders of a clear transparent membrane connecting the two halves of the cone became visible, and there also appeared two minute globular vesicles, one at either lower pole of each half of the cone. These seemed to be formed by the outward extension of the external investing envelope, and they invariably occupied the position indicated in the accompanying drawing (Fig. 17). These saccular appendages, gradually increasing in size, were evidently not the result of mere endosmosis, inasmuch as there appeared within them distinct evidences of another structure, which to all present appeared to be a filament spirally folded upon itself. This coil continued to unroll and extend itself until at length the globular sac assumed the condition of a cylindrical tube, the enclosed filament at the same time losing its essentially spiral aspect (Fig. 18). Many of the cones had by this time separated more or less completely into their characteristic halves, and the delicate outer membranes surrounding the partially uncoiled filaments subsequently disappeared (Fig. 19). No further changes affecting this latter structure, were observed that evening, but during my examinations of another fresh eye, made next day with Mr. Murray's "Oberhaüser" microscope, I saw one example of the half-cone, in which the filament had unrolled itself to the fullest extent of which it appeared capable (Fig. 20). In addition to the above particulars, I have further to remark that when acetic acid is added to these cones, they immediately lose their normally plastic character, becoming brittle, less regular in outline, and refract light more powerfully. Caustic potass, on the other hand, gradually dissolves them. Finally, it remains for me to state that the twin-cones of the cod, in their unaltered condition, present an average measurement of 1-500th of an inch in length by about 1-800th of an inch in breadth. On the addition of water they attain a length of 1-400th, but some normal cones which I have since examined measured only the 1-650th of an inch longitudinally.

It has occurred to me as possible that some might consider the filament shown in Fig. 20 to be referable to the class of structures known as the radial filaments of Müller, which are said to be normally connected to the upper end of the cones. Such an interpretation, however, I do not think probable, although it must be confessed that the filament in question bears a very considerable resemblance to the radial filaments attached to the similar twin-cones of the perch as represented by Kölliker and H. Müller in Ecker and R. Wagner's beautiful *Icones Physiologicæ*, plate 19, fig. 13. In support of my opinion, however, that the protruded filaments I have described are neither more nor less than the so-called baccillary prolongations (Zapfenstäbchen) from the outer, choroidal, or lower ends of the cones, I may observe that even in the human retina the true baccilli of the cones have been seen expanded at their free ends, whilst the radial filaments in the perch do not immediately proceed from the cones, but are connected thereto by the intercalation of nucleated corpuscles (Zapfenkörner) placed at the upper pole of the cones. Whatever interpretation be eventually put upon the phenomena I have here recorded, those members of the Brighton Microscopical Society who were present on the occasion to which I have referred, will bear me out as to the occurrence of many of the changes above described, and I consider myself particularly fortunate in having been assisted in the determination of these facts by Dr. William Addison, F.R.S., F.L.S., Mr. J. Jardine Murray, F.R.C.S.E., Dr. Hallifax, Mr. D'Alquin, and especially also by Mr. Hennah, whose skilful manipulations are so well known to microscopists. Let me add, in conclusion, that after a due consideration of the foregoing particulars, associated with many data previously known to science, as well as other personal experiences not here recorded, I think the following deductions may be legitimately drawn and placed on record.

1. That the occurrence of opaque, white, stellate, circular patches in the sclerotic of the cod is almost invariable in old and tolerably full-grown examples of this fish, and that their contents resemble the so-called pseudo-naviculæ of *Gregarinæ*. They are, in point of fact, tailless *Psorospermiæ*, and therefore, also perhaps, non-ciliated zoospoores, whose genetic relations with *Gregarinæ* are not clearly made out. In my opinion the *Psorospermiæ* are referable to the lowest forms of vegetable life, and should be transferred from the *Protozoa* to the *Chlorospores*, or *Confervoids;* or, to speak more precisely, they should come somewhere between the *Palmellaceæ* and *Desmidiaceæ*.

2. The so-called choroid gland of the cod and other osseous fishes, is neither glandular, muscular, nor erectile, but is a specialized vascular plexus of capillaries. It is in no way connected with the adaptation of the humours of the eye to varying focal distances, but is probably intended to modify the circulation of the blood in a situation where, from the proximity of the heart, a strong impulse would interfere with the reflection of a correct image from the choroid. In cartilaginous

fishes, where no choroid gland exists, other anatomical arrangements appear to subserve the same purpose.

3. The phenomena above described in connection with the twin-cones of the cod show that the baccillary prolongations (Zapfenstäbchen) are not persistently formed appendages, as hitherto supposed, but they are filaments capable of protrusion from the cones on the application of certain stimuli. The cones themselves are to be regarded as special tactile bodies, destined to receive and convey to the true nervous elements of the retina, pencils of light reflected from the choroid. They are analogous, therefore, to the ordinary Pacinian corpuscles of the skin, which they resemble in many respects, and each cone may not inaptly be compared, in a functional sense, to a single ocellus in the compound eye of an insect. The vertebrate ocelli, so to speak, are arranged on a convex expansion of the optic nerve, with their visual planes directed inwards, whilst in the compound eye of invertebrates the ocelli are directed outwards.

THE VOYAGE OF AGUIRRE IN SEARCH OF EL DORADO.*

No picture of the sixteenth century would be complete unless it recorded the remarkable adventures of the Spaniards in search of the marvellous treasures which the American Continent was presumed to contain. Nowhere else do we find such a strange combination of credulity, superstition, avarice, chivalry, and ruffianism, as was exhibited by the various bands of marauders who went in search of the famous El Dorado, the imaginary region of exhaustless wealth.

After plundering the flourishing states of Mexico, Bogotá, and Peru, the madness for gain was increased, and instead of availing themselves of the boundless opportunities for the exercise of industry, which the new countries presented, the attention of the adventurers was turned to the interior of the continent, where golden cities were supposed to be concealed by the vast primeval forests which separated them from the common world. Among the local facts and customs which served as the basis for the wildest fables, it appears that the chief of Guatavitá made a solemn sacrifice once a year, and to

* *The Expedition of Pedro de Ursua and Lope de Aguirre in Search of El Dorado and Omagua,* in 1560—1, translated from Fray Pedro Simon's *Sixth Historical Notice of the Conquest of Tierra Firme,* by Wm. Bollaert, Esq., F.R.G.S., Corresponding Member of the University of Chile, Member of the Ethnological Society of New York, with an Introduction, by Clements R. Markham, Esq. London: printed for the Hakluyt Society.

fit himself for this importaut ceremony, he smeared his body with turpentine, and then rolled in gold dust, which caused the precious metal to adhere. In this condition he went upon a raft, in company with his chief nobles, and when the centre of a lake (Guatavitá) was reached, he made an offering of precious stones, and then jumped in to bathe. These proceedings were supposed to propitiate the aquatic deity of the place—the miraculous Cacica—who, having been thrown into the lake by a quarrelsome husband, was believed to dwell in a delicious retreat beneath its waters, in company with her daughter, whose favour the worshipper likewise invoked. In his learned work* on the antiquities of these countries, Mr. Bollaert informs us that "the principal places of adoration of the Chibchas were lakes, where they could make offerings of the most precious things, without fear of others profiting by them; for although they had confidence in their priests, and knew that they carefully buried the offerings in the vases destined to receive them, they were naturally more secure when they threw those objects themselves into lakes and rivers." The same writer tells us that the Geques, or Chibcha priests, were taught, during an initiation of twelve years, the computation of time and other traditional learning, which has been lost through the savage persecutions to which the bigoted Spaniards exposed the ministers of a superstition scarcely grosser than their own most deplorably perverted faith.

The origin of Mexican civilization will remain a puzzle for future ethnologists and antiquarians to unriddle, if they can; but in any speculations of this nature we must not be too easily induced by analogies to imagine that it was copied from other countries, as large allowance should be made for the operation of the law, under which, similarity of condition, tends to produce similarity of habits and opinions amongst races the most remote. Whatever may have been the early history of the people of Mexico, Bogotá, and Peru, they were found by the Spaniards in a state of society peculiarly calculated to stimulate their adventurous and avaricious propensities. The love of the marvellous, the desire to acquire wealth without the monotony of daily toil, together with boundless opportunities for personal distinction, all conspired to make the New World a favourite field for the exertion of restless spirits, and as its unfortunate inhabitants were heathens who resisted conversion, they might be robbed and murdered with the sanction of the Church. It was while these feelings were in their full strength that a Captain Pedro de Ursua, having been duly authorized by the powers of

* *Antiquarian, Ethnological, and other Researches in New Granada, Ecuador, Peru, and Chile, with Observations on the Pre-Incarial, Incarial, and other Monuments of Peruvian Nations*, by Wm. Bollaert, F.R.G.S. Trübner and Co.

the State, left Peru in search of certain countries, of which some Brazilian Indians had given a tempting description. After various difficulties and dangers, he made his way from Lima to a spot on the Amazon, in the interior of the continent, and rather less than half way towards the mouth of the gigantic river. The young knight, who was accompanied by a beautiful lady, the Doña Inez de Atienza, appears to have conducted his operations with considerable skill. He was a brave and accomplished soldier, but far too mild a commander for the turbulent marauders he had undertaken to lead. Such an expedition, in imperfect vessels, through an unknown country, could not be devoid of hardships, and as these were encountered, mutinous feelings, which had manifested themselves from the beginning, gathered increasing strength, until, on the 1st January, 1561, Ursua and his lieutenant were murdered, and one Don Fernando chosen as chief, while Aguirre was appointed "master of the camp." The new commander commenced his administration by calling a council, at which he proposed that all the officers should sign a document incriminating Ursua, and representing his assassination as a necessary act done in a spirit of loyal obedience to the King of Spain. By this trick, Fernando hoped to secure the favour of his sovereign as well as the profit of the anticipated discovery of the golden lands. Such a scheme might have succeeded with villains of the common sort, but the new camp master was a monster of a different stamp, and with the reckless daring of unblushing infamy, he signed himself the "Traitor Aguirre," and ridiculed the idea of employing deceit. From this moment he became the real leader of the expedition, and from time to time he kept up his *prestige* by a series of revolting murders and atrocities, which are very wearisome and disgusting reading in Father Simon's memoirs. Of course, Don Fernando did not escape from so dangerous a rival, and not even the beauty and sorrows of Doña Inez could preserve her life from this tiger chief. As a career of crime, that of Agüirre is most extraordinary, and it gives us no little insight into the character of the kind of persons who joined these adventures, to find that such a mad monster should have been able to retain his command. It is not our intention to follow his guilty steps; but it may afford some consolation to know that both he and his principal followers were finally disposed of in pursuance of the decrees of the King of Spain.

In a geographical point of view, the voyage of Aguirre has been invested with a fictitious importance by a theory which Mr. Markham espouses, and according to which he managed to pass from the Amazon to the Orinoco by way of the Rio Negro and the Cassiquiare Canal. Humboldt, who was acquainted with Simon's book, assigned to him a much more probable route, and supposes that he simply sailed down the Amazon, and then followed the line of the coast to the N.-W. till he reached Margarita, a little beyond Trinidad. Mr. Markham goes so far as to represent the Rio Negro track as the one which is sanctioned by Simon's narrative. Such a conclusion does not, however, seem warranted by the text, and it would have been more prudent, if Mr. Markham had avoided committing himself to what will probably prove an untenable theory, not sustained by a single indubitable fact. We do not discover in Mr. Bollaert's portion of the volume before us any indications of his supporting the more improbable view.

THE NEW TEMPLE OF INDUSTRY.

BY JOHN HOLLINGSHEAD.

If the building raised at South Kensington for the Second Great International Exhibition had not been practically the work of a not over modest department of the State, it is possible that it might have been quietly accepted as one of those costly makeshifts for which, as a nation, we are rather famous. A few keen critics would doubtless have questioned the claim of its designer to be immortalized as a constructive genius; a few imaginative architects, who love to turn all our black riverside wharves into marble palaces on paper, and dream of reviving the glories of ancient Babylon at Holborn Hill, would have shown us pretty fancy chromo-lithographs of what it might have been, while the majority of practical exhibitors would have been satisfied with it as a shed that had the merit of being water-tight and sun-proof.

The building designed by Captain Fowke, however, can claim no pity on account of its parentage. It springs from the very centre of a school which aspires to teach the true principles of designing art to an ignorant and benighted country. From the days when Marlborough House schoolmasters lectured us upon our barbarously-coloured carpets, designed shirts, and shaped wine-glasses, to this present period, when the South Kensington Museum gets two hundred thousand pounds at a time from a not very flourishing exchequer to enable it to teach its doctrines, we have been loudly told where to go to if we want to improve our taste. We have been carefully directed to the one existing college whose professors believe they possess the only true eye for harmony of form and colour, and whose missionaries, duly primed at head-quarters, are actively teaching South Kensington art throughout the country in local schools of design. This is not an organization to be treated tenderly because of its weakness or retiring disposition, and what it builds must be taken as the realization of what it teaches. The structure prepared for the forthcoming International Exhibition is not so much the production of one man as of a clique, a school, and a system; and it affords us but a poor prospect of getting educational value for our money.

The first view of the building, approaching it from the Brompton Road, is disappointing and depressing. Never, perhaps, was so much thoroughly commonplace bulk put upon a given quantity of earth at one time. The factory-looking clerestory windows of the eastern transepts have an appearance of unutterable meanness; the long, dull line of the Cromwell Road, or southern front, overshadowed as it is by a row of unlet stuccoed mansions, looks like an ordinary carriage repository. The eastern dome, the first object prominently seen from this point, looks like a huge balloon that has fallen amongst the trees of the "Boiler" gardens; and the entrance under this disproportionate cupola is built much in the bygone bare style of a country dissenting chapel. A whole chapter might be written about these huge, misplaced domes, which have sucked up sixty thousand pounds sterling, or nearly one-third of the money guaranteed at the outset for the cost of the building. The lines of the sash-bars do not correspond in their curves with the iron ribs, and the result is that the panes of glass appear to be broken through by the iron-work towards the apex. The domes, though built of the lightest material, have a solid, earthy, heavy effect, because of their size and the lowness of their elevation. They are the largest structures of the kind ever executed, being one hundred and sixty feet in external diameter. The dome of St. Peter's is one hundred and fifty-seven feet and a half in diameter, and that of St. Paul's one hundred and twelve feet; so that, putting it arithmetically, Captain Fowke is a greater architect than either Bramanti, Michael Angelo, or Wren. Fortunately for the reputation of the old designers, the cross of St. Peter's stands four hundred and thirty-four feet, and that of St Paul's three hundred and forty feet above the pavement; while the gilded finials of Captain Fowke's structure are only two hundred and sixty feet above the ground. The domes of the two great cathedrals press upon buildings whose proportions are able to bear them without apparent effort; but Captain Fowke's swollen cupolas seem to crush the slight wooden framework on which they appear to stand. The South Kensington architect has certainly broken the flat monotony of his eastern and western fronts by these hollow mockeries, but at a cost of life and money far beyond what the effect is worth. The southern front gets no pictorial advantage from these overgrown monsters, being too far removed from them; and this is, oddly enough, alluded to as a merit in the general design. A great central dome over the southern courts (which will certainly never now be built) was intended to relieve the flatness of the southern front, and therefore the effect of the two existing domes in combination is confined to the Horticultural Gardens. As these grounds are now little more than a back garden to the Exhibition, it is only fair that they should have some compensating prospects, and from no point can Captain Fowke's building be seen in a more favourable light. Even here the disproportion of the domes still stands prominently forth, and they must be classed as twin monsters with the two water-towers at Sydenham.

Inside the building, the same harmony of proportion is felt to be sadly wanting, with the single exception of the British and foreign picture-galleries. The southern courts—called the open or glass courts—are light and spacious; but from the dwarfed height of the side-walls they have a depressing appearance of flatness. In design they are nothing more than a repetition of the Birmingham Railway Station, with this difference, that the latter has a noble span four times as great as that of these courts. The nave, which divides the building into two unequal halves lengthways, runs from one dome to the other; and its style, when we look at the meanly-glazed, commonplace, workshop clerestory windows, can hardly be called by any other name than factory-Gothic. The transepts, which run along the whole length of the eastern and western fronts (being intersected, of course, by the dome columns), are designed in the same style, and are surrounded, like the nave, with broad galleries. The spaces under these galleries must be more or less dark, as the flooring above is necessarily laid down dust-tight. The northern courts—a smaller repetition of the southern open or glass courts—are shut in by the brick wall of the refreshment-rooms, and as several windows and doors have been knocked in this wall to light and give access to the premises taken at a heavy rental by the food contractors, the eye is offended by what looks like a row of common irregularly-built houses. One or two of the staircases leading up to the galleries are also out of keeping with the rest of the building, having balustrades such as are generally found in small villas at Dalston. The two annexes—western and eastern—which sprout out from the main building, running along the sides of the Horticultural Gardens towards the Kensington Road, are lightly and inexpensively built, and having no avowed pretensions to architectural effect, promise to be the most pleasing parts of the structure.

The main picture-galleries, before alluded to, which occupy the upper part of the southern, or Cromwell Road front, are substantially built, as in all probability they will become the property of the Society of Arts. The proportions here are noble and harmonious, and the plan of lighting from the top gives large wall-space, and a light free from glitter. It is upon these galleries, and the other "permanent portions" of the building, that the Commissioners are bound to spend fifty thousand pounds in architectural improvements, under contract with their landlords, the Commissioners of the former Exhibition. Twenty thousand pounds of this amount are already expended, and the outlay of the other thirty thousand is made contingent on the realization of a surplus.

The decoration of the building was taken out of the hands of the South Kensington art teachers, and given to Mr. Crace. In the nave the roof is coloured a warm grey, with upright scroll ornaments in maroon red, rising from the sides to the apex of the roof, the ridge of which is strongly defined by a chevrony in black and white. The main arches are coloured a warm brown, with panellings of blue and red, relieved with light lines and ornaments, and separated by medallions of black, on which are gold stars. On the crown of each arch are inscribed the names of the principal countries and towns contributing to the Exhibition. To avoid the succession of repeated lines of the same colour, variety is produced by alternating the colourings. The edges of the arched ribs, which are in three thicknesses, are defined by springs of black and white in the outer, and red in the centre thickness. The iron columns supporting the roof are painted a pale bronze colour, relieved with light coloured vertical lines, and having the capitals painted red and blue alternately, the raised ornaments being richly gilt. The iron ornamental gallery railings are also painted bronze, relieved with gilding. The two domes are decorated in a very effective manner. The twelve main ribs are painted red and gold, bordered with black and white, and relieved with gilt stars on small lozenges of blue. The top centres of the domes are painted blue, with gold rays, and are bordered with red and gold. The broad frieze running round the springing is painted blue, with an inscription in bold gold letters, and the cornice above is principally in red and gold colour. The walls above the arches under the frieze are richly ornamented in red panelling. In the four smaller compartments are Europe, Asia, Africa, and America; and in the spandrils of the large arches are medallions containing figures representing Arts, Sciences, and Manufactures. The walls at the ends of the nave and transepts are also richly ornamented and inscribed with appropriate legends.

The picture-galleries have their walls painted a sage green as a background for the pictures, and the cove is tinted to correspond, the cornices and soffits being vellum-colour, relieved with maroon lines and ornaments. The wall round the arches is also ornamented, but the general decoration of these galleries was obliged to be curtailed, from the necessity of their being used for the arrangement of the pictures.

The Commissioners for the Exhibition of 1851, as before stated, are the legal proprietors of the site on which this building is raised—the ground having been bought out of the surplus (about one hundred and eighty-six thousand pounds) arising from the first Great International Exhibition. The investment of that sum in South Kensington land has proved so fortunate, that the old Commissioners, by making roads, letting ground on building leases, and their arrangement with the Horticultural Society, must certainly have doubled their capital.

To secure the greater portion of this remaining site for a third proposed Exhibition in 1872, they have agreed to reserve about sixteen acres of it for that purpose on receiving ten thousand pounds by way of ground-rent. It is already agreed that a lease shall be granted to the Society of Arts of the central portion of the picture-gallery, one acre in extent, along the Cromwell Road, for ninety-nine years, on condition that ground-rent to the amount of two hundred and forty pounds per annum be paid to them, and that the building be given up unreservedly for the use of the Exhibition in 1872.

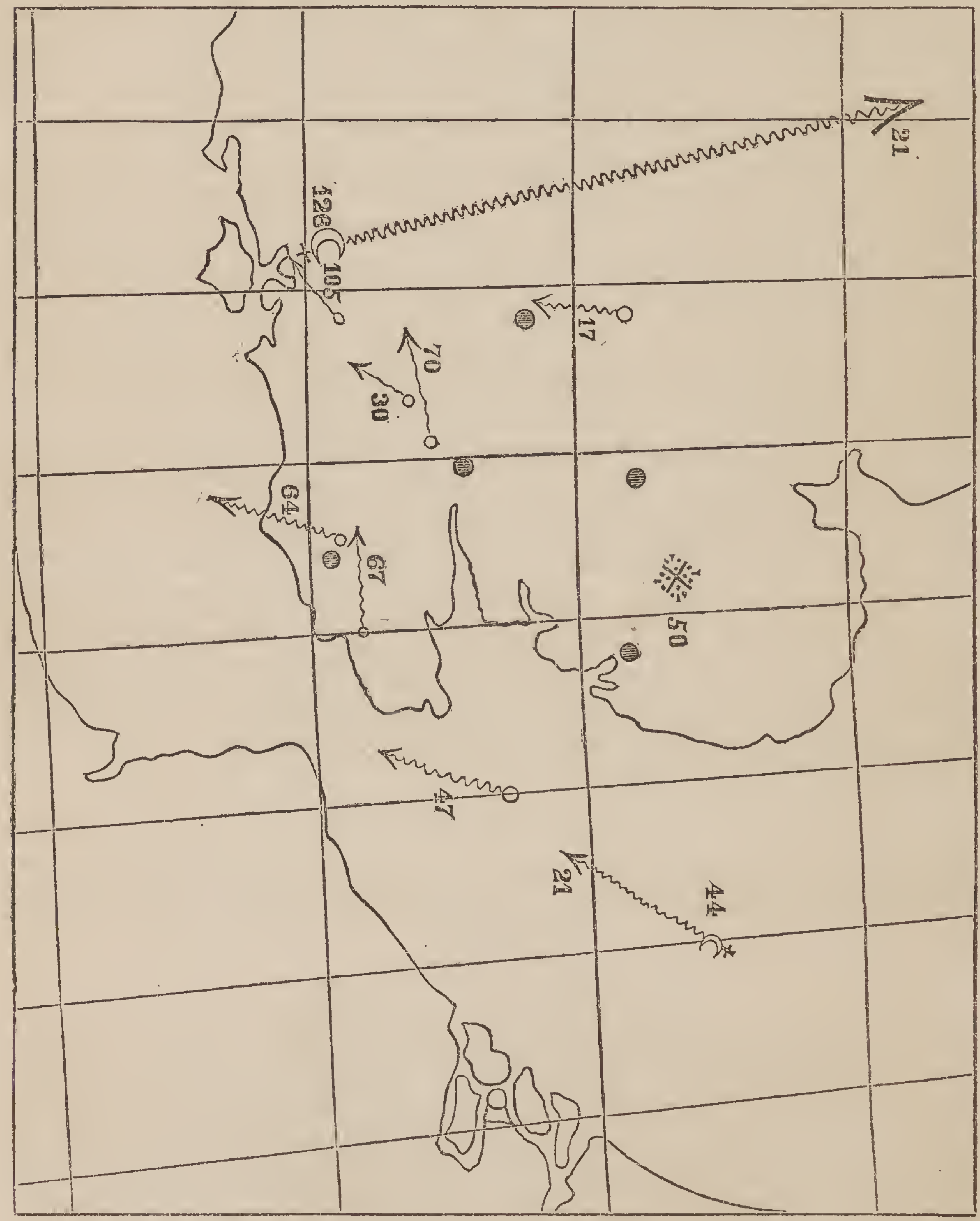
The work of building this new temple of industry was given to Messrs. Kelk and Lucas, under an arrangement with the Commissioners of 1862 that is very like a partnership. The whole responsibility for the execution of the works rested with the contractors, and the amount they are to receive is contingent on the receipts of the Exhibition. The Commissioners have the option of purchasing the building out and out, or of merely paying for the use of it. For the rent of the building a sum of two hundred thousand pounds is guaranteed absolutely; if the receipts exceed four hundred thousand pounds, the contractors are to be paid one hundred thousand pounds more for rent, and if the sum is fully paid, then the centre acre of the great picture-galleries is to be left as the property of the Society of Arts. The contractors are also bound, if required, to sell the whole for a further sum of one hundred and thirty thousand pounds, thus making its total cost four hundred and thirty thousand pounds. Captain Fowke's original design, with the great hall and central dome, was estimated to cost five hundred and ninety thousand pounds. This hall was to have been placed immediately behind the middle entrance of the south front, and was to have been five hundred feet long, two hundred and fifty feet wide, and two hundred and ten feet high.

The laying out of the works was commenced on the 9th of March, 1861. About two weeks were occupied in making the measurements, and the building was begun at the commencement of April. It covers about twenty-four acres and a half or sixty millions of cubic feet; and, though smaller than the building raised for the Paris Exhibition of 1855, it is larger than the Hyde Park Crystal Palace of 1851. The latter structure, however, covered nearly twenty acres; was begun about the middle of August, 1850, and was finished by the day appointed, February 12th, 1851; whereas the present building has taken a year to raise, and was not completed until six weeks after the contract date. The original contract for the building in 1851 fixed eighty thousand pounds as the cost; but this sum was increased by the Commissioners to one hundred and eight thousand pounds, and the sale of the materials to the Crystal Palace Company of Sydenham placed seventy thousand pounds more in the hands of the contractors—raising the sum they received to one hundred and seventy-eight thousand pounds. The old building had many imperfections, and was not, in many respects, well adapted to preserve costly goods from sun, dust, and rain; but still it was valued for itself alone, and was not the least interesting part of the show. The new building, however, large as it is, will add nothing to the forthcoming display except heaviness and bad proportions, and the wisest visitors will devote themselves to the industrial collections, and endeavour to forget the roof they are under.

OBSERVED HEIGHTS OF METEORS AND SHOOTING STARS.

BY ALEXANDER S. HERSCHEL.

On the night of Tuesday, July 16, 1861, three meteors at least attracted the attention of travellers in different parts of England. That of 10h. 15m. p.m., first described by the Duke of Argyle in the *Times* newspaper, was soon found to be irreconcileable with that of 11h. 32m., p.m., which took a southward course, and the discussion elicited an account of a third, which was seen at Bristol to move from north-west down to the west at half-past nine of the same evening. The accounts collected of the two former meteors showed that of 10.15 p.m. to have moved from 305 miles over Liege in Belgium to 35 miles over the North Sea, 70 miles east of the town of Morpeth, in Northumberland. This we gather from accounts at London, where it disappeared due north at an altitude given at Tunbridge Wells as 8° or 10°, while from Tunbridge Wells it was seen to commence at an altitude of 40° due east. At Darlington, in Yorkshire, the commencement was due south-east at altitude 30°, the disappearance was north-east by east altitude 25°. The intersection



of these lines of sight are accurate at the above points, and the prodigious flight of 350 miles appears to have been performed in 10 or 11 seconds, or a very little less. The inclination is 31° to the horizon towards 37° west of north. An adhering tail, but fugitive like the meteor, pursued the nucleus, which was almost globular and 5′ or 6′ in diameter, and shed at Furness Abbey a light equal to the crescent moon. This tail was 2° or 2½° in length, and colourless like the meteor. No change appeared throughout the flight until before disappearance a companion was seen to pursue it closely. Both then vanished together abruptly.

The second meteor appeared to move at London from 15° S. of the zenith towards a point of the horizon 54° W. of S. At Liverpool, it flew from alt. 40° in the S.E. by E. to a few degrees above the horizon S. by W. We infer from these data (slightly modified by other observations), a flight of 300 miles from 195 miles above the Straits of Dover by North Foreland, to 60 or 70 miles above the English Channel, 60 miles S. of Plymouth. This course passes at a height of 150 miles over the Isle of Wight, at which point an enduring tail began to be given off, and continued to be developed to the end of its course. After the dispersion of the nucleus, this tail drifted eastward in the direction of the rising wind at a speed of 1000 feet a second.

The course of 270 horizontal and 130 vertical miles, is inclined 27° to the horizon towards 57° W. of S., and the velocity of the meteor was 60 miles a second, while that of the former was only 30.

Encouraged by the success of these determinations, a campaign was organized for the observation of the shower of meteors on the coming 10th of August, in which Mr. Glaisher, and numerous other observers, professional and amateur, promised their assistance for a single hour on every night.

The first result of this combination was a letter from Mr. J. Baxendell, in Manchester, describing a brilliant meteor at 11h. 21m. p.m., I.M.T. of the 6th of August, having two maxima of brightness in a short crooked path of only 3½°, near the star ε Capricorni, in which it moved for more than two seconds of time. A later communication, from Messrs. J. Townsend and T. Crumplen, contained the following observation, of the same date, in Trafalgar Square. The time differs only one minute from that of Mr. Baxendell's observation :—" A meteor brighter than that of July 16th shot from near α Coronæ to χ Ursæ Majoris. It appeared to be extinguished, and then suddenly rekindled. Duration 6 sec.; tail 2 sec."

Taking half-way between the two last observed places as a trustworthy point in the meteor course as seen from London, this line of sight is found to pass within seven miles of that from Manchester to the centre of the meteor (as there observed), at 80 miles high, half-way between Leicester and Birmingham. Judging from the foreshortening of 48°, as seen from London, to 3½° as seen from Manchester, we must accept the course to have been directed through this point almost direct upon Manchester, and hence we obtain by the London observation a flight of 176 miles in five or six seconds; from 126 miles over Winchester to 21 miles over the north point of Staffordshire, at an inclination of 37° to the horizon, from 16° E. of S.; and in this course of 105 vertical and 140 horizontal miles, the flame was kindled into brilliance two distinct and separate times.

On the 8th of August the Rev. James Challis saw at Cambridge a second magnitude star shoot downwards at alt. 40°, 11° E. of S., rapidly at an inclination of 30° to the right from horizontal. While at Greenwich, within 20 sec. of the same time, Messrs. W. C. Nash and J. Howe saw a second magnitude star pass very rapidly from α Cygni to Delphinus, leaving a faint tail.

Placing the Greenwich centre at *q* Vulpeculæ, we have a line of sight which intersects the Cambridge line of sight accurately at 67 miles over Sandhurst, in Kent, through which point this meteor was directed upon Alton, in Hampshire, at 46° from horizontal towards 3° S. of W. The meteor may have been 20 miles long, with a speed of 30 or 40 miles a second.

Two minutes later a flash was seen at Cambridge Observatory by Mr. A. Bowden, altitude 61°, 73° E. from S. No path could be perceived in it. Dr. Lee's party of observers at Aylesbury beheld it near ω Andromedæ, but from the absence of any bright stars for reference near the foot of Andromedæ, we must not trust this observation beyond a certain point. It was recorded by Mr. S. Horton "Like a gas flame suddenly lighted and then put out. Very curious." These two lines of sight are 12 miles asunder, at 50 miles above the neighbourhood of Bury St. Edmunds, and as the parallax is 34°, we must suppose this singular meteor to have had no perceptible path, but to have been indeed, as described at both stations, a momentary flash equal to the illumination of not one, but of 500 or 600 gas-lights at once; for it is recorded equal to a second magnitude star at Cambridge, and there its distance was 54 miles.

The next accordances were on the 10th, when two third magnitude meteors appeared at Greenwich, one below the other, whose paths at Cranford were coincident. The apparitions were undoubtedly the same, but the observations are somewhat vague. The lines of sight for one meteor pass 15 miles apart, at 30 miles over Guildford, in Surrey. Those for the second are 19 miles apart, 105 miles over Bishop Waltham, in Dorsetshire; both appear to have been nearly vertical.

Three minutes after this remarkable pair, a more brilliant meteor shot at Cranford to the right in the square of Pegasus.

It was observed at Greenwich to commence over α Andromedæ. The parallax of 7°, obtained from the records, give a height of 47 miles over the English Channel, 20 miles east of the North Foreland. The meteor was conformable to β Camelopardalis, and we may infer for it a course of 35 to 40 miles, performed in little more than one second of time, at an inclination of 38° to the horizon towards 42° W. of S.

Five minutes later than this a second magnitude meteor, with a tail, was observed by Mr. Nash to fall from γ Ursæ Majoris towards the horizon, while at Cambridge two meteors with centres coincident succeeded each other almost immediately—one of third magnitude, the second of first magnitude, leaving a tail. The second was seen, by the Rev. James Challis, to shoot to the left at 45° to the horizon, at altitude 20°, 13° S. of W. A line of sight at Greenwich, half-way between γ Ursæ and the horizon, intersects this Cambridge line of sight accurately at 17 miles over Buckingham, and assuming it to have been slightly inclined to the left at Greenwich, we infer it to have flown some 20 miles at 40° to the horizontal from N. to S., from a height of 24 miles to perhaps only seven above the earth. This is the lowest meteor which the observations render in any degree probable.

About a quarter of an hour after this two small meteors appeared, to Messrs. W. C. Nash and J. Howe, to succeed each other rapidly from α Cygni—one to α Lyræ, the other towards Delphinus. Within 10 seconds of the time of the first, a meteor is recorded at Cambridge, by the Rev. James Challis, of third magnitude, altitude 46°, 26° W. of S., moving downwards to the right at 30° to the horizontal. A line of sight, directed from Greenwich to ι Lyræ 3-5ths of the way from α Cygni to α Lyræ, intersects a line of sight from Cambridge, altitude 48°, 21° W. of South, accurately at 70 miles over Leatherhead. From this point the meteor was directed to the town of Andover, at 54° to the horizontal, towards 20° S. of W., in a course perpendicular to the town of Cambridge, where, at a distance of 94 miles, every 5 miles of flight would subtend 3° of arc. This meteor closes the list among the accordances of the 10th of August. It was probably from 20 to 25 miles in length. At 300 yards' distance it would have shed the light of the full moon, and it burned with the brilliance of 400 ordinary gas-lights.

On August the 11th fewer accordances were obtained. Sixty observations at Hawkhurst, and nearly half as many at the contiguous station of Flimwell, are so strangely discordant that the wonder is how so many meteors should have been inserted so entirely disagreeing in time and place: the only one accordance is too vague to yield a useful parallax. This was dull red, and tailless during the last third part of its course, in strong contrast to the previous two-thirds, where the meteor was brilliant blue, and emitted a lengthy enduring train. It was not noticed at any other station, and was possibly of low altitude like that surmised over Buckingham.

Within five minutes from this time, however, a beautiful white meteor shot 8° very slowly in the E. from Hawkhurst. The tail was the most enduring of the evening (7 seconds). Duration $1\frac{1}{3}$ secs.; shot to clock hour IV$\frac{1}{2}$, at altitude 16°, 33° N. of E.; a careful observation.

At Ipswich the same meteor was seen to terminate at γ Pegasi, inclined 40° to the horizontal. We infer from this a path of 36 miles, from 44 to 21 miles above the English Channel, 70 miles E. of Ipswich, at an inclination of 42° to the horizon towards 20° W. of S.

Seven minutes later a second bright meteor was at Ipswich observed to pass down the centre of the Milky Way, which was vertical at Hawkhurst. It was of first magnitude and left a tail, and appears to have been 64 miles over Hailsham, in Sussex, performing 25 miles in half a second, almost horizontally towards 12° W. of S.

A map of these accordances is annexed for illustration, and it is particularly desirable to make these observations on the nights when meteors are most abundant, as we may hope to trace on quiet nights an outline to the regions where these fugitive particles become incandescent more surely than on separate nights, and in separate conditions of the atmosphere. On the 28th of January, 1862, a shooting star was very accurately observed, between London and Aylesbury, to traverse a horizontal distance of 60 miles, with a uniform speed of 40 miles a second, horizontally from 44 miles over Melton Mowbray, in Leicestershire, to 47 miles over Macclesfield, in Derbyshire. It shone throughout as a first magnitude star, without change of brightness; the course appears only 12° in length at London, and 20° in length at Aylesbury, and it is difficult to account for these decided points of kindling and extinction upon a horizontal course of a projectile, if we do not admit a column, or wave, of the atmosphere to be here singularly uplifted; and the rapid motion of the tail in the meteor of July 16th seems to point equally to violent commotions upon the upper surface of the atmosphere.

THE FISH WORLD AT HOME.*

EXCEPT as a race of creatures which supply a peculiar kind of food, the fish world is less popularly known than any other conspicuous division of the animal kingdom. Indeed, unless we consider it in a culinary sense, it is easier to like anything better than a fish; for although the forms of many species are strange and wonderful, though they are decorated with colours as varied and as brilliant as those of birds, the great difficulty of studying their habits diminishes the interest which their peculiar or splendid appearance might otherwise induce us to feel. Our affection for animals is strongly influenced by their agreeableness or unpleasantness to the sense of touch; and even when prudence forbids such tactile experiments, we look at the lion or bear as creatures we should have no objection to fondle, if their moral character was of a more amiable kind. When we pass from the warm-blooded mammalia to the important group of reptiles, we are conscious of a great diminution of sympathy, and though a few people make pets of snakes and tortoises, while some of the graceful lizards of warm countries are welcomed in the domestic circle, there is on the whole too great a gulf between the human and the reptile life for us to enter readily into their mode of being. This discrepancy becomes still more striking when we descend to the fish, the inhabitants of an alien element, and the dwellers under conditions by no means easy for us to ascertain. It is true that from an early antiquity men have half domesticated certain kinds in ponds, and before the aquarium assumed its present elegant and instructive shape, many generations had seen gold and silver fish swimming round the old-fashioned globes, with a monotony of motion only varied by the occasional occurrence of illness or death. But these experiments and observations added very little to our substantial knowledge of fishy life, and when the naturalist obtained his specimens, he usually studied them as dead organisms and not as fellow-inhabitants of this living world. These causes may tend to make icthyology less often a favourite study than other branches of natural history, but very little attention is required to invest it with an interest of its own. Regarded geologically, the fish present us with the oldest distinctly known group of vertebrate animals. Older, or as old, may have existed; but if land vertebrata should be proved to have been contemporaries with the earliest fish, the latter would still appear to have

* *A History of Fishes of the British Islands.* By Jonathan Couch, F.R.S. Vol. i., containing fifty-seven coloured plates from drawings by the Author. Groombridge and Sons, 1862.

played a very important part among the pristine* inhabitants of the globe. In our own times the waters cover two-thirds of the earth, and within certain limits they are thickly peopled by the finny race. The subaqueous land is as diversified as the subaërial, and if we could roam over the sea-bottom as we do over the dry surface, we should find its varieties of contour as strongly marked. In some spots we should discover sedimentary plains, in others elevated table-lands and lofty mountain chains, while the vegetation would be plentiful, scarce, or absent, according to laws analogous to those which affect terrestrial plants. In some situations, where the water is shallow and the soil appropriate, we should come upon green meadows of the common *Zostera marina;* on rocks in deeper water we should find groves and forests of the oar-weed (*laminaria*), and other tree-like algæ; and if in our own climate these seldom exceeded twelve or fourteen feet in length, we need only go to the coast of North America to find a tangle, named *nereocystis*, with stems three hundred feet long, and floats like huge casks, crowned by tufts of prodigious leaves, among which the sea-otter makes his lair. On dry land the most numerous population is seated at, or near, the sea-level, or at what we may call the bottom of the aërial ocean which enfolds our globe; except on the Mexican plateaux, animal forms become scarce after an elevation of a few thousand feet, while extreme mountain heights are solitudes scarcely broken by the sound or sight of life. In the watery regions some differences occur. There, the mountains, instead of being deserts, present conditions which offer some analogies to the sea-level surface of the earth. Light is abundant in such situations, and the moving waves carry to the limited depth a more ample supply of air. Here then life abounds, and it is the lowest valleys and plains of the ocean beds, which correspond with the subaërial mountain-peaks, in affording a very restricted accommodation for living beings. Recent discoveries in deep sea dredging modify old statements about the total absence of life in the dark and profound recesses of the sea; but at any rate, so far as the higher forms are concerned, dense populations occur only at moderate depths.

The subaqueous scenery of our own shores exhibits on a limited scale the varied aspects to which allusion has been made; but it nowhere sinks to remarkable depths. In the North Sea, between us and Norway, 140 fathoms is said to

* "No vertebrate animal higher in the scale than fishes is as yet certainly known to have been found in any rock of Devonian age. In fact, until demonstrative stentigraphical evidence of the Devonian age of the red known Elgin beds is obtained, the bearing of the palæontological evidence against that conclusion is too strong to allow of its being entertained."—Professor Huxley, *Memoirs of Geological Survey, Decade X.*

be the extreme depression. The English Channel, east of Eddystone, is not more that 50 fathoms; but on the west coast of Ireland, Dr. Harvey tells us, a depth of 300 to 400 fathoms is soon attained. As a rule, the sea-bed, within a a moderate distance from the shore, partakes of the geological character of the formations on the coast; and if a fish swam from the granites and slates of Cornwall to the chalk of Sussex, he would find the peculiarities of the watery region changing very much like those on the land. Such, then, are a few particulars of the localities in which fish existence is carried on. As on dry land, the plants nourish certain kinds of animals, and the strong devour the weak according to the various methods of predaceous life; but there is this difference between terrestrial and marine vegetation, that the latter derives nearly all its nutriment from the fluid element, as its roots are, for the most part, only anchors and supports, and not also a machinery for the absorption of food. Thus the water, with the various saline, earthy, and other elements that it holds in solution, forms the foundation of the entire mass of existence whichit contains.

If we pass from the consideration of where the fish lives, to the inquiry of what the fish is, we find it to be, in the words of Dr. Grant,* "a cold-blooded, oviparous, branchiated animal, with one auricle and one ventricle of the heart, not undergoing metamorphosis, covered with scales, and having the arms and legs constructed as fins, for a permanent residence in the waters. The rudimentary lungs (air-bladders) are very rarely employed for breathing, generally for regulating their specific gravity. They mostly impregnate the ova externally, aud there is no amnion or allantois in the ovum." To this brief description some particulars must be added, for, in the words of Mr. Couch, "in a fish the whole mass of blood passes through the gills for the purpose of receiving the influence of the air contained in the water, without being again returned to the heart, until it has been carried to the other parts of the body."

The heart of a fish is thus devoted to the *respiratory* circulation. In the reptile, which stands in zoological rank higher than the fish, the heart has three cavities—a single ventricle, and two auricles; but breathing air direct, by means of lungs, and passing much of its time in torpor, or repose, it does not need that all its circulating fluid should be exposed to the respiratory process before traversing its body; and hence one portion of aërated blood from the lungs, is mingled with another portion of venous blood which has not passed through them, and this mixture is sent out by the single ven-

* *Tabular View of the Primary Divisions of the Animal Kingdom.*

tricle of its three-chambered heart. As energy of character and capacity for exertion are usually proportioned to the amount of heat which an animal evolves, we must expect that fishes, with a respiration rendered imperfect or slow, from the nature of the fluid in which they live, and with bodies whose internal temperature is lower than that of mammals or birds, would be, in many respects, sluggish creatures; and to a large extent they deserve this character; though the shark tribe exhibit activities very analogous to those of terrestrial beasts of prey. In Mr. Couch's valuable and interesting *History of the Fishes of the British Islands,* which follows a generally-recognized system, these voracious creatures are placed at the head of all the families of Fish. Together with the ray-fishes, they belong to the *Chondropterygious* order; and it is consolatory for those who are alarmed at such an awkward, jaw-breaking term, that a better-sounding and more popular word, "cartilaginous," will do just as well. The characteristic of the skeleton of these fishes is the absence of that quantity of mineral matter which gives rigidity to ordinary bones; but, as Professor Owen says, "I know not why a flexible vascular animal substance should be supposed to be raised in the histological scale because it has become impregnated by the abundant intussusception of earthy salts." The shark has, for a fish, a large brain, immense strength, and a capacity for prolonged exertion, which Mr. Couch traces to the highly-developed character of its muscles, which "bear a resemblance to those of quadrupeds." The eye of this tiger of the deep affords the quick vision required for its predacious life, and Mr. Couch thus explains its peculiar mechanism:—"On examining the cavity in which the eye of the shark revolves, we find that the globe, which is the immediate seat of the power of vision, is lifted from the bottom on which, in other animals besides this great family, it rolls, and is placed on a small table that itself forms the top of a slender pillar, the bottom of which is fixed on the bony circle of the common ocular cavity, or, more properly speaking, of the pillar itself, which leans a little forward that it may be accommodated to the most usual direction in which objects are viewed . . . . . The height of this ocular pillar has the additional advantage of allowing a greater length to the muscles which move the eye, and, by so doing, of providing for a more sudden as well as a more extensive action of the eyes in prowling for their prey."

The general form of the jaws of the shark is well known through specimens in museums, but to Mr. Couch must be assigned the merit of observations on the formation of the teeth, which appear to have been simultaneous with those made known by Mr. Owen, and which are thus described:—"In all fishes the first step in the formation of teeth is the simple production of a soft vascular papilla, or pimple, from the free surface of the membrane of the jaw, near the mouth; but in the sharks and rays these papillæ do not proceed to sink into the substance of the gum, but become covered by caps of an opposite free fold of this membrane. These caps do not contract any organic connection with the papilliform matrix (and in the torpedo they are very loose), but as this is converted into the dental tissue, the tooth is gradually withdrawn (the points of the teeth at first lying flat downward, or in the direction toward the mouth) from the extraneous protecting cap, and as they become hard from being clothed with an enamelled surface, they assume the upright posture on the border of the jaw." The several rows of teeth are successively carried forward "by action in the membrane itself on which they rest, until being commonly broken or worn down by the violence to which they have been exposed, by the time they have reached the outer jaw, an exfoliation of the membrane itself has taken place, and they drop off by a natural process of exfoliation, to be succeeded by others, which are in their turn formed at the border of the jaw nearest the mouth, and pass upward and outward."

The greater number of sharks hatch their eggs in their own bodies, but the ground sharks deposit their ova in singular leathery bags, with long twisted strings at their corners, similar to those of the skates, which are common on every beach. The British sharks, which are most generally seen by sea-side visitors, are dog-fish of small dimensions; but many larger species frequent our shores, and Mr. Couch describes no less than seventeen which belong to us, as more or less regular inhabitants, and among them we find several quite worthy of their formidable fame. One magnificent species, and less ferocious than most of his brethren, performs a regular migration along the west coast of Ireland, and the western islands of Scotland, and is the profitable subject of periodical attack. This is the "basking shark," or sun-fish, so called from its habit of basking in the sunshine during calm, bright weather. It is killed with a harpoon, and valued on account of its liver, which weighs "two tons," and yields a large quantity of fine oil. Mr. Couch says this is the largest of all true fishes, and he gives a drawing of one captured in Cornwall, which measured thirty-one feet eight inches in length. The two most extraordinary-looking sharks are the "Thrasher," which is not "uncommon on the western and southern coasts of Britain in the summer," and the "Hammer-head," which is "a rare wanderer in our seas." The first is eleven or twelve feet long, and remarkable for the great length and strength of the upper division of its tail, while the second has a head extended sideways like a hammer on its handle, with an eye at each end.

We may picture the sharks roving freely in search of their prey; and could we witness the daily life of the sea, we should find them as ferocious, and more ravenous, than the lions and tigers of the land. But if we surveyed the bottoms of smooth bays, we should be struck with the peculiar aspects, and large dimensions, of the family of skates. Although capable of vigorous motions, their usual habit is to lie flat, and as they are creatures of high organization, they require a breathing apparatus which can act powerfully in such a position. Accordingly, each side of the body of a skate is provided with four double gills, and one single gill; the entire gill system exhibiting one hundred and forty-four thousand folds, with an aggregate surface of fifteen square feet, the whole being covered by an elaborate network of minute vessels. If a great fish of the skate family is seen lying dead, as a huge lump, on the beach, it is difficult to form an idea of its behaviour in the water, when its swimming capacities are aroused, but a glance at the beautiful coloured plates in Mr. Couch's work, affords an easy insight into some of their habitudes and powers. One of the most striking of these pictorial illustrations, is the figure of the "Eagle Ray," in which the brilliance of the green eye, the wing-like character of the expanded fins, and the fierce flapping of the long whip-like tail, furnish a picture as wonderful as that of any monster of which mythology or fable tells.

Nor must we suppose that, if it were possible for us to take a journey through the watery regions of the fish world, that we should meet with no instances of constructive skill, or intimations of that maternal affection which reaches its full development among the mammalian tribes. There is, for example, a fish well known on all our coasts which makes a nest, and watches over the safety of its progeny until they are able to take care of themselves. This is the "Fifteen-spined Stickleback," or Sea-Adder, a creature about six inches long, of an elegant tapering form, and varying in colour, but figured by Mr. Couch as golden-yellow and brown. The nest-making capacities of this animal have only recently been ascertained. Something of the kind was previously suspected, and this led Mr. R. Q. Couch to prosecute his investigations, until he was happily rewarded by success. The places selected by the Sea-Adder for its nursery are harbours or recesses sheltered from the violence of the waves. The nests are formed by tying together tufts of seaweed and coralline with a thread secreted from the fish's own body, and which resembles elastic silk. In one instance, Mr. Couch found a nest as big as a man's fist attached to the separated strands of a rope which was hanging in the water, and in this case the materials for the structure must have been carried about thirty feet. Mr. Couch observes on this interesting phenomenon, that the roe does not appear to be deposited all at once, that it is passed through the mass which forms the nest in various directions, and appears in little clumps in various stages of development. He adds—"They are watched over by the parent—in every case, I believe, by the male—who never quits his station; but an instance has occurred where two fishes have been engaged in attending one nest; and if the guardian is forced to retreat by the receding of the tide, he returns as soon as the way is open, and for three or four weeks continues his guard, until the young are able of themselves to take their chance in the broad expanse of the sea. So much is he intent on the principal objects of his solicitude, that at this time himself may be easily caught, but he resents every interference with his nest; and if the grains of ova be exposed to sight, as was done by way of trial, the breach was immediately repaired by the labour of dragging the materials into a position by which they were again concealed and protected."

Referring those who desire to gain a knowledge of the various genera and species of British fishes to Mr. Couch's agreeable and richly-illustrated pages, we may advert to the labours of Dr. Dufossé in rescuing the piscine world from the wholesale charges of dumbness that have been brought against it, and showing the foundation of ancient stories that were too often disbelieved. His researches have been chiefly confined to the gurnards and dories, which he tells us are able to utter prolonged and varied notes by means of vibrations in the muscles of their swimming bladder, and if all that the learned doctor tells us be true, the fish family may have oral discussions and concerts of their own, the performers being able to execute passages which an opera *prima donna* would be astonished to hear. This certainly opens a new view of submarine society. It may, after all, be diversified by other incidents, besides devouring and being devoured; fishes may exchange such thoughts and sentiments as their feeble brains may form, and their existence be rather more than

> "A cold, sweet, silver life, wrapp'd in round waves,
> Quickened with touches of transporting fear."

THE PLANETS OF THE MONTH.

BY THE REV. T. W. WEBB, F.R.A.S.

Mercury may be seen in the morning, at the beginning of the month; but a more favourable opportunity will occur in May.

Venus is now transferred to the other side of the Sun, and, rising before him, she will be only watched by those few who pursue their studies

"Under the opening eyelids of the morn."

They, however, will see her to advantage, as she has already attained a considerable elongation from the Sun. Her greatest brilliancy takes place on April 2, when, as well as for some time afterwards, she may be followed, not only with the telescope, but even with the naked eye, even till noon-day: and an exquisitely beautiful object she is, when her glare is thus subdued by an illuminated background. An equatorial telescope of course renders it perfectly easy to find her at any time; but those who do not possess such an instrument will have little difficulty in keeping her in view in a clear day, if she is first found before sunrise, and subsequently watched from time to time, without allowing too great an interval between the observations. The epoch of greatest brightness depends upon two continually varying conditions—her distance from the earth, and the magnitude of her phasis, that is, the proportion of her illuminated surface which is turned towards us. When her phasis is largest, resembling a full moon, she is so distant from us, that even were she not obscured by the Sun's rays, she would not be a very brilliant object; on the other hand, when she is nearest to us, we look for the most part upon her unenlightened side; and though her apparent diameter is then greater than that of any other planet, her crescent is so thin that the advantage gained in point of distance is lost by her narrowness of illumination. There will, however, be a point, which calculation will ascertain, where these two varying quantities will combine to produce the largest apparent illuminated area; this is not at the quadrature, or half-moon phasis, as she is then too distant, but when the crescent has attained a considerable breadth.

Jupiter is in great splendour, having been in opposition to the sun on March 12, with a diameter of 41″·6, only reduced to 40″ by April 17. His belts seem now to be becoming more distinct than they have been for some time; as usual, two, one on each side of the equator, are most conspicuous, and the southern asserts its customary pre-eminence. Their variations will form a most interesting study, especially should a season of activity be coming on in that frequently-disturbed atmosphere. The transits of the satellites and their shadows across the planet always afford a beautiful spectacle, if the air is favourable, especially in a telescope which has power enough to show the disc of the entering or emerging satellite distinctly, and the circular form of the ink-spot which marks the place of its shadow. Sometimes more than one satellite, or more than one shadow, may be seen at the same moment, on the face of that noble planet; at others, the satellite passes away into the clear blue sky, and leaves its shadow behind it, or the shadow breaks in upon the planet's limb, to announce the distant approach of the little globe that casts it. But these are not merely beautiful phænomena—they are attended with circumstances of mystery which yet remain to be investigated. Excepting towards the limbs, where the light of the planet is less vivid, or in front of a dark belt, a satellite is usually invisible upon the face of its primary, from want of contrast; but instances from time to time occur in which the same satellite—usually III. or IV.—assumes so dark an aspect in that situation, as to be barely distinguishable from its shadow. There can be no question that this arises from spots upon the disc of the satellite, which the magnificent telescopes of Lassell, Secchi, and Dawes, have occasionally rendered perceptible in III., even on the background of the blue sky; but as these dark transits are of irregular recurrence, we are obliged to suppose either that these little moons have atmospheres subject to extraordinary variation, or that they have rotations upon their axes much more rapid than their revolutions round their primary—each alternative inferring a constitution totally dissimilar to that of our own satellite. These dark transits were noticed from a very early period—I believe 1666; Maraldi saw IV. pass as a black spot in 1707; Schröter probably observed them under the mistaken idea that they were spots on the disc, in 1785 and 1786; he and Harding recognized their true nature in 1796; about this time Sir W. Herschel paid much attention to these objects, and suspected that their forms might not be spherical (which has since been actually shown in the case of III., by the telescopes of Lassell and Secchi); but, strange to say, he never alludes to these darkened transits—an omission which, on the part of so accurate an observer, seems to imply that none of them had taken place under his notice. Beer and Mädler too have made no mention of them, though it can hardly be supposed that they were ignorant of former observations. But of late years they have attracted much attention, and the following description by the American astronomer Bond will be the more welcome, as few of our readers are likely to possess the means of witnessing the minuter details for themselves :—" 1848, Jan. 28.—The 3rd satellite itself was seen with the great refractor" (of nearly fifteen inches aperture) " under very beautiful definition, as a black spot between the two shadows" (of I. and III.), " and not to be distinguished from them except by the place it occupied. It was smaller than its shadow in the proportion of 3 to 5, not duskish simply, but quite black like the shadows ;" and under March 18th, he thus records a similar transit of the same satellite :—" At the first internal contact the satellite was distinctly seen on the disc, *brighter* than *Jupiter*, though it had entered on a bright channel, south of one of the great equatorial belts ; twenty minutes after, it had become nearly of the same brightness with the planet, so as to be barely perceptible, yet still whiter than the surrounding surface. While watching it with close attention, a minute dark speck suddenly made its appearance in the place of the satellite, increasing very rapidly till it occupied a space of about one second of arc in diameter, quite black, and nearly round, though an irregularity of shape was suspected. Remaining thus for about two hours, the darkness gradually lost its intensity, and quite disappeared before the satellite left the disc." The change thus described is of course due to the rapid diminution of Jupiter's light towards the edges of the disc ; but it is strange that the eye is so little sensible of that decrease in any other way, though its amount must be extremely great, before it could thus turn white to black, from the mere effect of contrast. This wonderful observation, for such it really is, and will the more appear so, the more it is studied, tends greatly, it must be owned, to shake our confidence in the discriminating power of the eye. Dawes, from the perfection of whose telescopic vision there can be no appeal, informs us that the 2nd satellite is never thus shaded, that I. is sometimes grey, III. darker by many shades, and IV. darkest of all.

Another marvellous peculiarity, mentioned by several observers, is thus described by Lassell in the *Monthly Notices* of the Royal Astronomical Society, under the date of February 28th, 1850. "12h. 11m. The shadow and satellite" (IV.) " being now equally distant from the limb, the greater size of the shadow is most obvious ; indeed, it appears to be twice as great in diameter." It is difficult to conceive any mode of accounting for this, unless we could suppose the satellite to be encompassed with an atmosphere possessed of refractive power in the opposite direction to every substance or medium within the compass of our knowledge ; that it was no illusion is rendered probable by the fact that the irradiation, or spreading out of light, which is inseparable from telescopic vision, would have produced exactly the contrary effect, expanding the apparent diameter of the satellite on the dark ground of the sky, and diminishing that of the shadow on the luminous face of the planet. We have at present no means of interpreting this mystery. As the more obvious features of these curious and beautiful phænomena may be perceived with a very moderate aperture—I have myself seen the "ink-spots" well with only three inches—we shall give a list of all that are visible at convenient hours during the present month; including May 1st, for the sake of readers whom our information might not otherwise reach in time.

April 1st. I. is on the disc from 8h. 10m. to 10h. 27m. followed (as always after the planet's opposition) by its shadow. 2nd, II. emerges at 7h. 41m.; the shadow continuing in sight an hour longer. 8th, I. is in transit from 9h. 57m. to 12h. 13m. 9th, shadow of II. enters at 8h. 27m., the satellite being already on the disc; egress of II. 9h. 57m.; of shadow, 11h. 15m. IV. having crossed already, and being to the left of the planet in an inverting eyepiece, its shadow comes on separately at 9h. 28m. and leaves at 12h. 34m. 15th, I. enters at 11h. 43m., followed by the shadow at 12h. 28m. 16th, II. enters at 9h. 28m., its shadow at 11h. 1m.; it goes off at 12h. 15m., the shadow at 13h. 49m. 17th, I. leaves the disc at 8h. 26m.; its shadow at 9h. 14m. 22nd, I. enters at 13h. 30m., the shadow at 14h. 23m. 23rd, II. enters at 11h. 45m., the shadow at 13h. 36m. 24th, I. egress at 10h. 14m., ditto of shadow at 11h. 9m. 27th, III. being already off the planet to the left, the shadow enters at 8h. 13m., and departs at 11h. 28m. May 1st, I. is on the disc from 9h. 46m. till 12h. 3m.; the shadow enters at 10h. 47m.

It will be seen that there is no chance of a thoroughly dark transit this month, as III. and IV. will not be on the disc; but, weather permitting, we must not miss the interesting sight on the 9th, when the shadows of II. and IV. will both be visible at once for nearly two hours; and we shall not fail to remark, if we have a sufficiently powerful instrument, the contrast in the size of the spots, as well as the difference in their velocities, and distances from the bodies which cast them.

The presentation of Saturn's ring as a slender but conspicuous line, will be very beautiful this month. The Sun and Earth are at present both on the same side of it; were they both at the same elevation above its plane, it would, of course, exactly conceal its own shadow; but as the the Earth is slightly the more elevated, we see a very little under its inner edge, as compared with the Sun (the south side being the one visible), and it is possible that in fine telescopes a very narrow black line, the edge of the shadow, may cross the centre of the ball. The belts on each side of the equator seem to be faint this season. A three and three-quarter inch object-glass, if good, will show the five old satellites every clear night, unless any of them happen to be before or behind the planet, or in its shadow. The shadow of Titan, the largest statellite, was once seen crossing the disc by Sir W. Herschel in 1789. Gruithuisen also says he saw it in 1833 with a four and a-quarter inch object-glass; which is no doubt possible, as it may have a diameter of 0″·75; but his assertion that he saw the two innermost and most minute satellites at the same time, gives an imaginary character to the recital.

THE GENUS CEPHALOSIPHON.

BY ANDREW PRITCHARD.

It may interest naturalists engaged in these studies to learn the source from which I obtained the character of the genus *Cephalosiphon*, referred to in a paper by Mr. Gosse, "On a Rotifer new to Britain" (*Intellectual Observer*, p. 49). Allow me to premise that in preparing the fourth edition of my work on Infusoria, one part of my self-imposed task was the search through foreign transactions and journals for new forms, having determined to introduce every published genus and species. This task became laborious, as no public library contains the whole of the foreign works on this subject; nay, even a complete set of the proceedings of the Berlin Academy is not to be found in any one of them. After making these searches, a copy of my notes on the Rotifers was forwarded to Professor Williamson, who inserted the *Cephalosiphon* in his revise, for it is not in his MS., nor in my edition of 1852. On looking over my notes, I find that referred to was taken from the *Proceedings of the Berlin Academy for* 1853, p. 193, in the library of the College of Surgeons, and is as follows:—

"Cephalosiphon (new genus, *Ehrenberg*), Horn-Röschen. Family, *Flosculariorum*; organon rotatorium bilobum; ocelli duo; Vagina s. lorica singula; Cornicula duo frontalia siphonem includentia.

"*C. Limnias*, E. Vaginulis membranaceis annulatis, 1‴·6′ 1‴·5′. In ceratophyllo: Berolini."

In conclusion, permit me to express the pleasure I feel that the labour of collecting the characters of so many exotic forms has not been thrown away; also for Mr. Slack's valuable researches, by which we learn the rotatorial animalcules have a wide range of geographical distribution.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ROYAL SOCIETY.—*February* 6.

ON THE MOTION OF SMALL PORTIONS OF CAMPHOR WHEN THROWN ON THE SURFACE OF PURE WATER.—Mr. Tomlinson communicated a paper descriptive of the very elaborate series of experiments he had made to investigate this curious subject. The following is an abstract of the conclusions he had deduced from his investigations:—That to succeed in the production of these movements the camphor must be thrown on the surface of clean water in a perfectly clean vessel. That these phenomena may be also produced by certain salts, and other substances that diffuse readily over the surface of water. Thus the motions of camphor may be imitated by placing on water floating rafts of talc, tinfoil, paper, etc., smeared with or containing volatile oils, or any volatile liquid, such as ether, alcohol, chloroform, etc., provided there be a communication between such liquid and the water. The camphor or other volatile substance, being slightly soluble in water, spreads a film over the surface of the water the moment that it comes in contact with it. The dimensions and form of this film evidently depend on those of the piece of camphor operated on, and in general the film separates more easily from broken surfaces and angles than from a smooth surface, as the broken surface of a crystal is more soluble than the natural surface. These films being constantly detached from the camphor so long as it is in contact with the water, displace each other, the preceding film being conveyed away by the adhesion of the water in radial lines, which produce motion by reaction on the fragments of camphor, causing them to rotate in the same manner as a Barker's mill. These jets or films of camphor can be rendered visible by various means, as by fixing the camphor in water, and dusting the surface lightly with lycopodium powder, when a series of currents produced by the films will be made visible. The motions of the fragments of camphor on water are greatly influenced and complicated by their mutual attraction, and by the attraction of the sides of the vessel. The film of camphor diffused over the surface of the water is very volatile, disappearing as fast as it is formed, chiefly into the air, only a very small portion being retained by the water. Hence camphor wastes away much more quickly at the surface of the water than in water alone, or in air alone, because at the surface the film is being constantly formed at the expense of the camphor, and is spread out to the united action of air and water. Whatever interferes with evaporation lowers or arrests the motions of the camphor and the allied phenomena; so, on the contrary, whatever promotes evaporation exalts these phenomena—effects which are displayed with great energy on a bright and sunny day, are produced either sluggishly or not at all on a wet, dull, or foggy one. A fixed oil forming a film on water will displace the camphor-film, and so permanently arrest the motions of the camphor; but a volatile oil will only arrest the motions while it is present and undergoing evaporation. The motions of camphor on the surface of water are increased by the action of the vapour of benzole and some other volatile substances, such vapours condensing in the liquid form on the camphor, and being then diffused by the adhesion of the water.

ROYAL SOCIETY, *February* 20.

On the Dicyodont Reptilia brought from South Africa, by His Royal Highness Prince Alfred.—A communication was made by Professor R. Owen, describing some fossil remains obtained by His Royal Highness Prince Alfred, during his recent journey in South Africa. They belong to two genera of Dicyodont Reptilia, the first being an unusually perfect specimen of the skull of a species of *Ptychognathus*, which the author proposes to name *P. Alfredi*. The second specimen is the skull of the largest known species *Dicyodon trigriceps*. This skull is remarkable as exemplifying the near equality in size of this extinct two-tusked reptile of South Africa with the existing walrus. The pelvis of the Dicyodon is singularly massive, and offers many points of approach to the mammalian type, which is remarkable when taken into connection with the mammalian tusks in the skull.

GEOLOGICAL SOCIETY.—*February* 26.

On the Ice-worn Rocks of Scotland, by T. F. Jamieson, F.G.S. —The author, first referring to the eroded surface of the rocks beneath the Drift-bed in Scotland, proceeded to show that the action of ice, and not that of torrents, could produce such markings as he had observed in the bed of a mountain-stream in Argyllshire, down which had poured the torrent caused by the bursting of the reservoirs of the Crinan Canal. He then advanced reasons for considering that the erosion of the rocks in Scotland was due chiefly to land-ice, and not to water-borne ice, bringing forward remarkable instances of ice-action on the glens and on the hill-sides at Loch Treig and Glen Spean, where moraines, blocs perchés, striæ, roches moutonnées, and boulders lifted above the parent-rocks, indicate a northern direction for the great ice-stream from Loch-Treig to the Spean, and then an eastern course on one hand up Loch Laggan, and a western, on the other, down the Spean. Up Glen Roy the ice had apparently passed north-eastwardly, over the watershed, towards the Spey. In Knapdale, Argyllshire, similar evidence is obtained of a great ice-stream passing over hill and dale, here falling into the Sound of Jura. The author referred to Rink's and Sutherland's observations on the continental ice of Greenland, as affording a probable solution of these phenomena; and, objecting to the hypothesis either of floating ice and of debacles being sufficient to account for the conditions observed, he thought that land-ice, moving from central plateaux downwards and outwards, has effected the extensive erosions referred to, both in Scotland and other northern regions, at a time when the land was at a much higher level than at present. This must have been followed by a deep submergence, to account for the stratified and shell-bearing drift-beds.

ZOOLOGICAL SOCIETY.—*February* 28.

Incubation of the Python.—Mr. Bartlett exhibited a young python, taken on the 15th day of incubation from an egg which had been detached from the general mass; the animal was about 6 inches in length, the eyes were very distinctly visible; estimating the development as equal to that of a chick on its seventh day, Mr. Bartlett calculated the full period of incubation as being seven to eight weeks. In connection with Mr. Negretti, who had constructed some exceedingly delicate thermometers for the purpose, Mr. Bartlett had made a number of observations on the temperature of the incubating python.

The temperature of the air in the room was maintained at about 55° Fahr., that of the water-bath heating the sand on which the animals rested was 74°; on the 12th of February the temperature of the incubating female on the surface of the body was 73°, that of male in same den being 70°·2, whilst between the coils the female was 81°·6, the male only 74°·8. On the 23rd of February, the surface of the body of the female was 75°·4, that of the male 71°·8. Whilst between the coils the female was 83°·2, the male 74°. Observations made subsequently to this date showed a still greater difference of temperature between the two sexes, amounting on March 2nd to 20°, the female being 96°, the male only 76° between the coils. Some days after this, the female left the eggs and bathed in the tank placed in the den, changing her skin at the same time. After that her temperature fell considerably, and she did not for some days incubate the eggs with the same closeness as before. On March 16th the temperature was again carefully tested, the atmosphere of the den was 66°. That of the male on the surface of the body 72°·4, between the coils 77°·6; whilst the temperature of the incubating female was 77°·6 on the surface, and 86° between the coils; but as an outer coil was tested, it is probably that a higher temperature may exist between the innermost coils. On the 25th of March, the eggs were examined as far as practicable. Many of them promise to be productive; others have collapsed. The female python is now only 10° hotter than the male, instead of 20°, as formerly. She has now been incubating nine weeks.

On the Red Corpuscles of the Blood of Vertebrata, by Professor Gulliver, F.R.S.—There have been two parties differing essentially in their conclusions as to the structure of the corpuscles of the blood, both correct as far as they went. The first party, of which Hewson was the representative, insisted that the red corpuscle is a vesicle inclosing a nucleus; the second party, of which Dr. Hodgkin and Mr. Lister were the chiefs, were equally certain that Hewson was wrong, and that the red corpuscle has no nucleus. Professor Gulliver showed, as the result of his researches from 1839-42, that the red corpuscle of mammalia is destitute of any nucleus, while the red corpuscle of oviparous vertebrata, on the other hand, always has a nucleus. Hewson having drawn his description from the corpuscles of fish or fowls was quite right so far; and Hodgkin and Lister having examined only the corpuscles of man were equally correct in the same restricted sense. Thus Mr. Gulliver's observations not only completely cleared up the long existing discrepancies between former observers, but fairly settled "this vexed question of a nucleus," as it had so long been called.

Further, he asserted that the result of his observations clearly was, that the most important, because the most universal and fundamental, difference between the two great divisions of the vertebrate sub-kingdom, is the presence or absence of this nucleus; so that any one possessing a good microscope could at once plainly see the difference between the red corpuscles of these two divisions of vertebrata. It was also shown that this character is perfectly good from before birth, and throughout life, and in every age and sex, which was more than can be said of any other single diagnostic, whatever may be its importance. Hence Mr. Gulliver proposed to define the two divisions as follows:—

1. Mammalia, animals whose red corpuscles of the blood are destitute of nuclei.

2. Oviparous Vertebrata, animals whose red corpuscles of the blood contain nuclei.

He said there was no known exception to the accuracy of these definitions, and that he had proved in 1839 that even the singular oval corpuscles in the blood of *Camelidæ* were in size and structure truly mammalian.

The largest corpuscles among mammalia were shown to be those of the whale, the great ant-eater, and the elephant; and the smallest, as originally described by Mr. Gulliver, those of the musk deer. The largest corpuscles in the vertebrata are those of naked reptiles, and the most regular or least variable those of birds.

Thus the microscope is fairly enlisted into the service of systematic zoology. The subject was followed out in detail throughout the different classes and orders; and so plainly, that an observer might, by remarking the structure of the blood corpuscle, arrive immediately at results which, without the aid of the microscope would have formerly puzzled the most eminent comparative anatomists. One minutest drop of the blood, for example, of the duck-billed creature, *Ornithorynchus paradoxus*, would have shown it to belong to the mammalia, and this even in the most immature specimen!

The following suggestions have been made by Professor Gulliver. Reverting to his discovery of the microscopic structure of the red corpuscles of the blood being a better diagnostic than any hitherto offered between the two great subdivisions of the vertebrata, he now suggests that the intimate structure of the latex may afford good botanical characters. The milkiness or opacity of the latex may be due to equal sized particles of extreme minuteness, like the molecular base of the chyle of mammalia; or to larger, unequal sized, oil-like globules. There may also be starch-cells in the juice, as in *Euphorbiaceæ*. The limpid fluid in which the microscopic objects of the milky juice swim he calls Liquor Laticis. It is spontaneously coagulable at the temperature of the air, and is remarkably coagulated by water. The whole subject is one that may be easily examined by micrographers in the country, and the season is approaching for this interesting pursuit.

CHEMICAL SOCIETY.—*March* 1.

Destruction of Oak Timber in Sea Water by contact with Iron.—Mr. Crace Calvert called attention to the destructive action of iron plates and bolts on oak timber when submerged in sea water; the oak at the point of contact becomes dark in colour, softened, and partially disorganized. This change appears to be dependent on the presence of tannin, as teak and mahogany are not affected in the same manner as oak. The probable result of the action will be, that ships of oak plated with iron, after the manner of the "Warrior" and other vessels recently constructed, will become unserviceable in the course of a very few years. It is found that if the iron is protected by a coating of zinc—or, as it is termed, is galvanized—the action is prevented, and the oak timber does not change in colour or solidity. This mode of protection is even applicable to the iron bolts used in ship-building, as it is found that so close and complete is the adhesion of the two metals, that the zinc is not stripped off when the bolts are driven into the timber.

ETHNOLOGICAL SOCIETY.—*March* 4.

On the Shell Mounds of the Malay Peninsula.—Mr. G. W. Earl described the singular shell mounds existing in the province of Wellesley, near the Mudah River. They are about five or six miles from the sea, being situated on sand ridges that appeared formerly to bound the narrow estuaries communicating with the ocean. The mounds, which are entirely composed of cockle-shells, are about 18 to 20 feet in height, and recently have been largely employed by the Chinese immigrants as a source of lime. The antiquity of the mounds must be very great, as shown by the fact that the shells were partly cemented together by crystallized carbonate of lime, the result of the very slow action of atmospheric and aqueous influences. At the bottom of one mound, which contained 20,000 tons of shells, a human pelvis was found, and other remains and stone implements have been obtained from the Chinese lime-burners. The formation of these mounds was attributed by Mr. Earl to the Semangs, who are described as a diminutive negro race that are now sparsely scattered over the surrounding country, but who were evidently very numerous and widely spread formerly.

ROYAL GEOGRAPHICAL SOCIETY.—*March* 10.

Cambodia.—At the present moment, when the French appear likely to be about to establish their empire permanently in Cochin-China, any information about the little-known countries of Farther India must be regarded not only as valuable contributions to geographical science, but as worthy of general interest. The province of Cambodia, lying between Siam and Assam, was, in the end of last century, the subject of constant wars between the peoples of those kingdoms. In 1860 the French landed, and in 1861 took Saigon. They have since been endeavouring to establish a footing in Cochin-China.

M. Mouhot, a French traveller, has recently passed through Cambodia, up the Me-Kong, near to the frontier of Laos, and visited the savage and independent tribes which live between these two countries and Cochin-China. These Steings he considers to be the aboriginal inhabitants of the peninsula. During his journey, M. Mouhot discovered two active volcanoes on the north shores of the Gulf of Siam, and everywhere in the mountains to the north the evidences of volcanic action. He refers to the products of the country, which are cotton, iron, coal, gold, silver, and copper, besides valuable woods. In an extension of his journey across the lake of Touli-Sap, and through the provinces of Ongeor and Battambong, M. Mouhot discovered and examined some splendid ruins and a monument, the temple of Ongeor the Great. He has sent home drawings and descriptions of these ruins. Many of the buildings were constructed of large stones, elaborately carved and covered with designs of imaginary animals, as well as of beasts of burden. These temples were found in a district completely embedded in the forest, and in such a state of ruin that trees were found growing upon the roofs. The inscriptions, from their antiquity, were not intelligible to the natives; yet they so nearly resemble the Siamese character, that it is probable they will soon be deciphered.

NOTES AND MEMORANDA.

Influence of Water on Volcanic Action.—In a paper read before the French Academy, on "Volcanic effects corresponding with geological epochs" (*Comptes Rendus*, January 27, 1862), M. Pissis remarks that it is generally believed, in those districts of South America which are most subject to earthquakes, that these disturbances occur during the rainy season, and up to the period of drought. During twelve years of his own residence on the spot this theory has held good, and the years of most violent rain were distinguished by a greater number of earthquakes; and he adds, that if we consider that during the wet season the Andes are covered with a dense bed of snow, which is perpetually melting from contact with the soil, it will be obvious that an extensive infiltration must take place; so if there exist any fissures communicating with the interior, large quantities of water may be brought into contact with incandescent matter, and thus occasion very powerful disturbances.

Comparative Fusibility of Iron.—MM. Minary and Résal state that the fusibility of iron augments with the proportion of oxygen which it contains: thus, in placing side by side, in a blast furnace, two crucibles containing iron shavings of the best quality, but adding to the second a certain proportion of oxide of iron after exposure to a hot blast (*coup de feu*), the fragments in the first crucible preserved their original condition, except that they were slightly welded together, while those in the second were fused into a lamellated button.—*Comptes Rendus.*

VOLCANIC PHENOMENON IN MANILLA.—A letter to Dr. Hooke, communicated to the Geological Society, states that on the 1st of May, 1861, a portion of the river Pasig was subject to a violent commotion, which continued for four hours. For the space of a quarter of a mile the water was covered with air-bubbles and foam, the temperature being raised to 100° and 105°, other parts of the river being at 80°. Mounds of mud were raised several feet above the surface of the water, and gave out an offensive odour. At the expiration of the time mentioned the mounds disappeared, and the river resumed its ordinary aspect.

THE DIVINING ROD.—M. Chanoit, director of the hydraulic works of the Paris and Lyons Railway, announces that he has in service a young man so well practised in discovering springs or masses of water with the divining rod, that he would undertake that if he were taken blindfold through Paris, he would indicate the various water channels and their relative importance. He has such confidence in his hydrologist, that he begs the Academy to appoint a commission to witness his performances.—*Cosmos.*

PHYSIOLOGY OF THE NERVES OF INSECTS.—M. Yersin has communicated to the French Academy the results of observations on the field-cricket (*Comptes Rendus*, February 10th, 1862). He finds the power of co-ordinating movements not affected by cutting through both cords of the ganglionic chain. On the contrary, the motions became abnormal every time a single cord was severed at any point anterior to the ganglion of the meta-thorax, and likewise when two or more divisions were made, each of one cord, between different ganglia, one at least of the sections being anterior to the meta-thorax. He regards the cephalic and thoracic ganglia as together presiding over the co-ordination of locomotive movements, so that it is impossible to assign this function to any one ganglion, to the exclusion of the others. In this he traces a relation to the cerebellum of vertebrate animals, and he remarks that it is probable that it is in the "reunion of ganglia that we must look for an analogy to the brain of the vertebrata."

ELECTRICAL PHENOMENA OF VESUVIUS.—M. L. Palmieri first observed the flashes of volcanic lightning at a distance of a few hundred yards from the new crater at Torre del Greco. They always originated in large "globes of smoke," and were followed by explosions like pistol discharges. Afterwards from the Observatory he noticed similar flashes between the smoke and cinder masses and the aqueous vapour above them, but very seldom between the "globe of smoke" and the earth beneath it. At each violent projection of smoke, his instruments indicated a strong tension of positive electricity, and when this reached a certain force, thunder and lightning occurred. If the discharge occurred in the direction of the zenith of the Observatory, a sudden increase of positive electrical tension was produced; while, if the discharge was directed towards the earth, or to a distant region in the air, the tension became negative. The vapour which moved towards the Observatory, if free from cinders, was strongly positive; but the cinders which fell when the smoke of a superior current deviated from the zenith were negative.

M. PASTEUR ON FERMENTATION.—We find in the *Comptes Rendus* of the 10th of February a further account of M. Pasteur's laborious researches on fermentation, of which the following are the chief particulars. He began his investigations by experimenting on the *Mycoderma vini* or *cervisiæ*, popularly known as the "mother of wine." Causing this plant to develop in various alcoholic liquids in contact with air, he never obtained acetic acid; and if he introduced a small portion of that acid, it usually disappeared. When the *Mycoderma aceti*, or vinegar-plant, was grown in alcoholic liquids, acetic acid was always formed, with the intermediate production of small quantities of aldehyd.* In both cases

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* "The alcohols may all be regarded as compound oxides of hydrogen, and of a peculiar hydro-carbon. . . . The alcohols, by imperfect oxidation, furnish *aldehyds;* and these bodies, by the further absorption of oxygen, yield acids."—*Miller's Chemistry*, vol. iii. p. 119.

the chemical phenomena and the life of the plants were clearly correlative. When the experiments were performed in close vessels containing besides the liquid a known quantity of air, it was ascertained that the vinegar-plant took oxygen from the air, and therewith converted the alcohol into acetic acid; and that the mycoderm of wine took oxygen from the air, and converted the alcohol into water and carbonic acid. It was likewise ascertained that if the alcohol was removed, and the vinegar-plant grown in an acetic liquid, the acid was transformed into water and carbonic acid. With the mycoderm of wine the effect was the same, especially if there was a little alcohol in the liquid. From these facts M. Pasteur concludes that the wine and vinegar plants behave in the same manner, and that there are circumstances in which their action is exalted, that is to say, that the plant, instead of taking from the air two, or four, molecules of oxygen to combine with one molecule of alcohol, and thus produce aldehyd or acetic acid, takes eight, or twelve, molecules of oxygen, and by their aid completely transforms the alcohol and the acetic acid into water and carbonic acid. The vinegar-plant does not produce acetification when it is submerged. This was ascertained by noting the degree of acidity of a liquid in which a growing plant floated. The plant was made to sink by glass rods, and the acetification was arrested. Following his investigations, M. Pasteur arrives at the conviction that the well-known process of manufacturing vinegar by allowing a suitable liquid to trickle over wood twigs or shavings, is not, as was supposed, a purely chemical process, but dependent upon the formation of a pellicle of the vinegar-plant. The important paper from which we have condensed these observations concludes in these words:—"If the mycoderms possessed solely the property of acting as agents for the combustion of alcohol and acetic acid, their performance would be well worth attention; but I recognize in their functions a generality of action which opens a field for new researches in physiology and organic chemistry. In fact, the mycoderms are able to bring about the combustion of a great number of organic substances, such as sugars, organic acids, various alcohols, and albuminoid matters, giving rise in some cases to intermediate compounds, of which I have recognized a few. I may add that the property which we are discussing exists in various degrees among the mueidines, and I believe also among the smallest of the infusoria. I have observed that by the development of a mueidine, it is possible to transform into carbonic acid and water considerable quantities of sugar, so that scarcely any of that substance shall be left in a solution. If microscopic beings disappeared from our globe, its surface would be encumbered with dead organic matter and carcases of all kinds, animal and vegetable. It is they who chiefly give to oxygen its combustion-producing qualities. Without them life would be impossible, for the work of death would be incomplete. After death life reappears under another form, and with new properties. The germs, everywhere disseminated, of microscopic beings commence their evolutions, and by their aid oxygen is combined in enormous masses with the organic substances, and their combustion gradually rendered complete. If I may be permitted to characterize briefly another point of view to which we have been conducted, I would say that we obscure the existence of organized cellules endowed with a property of completely burning organic masses with considerable evolution of heat, or of carrying their oxidization to a variable extent. This is a faithful image of the respiration and combustion which take place in the pulmonary cells through the circulation of the blood, whose globules seek oxygen from the air, in order that they may burn in various degrees the different principles of the human economy."

Roman Ring-keys.—Some of the Roman keys attached to rings so as to be worn on the finger, and which are well known to antiquaries, were recently found at Water Newton in digging for gravel, close to the road from Stamford to Peterborough. Associated with them were cinerary urns and lachrymatories. The rings were of brass and bronze, and of the size used by the Roman ladies, who were accustomed to carry their casket keys in this manner.

New Theory of Comets.—Mr. Benjamin Marsh has published some interesting facts and opinions concerning these curious bodies in the *American Journal of Science and Arts*. He attributes the peculiar character of cometary matter to the extreme and violent changes which it undergoes in its rotation round the sun. Halley's comet, for example, at one time approaches the sun to within 56 millions of miles, and then recedes to the enormous distance of 3370 millions of miles. At the time of its perihelion, or least distance, it passes through one heliocentric degree of its orbit in 15·7 hours, and receives in a given time 3600 times as much heat as when it reaches its aphelion, or greatest distance, in which position its motion is so slow that 6½ years are required for its passage through one heliocentric degree. Thus it will be seen that comets with eccentric orbits are subject to violent changes of temperature and velocity, which do not affect planets whose orbits approximate more closely to the circular form, and from this circumstance a greater electrical disturbance and excitation may possibly be produced. Mr. Marsh gives a table of remarkable comets, showing that those which have exhibited the greatest splendour have been distinguished by extreme eccentricity, while comets of small eccentricity have been inconspicuous. From this law it follows that brilliant comets have long periods; and he tells us that, with the exception of Halley's comet, which performs its journey in seventy-six years, no other first-class comet has a shorter period than one measured by centuries. Mr. Marsh likens the tails of comets to auroral streamers, and considers that their envelopes resemble the electrical discharges in Mr. Gassiot's vacuum tubes, the luminous character being derived from the solid particles which the electrical current transports from the nucleus, just as similar particles are carried off from the electrodes in a voltaic discharge.

Heliography.—M. Chevreul, in presenting to the French Academy some fresh researches of M. Niepce de St. Victor, explained two remarkable facts: "the first is, that the image produced by the sun is direct, and not inverted, like those obtained by ordinary methods; the second is, that the light whitens the parts which it strikes, through a special action of the dextrine and chloride of lead varnish, while without this varnish it would impress a violet tint on the chloride of silver of the daguerreotype plate—a remarkable result, since M. Niepce has observed that the shadows of an engraving are reproduced in black on plates prepared with his varnish. The colours of the image are not produced simultaneously; for example, the yellow appears before the green, and when this latter is manifested the yellow is weakened, if not effaced. Does it not follow from this, that the way to reproduce the colours with fidelity would be by the use of screens, so arranged as to cover the parts where the colours are first exhibited, so as to give more time to other colours which require it?"

M. Flourens on Respiration.—In a warm-blooded vertebrate animal, respiratory movements are instantly arrested if the medulla oblongata is divided "in the centre of the V of the gray matter," and the creature dies immediately. In a frog, pulmonary respiration ceases on making a similar division,* but the animal continues to live through its cutaneous respiration. The respiration of a fish ceases if the medulla oblongata is divided by a section which passes just behind the cerebellum, and the animal dies more or less quickly, according to the species. M. Flourens observes—"The lobes, or cerebral hemispheres, minister to intelligence, and that only; the cerebellum is devoted to the co-ordination of the movements of locomotion, and there is a point in the medulla oblongata which presides over the movements of respiration."

Connection between Human and Cattle Disorders.—Professor Gamgee, in an article on the "Health of Stock," in the *Edinburgh Veterinary Review*, states that he has noticed a remarkable connection between diseases in man and in the lower animals; he believes many of the former may be traced to unwholesome food. The same authority affirms that on the average 33⅓ per cent. of the cows kept in any large town die annually of disease; and he asks, "If our sanitary reformers are alarmed at a mortality of two hundred persons in ten thousand, what will they say to more than sixteen times that mortality amongst our poor cows?"

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* The "nœud vital" of the frog exists in "l'espèce de pont que forme sur le plancher du quatrième ventricule, le cervelet, d'ailleurs très-petit, de ces animaux."—*Comptes Rendus*, p. 315, No. 6, 1862.

METEOROLOGY.—On the 18th of February, 1862, Mr. Thomas Hopkins read a paper before the Literary and Philosophical Society of Manchester, in which he alluded to the abandonment, by some recent writers, of the Hadleian theory of winds being caused by the ascent of heated air in tropical regions, and contended that "the great cause of atmospheric disturbance is to be found in the local heating of gases by the liberated heat of condensing vapour." He complained that such a phrase as a storm "comes from" a certain quarter misleads, as the cause of storms exists in the quarter towards which the wind blows.

POISONOUS FUNGI.—The *Veterinarian* of February, 1862, contains an important paper, by Professor Varnell, on the poisonous character of some oats on which fungi were growing. It appears that in August last year six horses died suddenly in the neighbourhood of Leeds, and the local surgeons and analysts could discover no traces of poison, although they ascertained that three feeds of the suspected oats were sufficient to cause death. The symptoms of the attack were a staggering gait, laboured respiration, and partial paralysis. *Post mortem* examinations exhibited congestion of liver and lungs, with inflammation of stomach and bowels. Having obtained a quantity of the oats, Professor Varnell examined them chemically and microscopically. The first method gave no information as to the cause of their action, but the latter disclosed a fungoid vegetation belonging to the genus *Aspergillus*, and some of the affected grain soon killed a horse to which they were given by way of experiment. Mr. Jabez Hogg, to whom drawings of the fungi were shown, stated that he met with many instances in which similar fungi had occasioned sickness and death in various animals.

HIND'S VARIABLE NEBULA.—The position of this curious body for 1862 is 4h. 13m. 54·6s. right ascension, and declination + 19° 11′ 37″. It was noticed by Mr. Hind, in 1852, by the side of a star of the tenth magnitude. Both nebula and star appear variable. From November 3rd, 1855, to January 12th, 1856, they were observed by M. Chacornac, who found the nebula plainly visible and the star 10 mag. Recently M. Le Verrier viewed both objects with a twelve-inch equatorial, and he found a star *a*, to the south-west of which the nebula is situated 5′ distant from a star *b*, marked 10 mag. in M. Chacornac's chart, No. 13. Like the latter observer, he found the star *b* always of 10 mag., but the star *a* only 12 mag. In a line with these two stars, and near *b*, he found a third star, smaller and not exceeding 13 mag. Neither M. Le Verrier nor M. Chacornac could discern any trace of the nebula. M. Foucault, with a larger telescope, confirmed this negative result. On the same date (January 26th), Mr. Hind noted the disappearance of the nebula. On February 14th, M. Chacornac found the star *a* visibly diminished, and less than the star *c*; the following evening *a* still inferior to *c*, and dull and nebulous, but no certain trace could be obtained of the nebula. On the 18th *a* was brighter than *c*, but still nebulous; at midnight the moonlight rendered *c* invisible with a telescope of 25 centimètres aperture, but *a* was distinctly seen.—*Comptes Rendus*, No. 6, 1862, p. 299.

TERRESTRIAL MAGNETISM.—M. Secchi, of Rome, publishes in *Comptes Rendus* a table of observations in 1861, from which it appears that the horizontal intensity of magnetic action has a tendency to vary with the wind. He observes, "this table evidently shows the predominance of a descending movement when the wind is south to the extent of 74 out of 100 times which this wind blows, and of an ascending movement during a north wind to the extent of 84 in 100." East and west he calls "winds of transition." He believes that the indications of a delicate galvanometer are capable of giving us notice of distant atmospheric perturbations, or of those which are coming within a couple of days.

THE COMET OF 1860.—M. Secchi observes—"It is singular that this comet should exhibit an obscure place in the middle of its tail till the 13th of June; it then manifested a bright luminous ray, which lasted till its disappearance in the southern hemisphere. The head had the nucleus surrounded with an aureole of rays. At length, on the 26th of June, a great eccentricity appeared in the two branches."

THE INTELLECTUAL OBSERVER.

MAY, 1862.

THE PROGRESS OF ZOOLOGY.

BY SHIRLEY HIBBERD.

Zoology may be considered one of the most fortunate of sciences. Like a well-spread table, it has something to tempt every taste, milk for babes, and strong meat for men. Its subjects are so varied, many of them so familiar, and all of them have so direct a reference to life, that its very theories are romantic, and its facts oftentimes rise to the level of poetry. The affection of a dove for her nestlings, or the persistent faithfulness of a dog following the corpse of his master to the grave, that he also may die there, are matters that scarcely come within the domain of the science to which the modern term "Biology" has been applied, but they represent the sentiment which has been, and still is, the corner-stone of zoological science. The animals that are more immediately associated with man in his enterprises are those in which the most notable variations of form and colour occur; and the economy of civilization has required a more than casual investigation of the circumstances which influence their welfare, as well as of their relations to each other. The two most natural of all sciences—if such a term may be allowed—are zoology and botany: they deal with the material necessities of human life, with the best adornments of the world, and, above all, with organization. It is the possession of Life that renders a waving blade of grass or a chirping sparrow more attractive than an impassive stone. If there were no stone there would, perhaps, be no sparrow, they are both essential to the oneness of the world; but the sparrow has consciousness; it exhibits the working of mysterious instincts; it moves by volition *per se*, and it utters in its chirpings somewhat of an idea. It may be that we are searching after the Principle of Life as if it were a material substance or mathematical entity, forgetful of Stahl's definition, *putredini contrarium;* but any way we do search, and not in vain, for at every step some discovery is made which affords encouragement for perseverance. But we may adopt the term "natural," as applicable to zoology and botany, in an especial sense, not because they treat of natural objects, for all sciences do that, but because their subjects are almost wholly contemporaneous, and those that are not so may be made so by the aid of analogy; so that even palæontology may be studied at the Zoological Gardens, and recent species among the models of extinct forms in the Crystal Palace. What Margaret Fuller expected of the sculptor may be as well expected also of the zoologist :—

> "If he already sees what he must do,
> Well may he shade his eyes from the far-seeing view."

Student and professor are alike concerned in one effort, and that is the separation of the natural from the artificial, and the proven from the conjectural, in all inquiries and all accumulations of facts. At the very threshold of zoology we perceive that there are many stumbling-blocks, and if we escape those without damage, we next perceive that there is a sort of antagonism between man and nature, the one insisting on creating, if he cannot find, a system, the other insisting that every fact shall stand for itself, and every creature enjoy an independent sovereignty. No doubt the plants and animals that redeem the world from stony deadness are so many members of a system as truly mathematical as the law which governs the relationships of the planets, but man has not yet discovered what that system is; and until he has mastered the last little item of organography, he must perforce rely upon invention, and classify his knowledge by artificial rules. It is a wonderful testimony to man's power of perception and analysis that since the second edition of Cuvier's *Règne Animal* there have been scarcely any contributions to the classification of animated nature of a character to influence deeply the aspects of the science. Even those of Professor Owen, who, pursuing the indications of analogy with the instinct of a poet, has only been able to rectify in some few particulars the deficiencies of Cuvier's magnificent scheme. In fact it is no easier for Owen than it was for Cuvier or Linnæus to define on what grounds a class, order, or genus shall be formed. Nature has no classes, no orders, no genera, she fashions creatures to lead a certain life, and places them in the conditions requisite to their well-being, and with a defiant nonchalance says, "Group them as you please;" and all that we can do is to define apparent relationships, and make a sort of artificial memory out of the signs presented to us. The acquisitions of anatomy and physiology have favoured the study of zoology in connection with the homologies of internal structure, and rendered zoology more recondite in the exact proportion in which its tests and comparisons have been removed from popular eyesight; but it has yet to be proved that structure and function are alone sufficient to afford satisfactory evidence of relationship for the purpose of grouping the subjects of the science into families and classes. There is a tendency in the modern school of zoologists to consider form as an accident of life, and as very remotely connected with organization, whereas, though it be very objective, it is certainly the true key to structure and function. The botanists have the best of it in a choice between two systems; they are neither tied to Linnæus nor Jussieu: and while the system of the first is a mere aid to memory, and as such invaluable, the other is self-expounding, and conveys information in its very terms, yet becomes entirely artificial under false pretences, when its assumed "natural" principle fails in the application.

It has never been attempted yet to establish a parallel between Bacon and Linnæus, and show how the inductive method so differently dealt with by each became the substantial basis on which their successors in the several departments of physics and natural history have built up the edifice of modern science. The *Novum Organon* and the *Systema Naturæ* are the two great pillars which sustain the portico of the temple for the completion and embellishment of which so many energies have been evoked, and so many splendid abilities combined. When we compare the classification now generally adopted with the scheme of the mammalia which Linnæus so patiently elaborated, we are astonished at the few departures from it which have been found necessary in modern times. Cuvier found ready to his hand a magnificent framework, and he did well in boldly clothing it, to hold in reverence the genius of his Swedish predecessor, who had determined the true elements of zoology so accurately, and had invented a language so well adapted to a comprehensive natural system, that the supply of deficiencies was almost all that remained to be done. But the deficiencies were many, and in none of the groups has rectification been more necessary than in the section to which Linnæus assigned the opossums, in the order *Feræ*, placing them between the bears, badgers, and racoons. Cuvier had the advantage of knowing most of the marsupials of Australia, and he arranged them in an order between the Carnassiers and Rodents, making the one great peculiarity in their mode of reproduction, the basis of the order *Marsupiata*. This, as regards the mammalia, was the distinguishing feature of Cuvier's scheme, and it is the one most likely soon to undergo a complete revolution. It is in the classification of the tribes below the Mammalia, and especially the invertebrates, that Cuvier shines; as on the other hand it was amongst those that Linnæus lost himself, as witness his class "Vermes," into which he flung all the animals that refused to take positions among vertebrates, or insects. To form a fair estimate of the progress of zoology in the classification of the orders in the vast stretch between Batrachians and Zoophytes, the *Systema Naturæ* must be explored, and its method of dealing with these compared with the labours of Cuvier and his successors. Still the principles of classification have remained nearly the same, at least since Cuvier, proving how truly he seized upon the characteristics really indicative of structural and physiological relationships. The most important proposal for a redistribution is that of Professor Owen for the division of the Mammalia into two great groups, the designations of which are self-explanatory. Under *Placentalia* he ranges all the higher mammalian forms in the same order as in Cuvier's scheme, but the marsupiates and monotremes are separated to form another grand division called *A-placentalia*, in which the monotremes are ranged to correspond to the edentates in the first division, and as their counterparts with a less perfect mode of reproduction. But this, though based on obvious and important distinctions, appears to have found little favour with zoologists, and, like the labours of Grant and Blainville on the nervous system, is valued more for the prominence it gives to certain physiological facts than for its adaptability to the purposes of classification in the present transition state of zoological science. These things are, however, the proper fruit of the labours in philosophical zoology which have been conducted with such ardour in Europe during the past half century, and we seem now to be waiting for a second Cuvier who shall boldly grasp the distinctive features of the animal kingdom, and arrest for a time the growing tendency to trifle with zoological landmarks by a revision of all boundary lines, and fitting into their proper places all that is true and durable in the various systems that have been of late propounded.

The frequent varying of the basis of classification, though inevitable, is not the less destructive to harmony, and that correspondence of mutual relationships which a system professes to unfold. That homologies of structure are to be regarded as of the first importance in the determination of the place an animal is to occupy in a natural system is self-evident; but it is worth asking, whether a purely artificial system would not serve as useful a purpose in zoology as it has done in botany, because it could be framed once for all, and serve for comparison at any future time with a progressive natural system, which of necessity can never be perfect. Pliny excites the laughter of the young naturalist when he describes the cat as the *only bird* that suckles its young; but a strictly homomorphic system would have its value, and the wonder is that no one has ventured hitherto to propose a scheme of the kind. Bats, squirrels, and marsupiates claim relationship with birds in their faculty of flight; the quadrumanes might as well contribute the marmosets to the family of squirrels, and the Douroucouli to the cats, as retain them for the doubtful character of their hands. The armadillo, *Dasypus apar*, is more like a turtle than a mammal; the Aard-wolf, *Proteles Lalandii*, is a hyena in its external aspects; the Cetacea are fishes, to all intents and purposes, in their habits of life, as well as in general form. Perhaps the difficulty of classing the marsupiates might be got over at once by homomorphism, for as at present regarded they threaten the boundaries of Rodentia, Carnivora, Cheiroptera, and Testudinata, and a classification resting on external configuration would serve all the purpose of an index to species without impeding inquiry into physiological and anatomical details. As it is, the natural system affords only a few faint indications of character, and the fault of all natural systems is that as soon as they cease to indicate correctly they lead the student astray, for after a few of the most characteristic groups have been defined—as in botany the Coniferæ, the Cupuliferæ, and the Ranunculaceæ, and in zoology the Quadrumana, the Carnivora, and the Rodentia—there are innumerable other subjects that refuse to conform to distinct positions by reason of their combining the characteristics of many. No system can suffice to indicate the place, for instance, of that curious vertebrate, *Amphioxus lanceolatus*, which, emulating the chameleon, has a life on one side, which has no necessary conformity on the other. The chameleon may sleep on the left side, while the right side is awake, and in the *Amphioxus* the bronchial aperture, the olfactory organ, and the eye, are all situated on the left side. The *Chamælonidæ* are, however, a well-defined group of saurians, but the *Branchiostoma* is as indefinable for scientific purposes as any of the cattle of fairyland. There is certainly room for an artificial system of zoology of a comprehensive kind for the tabulation of the entire animal kingdom.

Looking at the several departments of zoology in their present aspects, it is evident that the most satisfactory progress has of late years been in the study and classification of the lower forms of life. The aquarium and the microscope have given an impetus to the study of the Invertebrata, and such immense additions have been made to the knowledge of this great section, that the mere weight of facts threatens to separate it from the hitherto recognized connection with the vertebrates, and so to constitute in zoology two distinct sciences, the future paths of which will be separate though parallel. It is in this section that we have most striking evidence of the abundance of life in every region of the globe. Dr. Wallich and Mr. Gwyn Jeffreys have, by their researches on the subject of deep sea life, enlarged immensely the geographical limits and the physical conditions known to be favourable to the production of animal life. In that still lower department of the Infusoria, the magnificent work of Pritchard offers another example of the splitting up of old divisional arrangements through the accumulation of facts indicative of distinctive characteristics. The publication of a fourth edition of this work, combining the labours of Arlidge, Archer, Ralfs, Williamson, and Pritchard, with the magical delineations by Mr. Tuffen West,* is a sufficient proof that natural history flourishes in Britain, and that the objects least attractive to the popular eye are acquiring a popularity, such as to assure us that the cultivation of science is almost universally shared in by the intelligent classes of this country. But when we get among desmids and diatoms we have almost done with zoology, and we may take advantage of this extremity to offer a few remarks on the higher forms of the vetebrata.

If we are astonished at the abundance of life on the globe, and can sympathize with Dr. Livingstone's remark, that it "seems like a mantle of happy existence encircling the world," it is also pretty certain that some of its forms are fast passing away from us, and that not very far in the future the zoologist will pay as much attention to mammals recently extinct, as we do to certain fossil forms, because they fill up gaps in our classified system of transitions. That the dodo is utterly extinct there can be no reasonable doubt, for the region it inhabited has not only been thoroughly explored, but is now densely populated. The kiwi or apteryx is fast going in the same direction, and as the interior of New Zealand becomes a home for the white man, that and other feræ must of necessity disappear. The last dinornis has probably long since perished; yet it could not be long since there were at least eight species of dinornis, varying in size from that of the bustard upwards, *D. giganteus* being vastly superior to the ostrich in magnitude. The great quadrumana will probably be the next to disappear, for civilization will not tolerate the existence of anthropoid apes, and the mere savagery of what is called "sport" will extinguish them. The gorilla evidently occupies but a limited range of country, and that near the coast, and the tendency of civilization is to people the coasts everywhere with colonies of Anglo-Saxons, French, and Portuguese, respecting whom it is not easy to say which are the most active in the destruction of indigenous fauna. The beaver still holds a few secluded weirs in the North of Europe, but no one can say when it became extinct in Britain. The otter is so scarce in this country that the sport

* *A History of Infusoria, including the Desmidiaceæ and Diatomaceæ.* By Andrew Pritchard. London: Whittaker and Co.

of hunting it is almost obsolete, yet it is only thirty years since the finest otter ever seen in Britain was shot at Walthamstow, on the borders of Epping Forest, where it may still be seen in a very fair state of preservation. Of the *Falconidæ* there are few living examples left in these islands, and the eyrie of an eagle is as rare in England as the nest of a thrush in France, where the most melodious of songsters is valued only for its flavour in a pasty by a people who make great pretensions to the culture of the sentimental. The noble blackcock and the ignoble black rat appear to have vanished almost simultaneously from the British fauna, and the fox is probably following the wolf in full conviction that its mission is accomplished. Indeed the fiercest war maintained by man against animal races, is waged against the carnivora and the raptorial birds. In the Biblical narrative there are numerous evidences of the abundance of beasts of prey in Palestine and Phœnicia, where there is now scarce anything more rapacious than a fox to be found. David's adventure with the lion and bear could not now be repeated by any brave shepherd within a hundred miles of Jerusalem, and the traveller on the Euphrates and Tigris need entertain but little fear of those hungry lions which figure so conspicuously on the hunting freizes of Nineveh. Man not only lays the whole animal kingdom under tribute to furnish him with meat and labour, and entertainment and knowledge, but he busies himself to disturb the balances, and the gamekeepers of this country might be collectively described as destroyers of the British fauna. The relations of Sir Emerson Tennent and Dr. Livingstone make it pretty evident that the "half-reasoning elephant" is fast passing from the face of the earth to be numbered among the extinct animals by the naturalists of a century hence. When we read of the wanton slaughter of thousands of elephants, with no object but the gratification of the passion for destruction, we are tempted to lament that man possesses such complete dominion to subjugate, and such unlimited power to destroy. "Had the motive," says Sir Emerson Tennent, "that invites to the destruction of the elephant in Africa and India prevailed in Ceylon, that is, had the elephants there been provided with tusks, they would long since have been annihilated for the sake of their ivory. But it is a curious fact that, whilst in Africa and India both sexes have tusks, with some slight disproportion in the size of those of the females, not one elephant in a hundred is found with tusks in Ceylon, and the few that possess them are exclusively males."* In Africa the hunger for meat and ivory causes the destruction of the elephant to an extent which threatens soon to extinguish the large-eared

* *Sketches of the Natural History of Ceylon, with Narratives and Anecdotes* &c. &c. By Sir J. Emerson Tennent, K.C.B., LL.D., &c. Longmans and Co.

species altogether, but with neither of these incitements, it is perhaps being extinguished with still greater speed in Ceylon and India. There is a saving clause in the fact now established, that elephants will breed in captivity, but against it must be set the fact that in captivity it does not pay for its keep, and is scarcely worth the attention of those who employ it either for burden or draught. The elephant has too much character, too high a reasoning faculty, to be perfect as a servant; it has too many whims, too many eccentricities of temper, and consumes far more food than it earns in harness. Thus economically regarded, everything is against its preservation, and when the wild herds disappear, there will probably remain but few in a domesticated state, for unlike the horse, ox, ass, and sheep, it is both unprofitable and unmanageable.

Zoology has been somewhat restricted in aim, spite of its own breadth as a science and the liberality of its leading cultivators. It owes most of its advance in recent times in the absorption into its circle of the facts of past biological history to Professor Owen, whose "Palæontology" is a sort of panorama of extinct forms, placed side by side with their existing congeners and representatives. Australia and New Zealand have not only furnished innumerable subjects of anomalous kinds for the consideration of system makers, but they have opened the way for rays of light to fall on the present direct from the past, by their illustrations of geological eras. Nothing more strikingly exemplifies the relationship that subsists between all departments of knowledge, than the aid which zoology and geology respectively offer to each other. The existing fauna of Ceylon, as analyzed by Sir Emerson Tennent, affords very satisfactory indications that the island is, in no geological or zoological sense, an outlier of the vast Indian continent, but a site *sui generis* like Australia, detached not only in its geography from the neighbouring continent, but in its chronology also, and in all its organic productions. On the other hand, geology does more than whisper of the connection that once subsisted between England and the Continent of Europe by way of the straits of Dover, for it furnishes all the evidence requisite to establish the conclusion that the separation was effected not very long antecedent to the commencement of the historic era. Zoology does not touch the chronology of the question, but it affixes the general conclusion; and we begin to discover that, however valuable are the floras and faunas of Britain, they tell but half their proper story unless considered in connection with the floras and faunas of the Continent.

Two admirable works have recently been published, with the object of indicating the relations of British and Continental zoology. That by Lord Clermont is a compilation, but it is accomplished with so much skill and good taste, that it acquires a character of originality both by its purpose and its merit.* The British fauna is a part of the fauna of Europe, just as the fauna of a county is part of the fauna of the country at large: and Lord Clermont's work will tend to widen the range of the British naturalist, by showing that many of his subjects have an extensive area, and must be studied under all their several geographical conditions for a full knowledge of their habits and physiology. Dr. Bree,† though working in another direction, points to the same lesson. By registering the birds of Europe *not* found in Britain, he enables us to estimate the close connection by reason of community of species which exists between the aves of Britain and the Continent, so that we can lay claim to but very few as exclusively British.

The great scientific question of the day is, What is a species? We shall not attempt to offer a reply. Mr. Darwin has made as great an agitation in the world of science as the *Essays and Reviews* have in theology, but there is no process of excommunication known in the zoological establishment; and those who differ from Mr. Darwin can heartily thank him for having put their accepted formulæ to a severe test, and opened an almost new channel of inquiry. If there is a vagueness about the characters of species, there is still more about the meaning of varieties. Has it never occurred to the reader that every animal is, in a certain sense, a variety; that every individual creature has a distinctive character of its own; so that our so-called varieties are such only by reason of a greater departure from type than usual, the fact of departure being itself so universal that type is almost undiscoverable. Sir Emerson Tennent says every herd of elephants in Ceylon has some distinctive features; in one herd the individuals are affected with red spots on the skin, in another the tushes are more fully developed; and what is more remarkable, as bearing on this question of species, it appears that every separate herd is a separate family, bound by ties of consanguinity, so that we may suspect—the case not being proved—that the distinctive family characters, which give every herd some peculiarity of form or colour, is the result of breeding in and in, which every flockmaster and poultry-keeper knows to be remarkably productive of what are called permanent varieties. The African elephant appears to be equally subject to variety as those of India and Ceylon. In his twenty-seventh chapter

* *A Guide to the Quadrupeds and Reptiles of Europe.* By Lord Clermont. London: John Van Voorst.

† *Birds of Europe not observed in the British Isles.* By Dr. C. R. Bree. London: Groombridge.

Livingstone says, "On the Kalomo we met an elephant which had no tusks—as rare a sight in Africa as one with tusks is in Ceylon." So in the proportions of the beast it varies so much that the rule that twice the circumference of the fore-foot equals the height of the animal has many exceptions, and one measurement is by no means a certain indication of the other.

The facts accumulated by Darwin and his coadjutors in this inquiry place the question of species in a very different light to that in which it was regarded by Lamarck. External influences and a power of adaptation to circumstances are terms that sound well and promise much, but they come to little when severely tested. *Felix qui potuit rerum cognoscere causas.* If the wading birds have acquired long legs by treading tip-toe on the muddy flats where they seek their food, how is it the ostrich has not, during more than 3000 years, accomplished a stretch of its wings? for it flaps them fiercely enough during its perambulations to cause growth if they were conformable to the alleged law of modification by circumstances. The fancy pigeons, which assume so many forms that we almost doubt at last if they are pigeons, maintain the specific characters of the wing almost unaltered. The ibis of to-day is the same in all its characters as the ibis on the oldest Egyptian monuments; the same is the case with the African elephant as figured on ancient coins, and it becomes now a question whether any departure from type can long maintain its ground—whether, in fact, variation in a marked degree is not the first step in the process of the extinction of the race in which the variation has occurred. The turnip and the potato as now cultivated in our fields are varieties secured by *artificial* selection, and they appear to be fast declining in vigour, so much so that farmers are seeking substitutes for both, to fill the places in the routine of tillage, which they threaten soon to leave vacant. In these cases the process of Nature seems to be only permissive as regards varieties, and that but for a season; they must revert to type or disappear.

In the applications of zoology, especially in connection with physiology, which is the key to zoological secrets, this question of species has more than a technical value. The whole interests of civilization are bound up with it. The patriarch Jacob was evidently an adept in cross breeding and the selection of races, and observed the law that "like produces like" with as much discretion as Mr. Jonathan Webb, the modern master of the art of sheep breeding. Dr. Beke, who has just traversed the country where Jacob grew rich in tending Laban's flocks, reports that "ring-straked, speckled, and grisled cattle" abound there, and apparently within such a circumscribed range as to render it probable that the race has maintained its integrity since the day of the patriarch's servitude, which our marginal Bibles place at a date 3600 years antecedent to the present time. The tailless cats of the Isle of Man and the tailless poultry of Burmah are scarcely to be traced back to their parentage, and have all the characteristics of true species as far as their constancy of reproduction is concerned. In his twentieth chapter Livingstone says, "Near Massangano I observed what seemed to be an effort of Nature to furnish a variety of domestic fowls capable of bearing with comfort the intense heat of the sun. Their feathers were curled upwards; thus giving shade to the body without increasing the heat. They are here named 'kisafu' by the natives, and 'arripiada,' or shivering, by the Portuguese. There seems to be a tendency in Nature to afford varieties adapted to the convenience of man. For instance, a very short-legged species of fowl was obtained by the Boers, who required one that could be easily caught in their frequent removals. A similar instance of securing a variety occurred in the short-limbed sheep of America." Such things as these are matters of daily observation; the question is, to what law are they subject, or, in other words, what is the philosophy of their occurrence? If Mr. Darwin had sent forth his book as a collection of data, instead of as the statement of an hypothesis, there would have been the same broad field for discussion, but with the advantage of greater freedom; for it is in vain to seek for the philosophy of varieties until we have arrived at an unexceptional theory of species, which we certainly have not, unless it be the vague definition that a species is a congenital expression of all the forces concerned in its production. Our conclusions for the present are provisional, and each new conclusion arrived at simply pushes the inquiry a stage farther back. The subject is as much one for experiment as for inquiry into the accidents of nature. The intermediate form between the horse and the ass is a mule, which is infertile with another mule of the opposite sex, and it is thenceforth concluded that all hybrids of a given class are incapable of procreation among themselves. But M. Rouy, of Angoulême, is reported to breed hybrids between the hare and the rabbit by thousands for the market, and these leporines are further stated to be fertile both with the hare and the rabbit, and with each other. Some of these leporines have borne young in the Gardens of the Zoological Society, but whether they are of the first cross is at present unknown. The differences between the two types are many, yet they are rather in degree than kind. The heart of the hare is nearly five times the weight of that of the rabbit, the lungs are nearly four times as heavy, the calibre of the trachea three or four times as great. Furthermore, the period of gestation in the hare is understood to be a month, that of the *wild* rabbit three weeks; the young of the rabbit are born blind, those of the hare see; the rabbit burrows, the hare seldom goes to earth. There is one great peculiarity of these hybrids of very great importance as to the question at issue—the males show a great disinclination to copulation, which is very different to the males of the (so-called) species, and if we were to suppose such a cross to arise in nature, we must also suppose it would soon be lost through this very peculiarity. But much more interesting cases bearing on the same question were communicated by Dr. Crisp, in the paper from which we have gathered the above particulars.* Four hybrid ducks were bred at the Zoological Gardens between the summer duck (*Anas sponsa*), the pochard (*Fuligula ferina*), and the ferruginous duck (*Fuligula nyroca*). It is true that in these instances the parent species are in structure and habits very nearly allied, and the only difference of importance is, that the summer duck has eight pairs of ribs, the others have nine; but an extra pair of ribs is no proof of specific distinctness, for in man an extra pair occurs occasionally, and in the anthropoid apes there is sometimes a pair of ribs and one or two vertebræ above the typical number, and the ribs themselves are but elongations of processes with which every segment of the vertebral column is furnished. But these facts compel us to ask still more eagerly, what is a species? Are the three species of duck just named specifically identical, and did the hare and the rabbit originally proceed from the same stock?

It will be observed that the most notorious cases of hybridization and variation occur in connection with the interference of man with the proceedings of Nature. Wild varieties are plentiful, but the range of variation is more limited. The first object of man, whether he subjects animals to an artificial mode of life for profit or amusement, is to cause them to produce varieties. One way or another he invariably makes attack on the organs of reproduction, or attempts a diversion of their function from its normal course; and it is worth considering whether he does not unintentionally bring into action circumstances that will some day bring about an extinction of his varieties, unless their vigour is occasionally replenished by the infusion into it of wild blood. The frequent crossing of the most valued varieties of domestic animals indicates somewhat of a recognition of this fact, that varieties tend to die out. In the case of the animals used in agriculture, the practice of castration must have some effect in diminishing the vigour of races. The males castrated are at once removed for ever from

* *Proceedings of Zoological Society*, Feb. 12, 1861, paper by Edward Crisp, M.D., F.L.S.

the domestic circle, and no variation or deterioration of the race can possibly arise through their communication of a diminished vital force. But their removal throws the task of procreation on a fewer number of males, and a given amount of procreative force is of necessity spread over a larger surface; in other words, every ram, bull, and stallion, has to beget a larger number of progeny than it would do in a state of Nature, and that progeny, it seems fair to assume, must inherit less of the initial vigour which is the foundation of the physical constitution of the individual. Variation itself, apart from this consideration, appears to be in the majority of cases congenital, and so representative of the circumstances attending the physical origin of the individual life. The story in the *Cloud of Witnesses* of a man yielding milk when a child was put to his breast during the persecution in Scotland, receives some confirmation from the account given by Humboldt of a human male that gave forth milk. Livingstone tells of grandmothers suckling grandchildren, which are cases quite to the point, and evidently of the class of congenital variation. In the individual, castration has an immense influence in modifying all the characteristics peculiar to the male sex; and barren females and impotent males, whether of the genus *Homo* or any other genus, are influenced in their whole physical character in a manner consistent with their exceptional sexual condition. Among our domestic horned animals, the size and configuration of the horns vary so much from the normal type, that we have a tolerably safe index thereby to the whole pedigree of the races, and congenital peculiarities are most strikingly exhibited in the variations which the horns exhibit. It is said that if a stag is castrated when his horns are in a state of perfection they will never be shed; that if the operation is performed when the head is bare they will never be regenerated; and if it is done when secretion is actually going on, a stunted, ill-formed, permanent horn is the result, more or less developed, according to the period at which the animal is emasculated.† In the museum of the College of Surgeons is the head of a fallow-deer, bearing a pair of half developed horns unequal in size, and wholly without palmations, but of unusual thickness, and covered with wart-like protuberances resembling incrustations. This animal was castrated; the horns were not shed at the usual time, and they shortly afterwards acquired the peculiar character which renders them so unique as specimens.

In horned animals that have never been subjected to domestication, there is a remarkable constancy of character in the development of the horns and their symmetry. The beau-

* *English Cyclopædia*, Nat. Hist. Cervidæ, c. 843.

tiful lyrate horns of the *Kobus maria* (Gray), a new antelope from Central Africa, afford a fair sample of the beautiful proportions and graceful outlines common to all horned animals in a wild state; and though no antelope from Central Africa could be expected to prosper in our climate, so as to form an addition to the embellishments of an English park, the southern regions of the same continent offer numerous species equally beautiful for economic as well as decorative uses in this country. (Fig. 1.)

Another equally beautiful example is that of the Sable Antelope, *Aigocerus niger*, recently added to the collection of the Zoological Society from the mountainous region lying to the north and east of Southern Africa. The graceful crescent-like sweep of these horns, upwards of three feet in length, would, doubtless, soon undergo such modifications as would make an end of their beauty if the animals were reduced to domestication, and a breed secured for market purposes. (Fig. 2.)

That we are not giving undue importance to this subject may be determined any day in Smithfield market. The tendency of breeding is to destroy horns altogether. Our best breeds of sheep are now hornless. Many of the most esteemed breeds of cattle are also hornless, and of those that still possess those appendages, the *short horns* are the most prized. In the few forests that still shelter the deer in Britain, fine specimens of horns are rare, and the "muckle Hart of Benmore," stalked by the late Mr. Charles St. John, was probably the last of its race for magnitude of frame and antlers. So the goat having altered less than any of the animals of the homestead, because less cared for than all the rest, retains his "crescented cornua" in all the breeds except the Spanish, which is the most fertile, the most improved according to agricultural standard, and the most easily managed, because by loss of horns rendered harmless. Bucks of this breed do occasionally wear the proper sign of Capricornus, but they are becoming more rare every day. But Nature defends her types with some obstinacy, and rather than part with them when the current of her aims is turned aside by the inventions of man, she sometimes pursues an opposite course, and in the case of horns the development is then such as to indicate a stronger probability of extinction than when horns are obliterated altogether. A curious example of this is the Galla, or Sanga Ox of Abyssinia, of which Bruce gave the first account, alleging that "the extraordinary size of the horns proceeds from a disease that the cattle have in these countries, of which they die, and is probably derived from their pasture and climate. * * * * His value then lies in his horns, for his body becomes emaciated and lank in

Fig. 1.—Symmetrical Horns of Kobus maria (Gray).

Fig. 2. Symmetrical Horns of Sable Antelope (*Aigocerus niger*).

proportion as the horns grow large; at the last period of his life the weight of his head is so great that he is unable to lift it up, or at least for any space of time." Mr. Salt, who saw these oxen in Abyssinia, denied that the size of the horns was occasioned by disease; but Mr. Vasey, in his *Delineations of the Ox Tribe,* insists that Salt's own evidence is against him, and he reproduces a figure from Salt to substantiate Bruce's account of the animal being both "lank and emaciated." We have copied the head and horns from Vasey's plate (Fig. 3), which will give the reader an idea of the disproportion between the horns and the head that carries them. This is usually considered to be a variety of *Bos Taurus,* but there are some differences which Mr. Vasey considers sufficient to render the identity doubtful. In the specimen of the Sanga, in the museum of the College of Surgeons, which is not the largest that has been seen, the horns measure 3 feet 10½ inches in length round the outer curve; the distance between the tips is 3 feet 4 inches, the circumference at the base 1 foot 3 inches; and the distance between the bases at the forehead, 3½ inches. The last measurement is certainly favourable to Bruce's statement, for it implies a narrowness of the frontal plate quite out of proportion to the enormous magnitude of the horns. According to Livingstone, the Bakalahari, one of the oldest of the Bechuana tribes, possessed "enormous herds of the large-horned cattle mentioned by Bruce, until they were driven into the desert by a fresh migration of their own nation," and their loss of them may be attributed to their occupation of an almost rainless region unfitted for the support of herds of cattle, rather than to any inherent weakness in the large-horned race. The Hungarian ox, which has horns measuring 3 feet 4½ inches, with a distance between the tips of 5 feet 1 inch, though known to be a variety of *Bos Taurus,* resembles the Sanga in the narrowness of the head, which is so neatly and delicately formed as to appear unfit to carry such enormous appendages. The Arnee, a native of the higher parts of Hindostan, has horns of still greater dimensions than either of the preceding examples of the genus *Bos.* A pair in the British Museum measure in length from tip to base 6 feet 6 inches and 6 feet 3 inches respectively, but the animal is reported to measure usually twelve, and sometimes fourteen feet from the ground to the highest part of the back. To quit this subject we subjoin a figure of the head of a four-horned sheep in the possession of the writer, in which the horns are remarkably unsymmetrical and largely developed, the result of imperfect castration. (Fig. 4.)

Whatever may be the ultimate effect of hybridizing and domestication, society looks to zoologists for assistance in

Fig. 3. Four-horned sheep (unsymmetrical).

Fig. 4. Horns of Sanga Ox of Abyssinia.

increasing the necessities and comforts of life by an utilization of acquired knowledge. The Zoological Society has done so much in the way of acclimatizing animals suited to vary the supplies of our tables, that we look to it for something more: the contribution, for instance, of a few new dishes, for it begins to be a discredit to us that, having laid the world under tribute for its animal products, our staple animal foods should still comprise so small a round as beef, mutton, and pork, varied only by inversion to pork, and mutton, and beef. The kangaroo, which affords the choicest of all dishes to the Australian squatter, has been found to prosper in English parks, and is remarkably prolific and manageable. We may some day see herds of elands among the pasture stocks, for it is now thoroughly acclimatized at Hawkstone and Taymouth; but there are numerous antelopes, Himalayan partridges, and species of *Ovis* and *Caprea* that prosper in this climate, and might become permanent additions both to our fauna and our food resources. The nilgai, the largest of the Asiatic antelopes, breeds freely in the Society's garden, and produces two fawns at a litter. The Sambur deer (*Rusa aristotelis*) is proved to be as hardy in England as any of our domestic cattle. The Persian deer (*Cervus Wallichii*) promises to become permanently established. The Barbary deer (*C. barbarus*) is bred by Viscount Hill, at Hawkstone, and has been seen in England in the form of meat. The pretty Ceylonese deer (*Hyelaphus porcinus*) breeds readily in confinement, and might be distributed for fancy culture as a household pet, and to vary the round of comestibles on festive occasions; and the magnificent species of wild sheep from Northern India and Tartary thrive so well in this country, that breeders might take note of them as offering the materials for new crosses with our domestic breeds, to stimulate with fresh vigour the future races of British sheep. It is odd that among nearly ninety species of antelopes now known, there is not one available for the purposes of the butcher. The ravages of pleuropneumonia and rot among cattle and sheep in this country, entail losses which, if the average annual aggregate were stated, would appear fabulous, afford, at least, one good reason for a bolder policy in the applications of zoological science. It would be a good beginning in such a desirable undertaking if the Zoological Society were to follow the example of the Horticultural, and appoint committees to cook and eat a few selected specimens occasionally, and having reported thereon, to arrange for the distribution of animals in pairs for peopling the parks and meadows, and, if possible, the paddocks, and waysides, and commons of Britain.

We remarked above that the literature of science is of late years distinguished by the number and value of monographs. We have already referred to some of these, and must now be brief. The best *resumé* of the rectifications now generally adopted in the classification of the animal kingdom, is unquestionably Mr. Rymer Jones' *General Outline*,* and in this will be found carefully digested, the results of recent inquiries into the structure and physiology of the Quadrumana, the Marsupiata, and the Reptiles. A Dutch zoologist, Professor Van der Hoeven, of Leyden, has published a valuable systematic work, which has been carefully translated by Dr. Clark. This is the best summary we have of the present state of zoology, and, as soon as it becomes known, will be generally accepted as a safe guide to the results of scientific endeavour in the rectification of fundamental principles.† The *Essay on Classification*, by Louis Agassiz,‡ is a grand analysis of the distinguishing features of the several departments of the animal kingdom. Professor Bell's *History of British Quadrupeds*,§ is a worthy companion to the same author's admirable *History of British Reptiles*, and the beauty of the illustrations give it that peculiar value which most of Mr. Van Voorst's books have; that of rendering zoology popular and attractive without lowering the tone of scientific teaching, or coupling with it the sin of inaccuracy which is so wofully committed by compilers of popular books. But the best monograph of modern times is Mr. Gosse's *Actinologia Britannica*,|| because it compasses untrodden ground, rectifies the errors of Johnston, who stood for this class until Mr. Gosse took it in hand, and develops a system of classification founded on observation, dissection, and experiment; it is, in fact, as near an approach to the model of a natural system as can be imagined in the present state of zoological science. If envy were pardonable, we would envy Mr. Gosse the two-fold capability of wielding pen and pencil with equal effect, and by reproducing living forms of a somewhat untangible character, so that whether by description or representation, we can not only identify them as counterparts of realities, but penetrate the secrets of their structure, as he himself has done by unwearied toil and perseverance, with the aids of the aquarium and the microscope. Jonathan Couch's *British Fishes*¶ will probably supersede the great and glorious

* *General Outline of the Organization of the Animal Kingdom.* By T. Rymer Jones, F.R.S. London: Van Voorst. Third edition.

† *Handbook of Zoology.* By T. Van der Hoeven, Professor of Zoology in the University of Leyden. Translated by the Rev. W. Clark, M.D., F.R.S., etc. 2 vols. Longman.

‡ Longman and Co., and Trübner and Co.

§ Van Voorst.

|| *A History of British Sea Anemones and Corals.* By Philip Henry Gosse, F.R.S. Van Voorst.

¶ *A History of the Fishes of the British Islands.* By Jonathan Couch, F.L.S., with coloured illustrations of all the species. Groombridge and Sons.

work of Yarrell. There is a magic in colour where birds and fishes are delineated, and identification can only be safely secured by the assistance of coloured prints accurately drawn from the life. Mr. Couch has done this much for British fishes, and deserves the thanks of all naturalists for the production of a work that was much needed, and that will add considerably to his high reputation. Mr. Vasey's work on the *Genus Bos* * has evidently been a labour of love. It embodies the results of painstaking research extending over several years, and the spirit of careful discrimination and severe accuracy in which it is written, merit the attention not only of readers of books on natural history, but also of the writers of them, for guess-work is largely indulged in and anecdotes are too often made the means of covering positive deficiency of zoological knowledge. We need monographs of the Equidiæ, Cervidæ, and Antelopeæ, in a similar style, and a gathering of the facts in each towards the determination of the relations of varieties to types, and the economical values of the species which are adapted to the climate of Britain. Another desideratum of zoological literature, is a comprehensive treatise on the distribution of the British fauna, for which Dr. Forbes's *British Quadrupeds* already affords a basis. If such a work were undertaken in the spirit and worked out to the completeness of Watson's *Cybele Britannica,* it would be invaluable, not only as affording information of the geographical range of any British species, but also of assisting to the determination of the relations of British to European zoology. Other monographs, which we cannot stay to eulogize as they deserve, are Mr. Blackwall's on *Spiders,* published by the Ray Society; Dawson's *Geodephaga Britannica;* and the *Dodo and its Kindred,* by H. E. Strickland and Dr. Melville. But the strictly popular works of the present day are mostly built on substantial frameworks, and the fragmentary knowledge they communicate to the great class known as "general readers" is good of its kind, carefully arranged, and reliable as to detail. The Rev. J. G. Wood's *Natural History*† is the best sample we know of the popular method of treating a scientific subject, and it is due to its amiable and industrious author to say that he has gathered pearls from many seas, and strung them on thread that will bear some critical tension. It is the best and most beautiful popular work now before the public.

* *Delineations of the Ox Tribe, or the Natural History of Bulls, Bisons, and Buffaloes.* By George Vasey. Briggs, 421, Strand.

† Routledge, Warne, and Routledge.

WORK FOR THE TELESCOPE—PLANETS OF THE MONTH—DOUBLE STARS.

BY THE REV. T. W. WEBB, F.R.A.S.

PLANETS OF THE MONTH.

Mercury will be favourably situated towards the end of the month, and may be looked for with the naked eye, between sunset and 10 p.m.

Venus continues very brilliant in the mornings.

The transits of Jupiter's satellites and their shadows will occur as follows:—

May 1st was included in our last number. 4th, III. emerges at 11h. 14m.: its shadow enters at 12h. 12m. 8th, I. enters at 11h. 36m.: its shadow at 12h. 42m. 10th, shadow of I. goes off, 9h. 27m. 11th, shadow of II. emerges at 10h. 49m. III. enters at 11h. 34m. 12th, IV. enters at 10h. 40m. 17th, shadow of I. comes on, 9h. 6m., the satellite itself leaves at 10h. 12m.: the shadow at 11h. 22m. 18th, shadow of II. enters at 10h. 37m. II. goes off, 11h. 24th, I. enters at 9h. 47m., and departs at 12h. 4m.: the shadow's ingress is at 11h. 1m. 25th, I. comes on, 10h. 40m. 31st, I. enters at 11h. 40m.

It will be observed how much the satellites and shadows have widened their distance in proportion to the increasing departure of the planet from opposition to the Sun. There may be some hope of dark transits on 4th, 11th, and 12th; but we must look out carefully, for the planet is getting further from the Earth, and by the end of the month his diameter will have diminished to 35″·4.

The most interesting phenomenon in the heavens at the present season is unquestionably the disappearance of the ring of Saturn, which will take place May 18, from which time, till August 12, the planet will appear destitute of this magnificent ornament, if ornament that may be called, which is no doubt so constructed by the All-wise Creator, as to subserve the most important and beneficial purposes. The cause of the phenomenon is pretty generally understood; but it may be well to refer to it in this place on account of some curious details connected with it. The position of this great plane (or rather assemblage of planes—*the only flat surface that we know of in the universe*) does not coincide with the plane of the orbit of Saturn: if it did, it would always present its edge to the sun, and neither of its sides would receive more than a horizontal illumination. Nor does it lie in the plane of the orbit of the Earth, which is inclined to that of Saturn, and, excepting in the two points where it crosses his orbit, has no reference to it whatever. But it is so placed as to make a considerable angle (26° 49′ 17″) with the orbit of Saturn, and while it is carried round the Sun with the planet, it remains always parallel to itself, since a fresh direction could only be the result of a fresh force impressed upon it from without; and no such force exists. Hence, in the course of one revolution of Saturn, or $29\frac{1}{2}$ of our years, it turns first one and then the other side to the Sun; and in passing from the one to the other position, presents to him for a short time its edge, in which situation, from its extreme thinness, estimated by the American astronomer Bond at less than 40 miles, it will not reflect light enough to be visible at the distance of the Earth, without the greatest difficulty. But this is not the sole condition of the phenomenon, which depends not only on the position of the Sun, but of the Earth also: as the Earth is but seldom exactly in the line between the Sun and Saturn, it may so happen that the edge of the ring, when not presented to the Sun, may be turned towards ourselves, and then again its thinness will withdraw it from sight. And there is a third case of partial disappearance when the Sun and Earth are on opposite sides of the ring, and we look on the darkened side. This conjuncture is soon about to take place. May 18, the Sun passes from the south side, which we have been looking upon since February 1, to the opposite one out of sight from the Earth, and consequently its aspect will be entirely reversed from light to dark, with a singular corresponding reversal of visibility: the portion crossing the ball, hitherto undistinguishable on a bright background, will become strongly visible as a dark line of fully 2″ in breadth, and the extremities, previously so distinct against the dark sky, will disappear. After this epoch (May 18) the Earth's orbital motion carrying our eye towards the plane of the ring, the breadth of the dark streak will diminish; but not in a regular progression, for the Sun, gradually rising to a height of 1° 20′ above the ring, will cast a shadow upon the ball, which, increasing as the ring decreases, will keep in some degree the apparent breadth of the band. A few telescopes will be able, during this period, to distinguish the ring from its shadow, by bringing out a most delicate line of light between them; but they will be few indeed. It was seen by Dawes in 1848 with a $6\frac{1}{3}$ inch object-glass; but his eye is an extraordinary one. Schmidt also seems to have seen it in that year; and Jacob perceived it with an object-glass of 9 inches as recently as last December. This interesting series of phases will terminate on August 12, by the final disappearance of the ring as we pass to its enlightened north side, which will continue uninterruptedly in sight for nearly fifteen years; and fifteen years are enough, compared with the short existence of man, to make us anxious to see all we can of this beautiful phenomenon, whose recurrence to us lies among expectations so uncertain in the far-off distance.

Were the ring symmetrical in all its parts and subdivisions, as we perhaps might have expected, this description would comprise all that would fall under our notice: the ellipse would close up into a line, and open out into an ellipse again, with mathematical precision. But such is not the case: there are anomalies, and like other anomalies they are, or may become, peculiarly instructive. As to the knotty aspect which the ring often assumes when reduced to extreme thinness, this, as Olbers pointed out long ago, is the mere effect of perspective foreshortening upon unequal degrees of illumination: the ring consists of concentric zones of different degrees of brightness; the ends of these, when viewed very obliquely, will expose the greatest amount of illuminated area, and in consequence of that irradiation which apparently enlarges all luminous spaces, in proportion to their brilliancy, at the expense of neighbouring dark ones, will appear to project like knots or beads upon the minute line formed by the fainter parts of the ring.* So far the explanation is satisfactory: and though these knots have been seen even when the dark side of the ring has been turned towards us, this has been accounted for by Bond, as the reflection of the Sun's light from the edges of the rings, which we might see through their interstices from beneath. But when we find the number of knots unequal on the two sides of the planet, as has often been noticed, and especially by Schröter and Harding in 1803, or when the two ansæ are unlike in length, or breadth, or continuity, or in the epoch of vanishing or reappearing, as in 1671, 1714, 1744, 1774, 1789, 1803, 1833, and 1848, we are obliged to infer some physical irregularity;—either the rings do not all lie in the same plane, or they have, as Schröter thought, mountainous prominences of great magnitude: the latter idea, singular as it may appear, is countenanced by the notched form of the shadow upon the ball which was several times seen by him, and since by Schwabe (probably) in 1848, by Lassell in 1849 and 1861, and by De La Rue also last spring. If this, however, is the cause, the rotation assigned to the ring by Sir W. Herschel from a moveable protuberance in 1789 must be abandoned, at least upon that ground, since his observation, never since confirmed, is contravened by the stationary character of these projections: rotation would not be incompatible with the idea of different planes;

* This appearance I witnessed with my $5\frac{1}{2}$-inch object glass on February 7 and 8, and March 4, last, but best under inferior definition, any obscuring cause affecting the brighter less in proportion than the fainter parts of the line.

but if we may credit the statements of a far inferior observer, De-Vico, who saw a lucid point adhering to the *opened* ring in 1840 and 1842, it can no longer be maintained upon any ground, and the ring must be considered fixed. How to account for its stable equilibrium and permanency would then be a difficulty indeed; for even with the powerful aid of rotation it has driven the American mathematicians (who have especially investigated the subject) from the old idea of solidity; Pierce taking refuge in the supposition of a fluid, and Maxwell in an aggregation of unconnected particles. The great Roman observer, Secchi, inclines to the idea of a gaseous or vaporous constitution. The faint visibility of the dark side of the ring, when it has been turned towards us, which was remarked by Herschel I. in 1789, and by Bond and Dawes in 1848, is an additional puzzle, especially the coppery tinge which was detected in it by the latter observer. It seems, from Bond's investigations, that it cannot arise from a twilight produced by an atmosphere surrounding the ring; nor is the direction of the Sun's rays favourable to the idea of a slight transparency, which otherwise its astonishing thinness would render very probable. Almost everything connected with this wonderful appendage seems at present involved in impenetrable mystery.

DOUBLE STARS.

Before offering to the reader a list of beautiful or interesting double stars,* we shall repeat what was stated at the close of the previous paper, that the possessors of even small telescopes will find many of them within their range, though of course limited apertures will detract from their brilliancy and distinctness. Admiral Smyth has assured us that the majority of the binary pairs may be reached with an object-glass of $3\frac{3}{4}$ inches in diameter, and that many of them may be beautifully seen with $2\frac{3}{4}$ inches; some of them he found distinctly visible with only two inches. Even the common little hand telescope, if good, may be turned to some account by any one who will adapt to it a deep astronomical eye-piece, and a small amount of skill in such matters will enable this to be done, and a suitable stand to be added, at a trifling expense. As an illustration of what might be effected in this way, I may mention that I have thus seen not only Mizar, but even Castor, of course in feeble light, but very well defined, with an object-glass of only $1\frac{1}{3}$ inch. It is possible indeed that with inferior optical means our first view may not answer our expectations; but the same great master, to

* See an "Introductory Paper on Double Stars," *Intellectual Observer*, p. 143.

whom we amateurs are so deeply indebted, will teach us that "many things deemed invisible to secondary instruments are plain enough to one who 'knows how to see them;' . . . . the eye itself improves, and the vision becomes sharper under practice, insomuch that the telescope seems to improve."

Assuming, then, that the student is anxious to make the best of his means, whatever they may be, we shall previously beg his attention to a few remarks which, in some cases at least, may be found of service.

No observer who hopes to see anything to advantage will think of stationing himself at a window, unless indeed his tube is long enough to carry the object-glass well out into the open air. Excepting at those seasons of the year when the external and internal temperature are equalized, the intermixture of warmer and cooler currents at an open window destroys all hope of distinctness with any magnifying power worthy of the name. It seems to be from this very cause on a large scale that the undulations and flickerings arise of which astronomers complain so much and so often. The success of Professor Piazzi Smyth's "Experiment" on the Peak of Teneriffe demonstrates how much the definition of our telescopes would be improved, could we leave the less equable regions of the atmosphere beneath our feet; but at any rate we need not artificially aggravate the evil which at our ordinary level we cannot avoid. The indistinctness thus produced is found to grow rapidly with increase of aperture, as indeed must be the natural consequence of including a greater amount of agitated medium in the cylinder of rays which the telescope brings to a focus; and hence the Roman astronomers who, even in that serene and pellucid air, find many a cause of complaint, occasionally contract the 9½-inch aperture of their noble achromatic to little more than five inches, in order to diminish the disturbance in less favourable nights. So far the possessors of smaller instruments are not without their advantage: they do not see so much, but they see more quietly, and they can employ a greater number of nights with tolerable comfort. The unsteadiness of a boarded floor is another argument for out-door observation. We are, generally speaking, scarcely aware how extensively vibrations may be propagated, even through materials of little apparent elasticity; but the shaking of the earth for many miles round an exploding powder-mill—fifty or sixty miles in the terrible Hounslow explosion in 1850—is a convincing instance of this; and when the celebrated optician Troughton used a small observatory in Fleet Street, during the two quiet hours—from 2h. till 4h.—in a London night, he used to perceive the approach of a distant carriage by the vibrations of a star in the telescope some considerable time before the slightest sound was audible. Hence, for accurate observations, instruments are mounted on the most solid piers of stone or brickwork, entirely insulated from the tremors of the surrounding floor; and hence the disadvantage of keeping the same boards under our telescope and ourselves. On all accounts, therefore, an out-door situation is best; and we may be assured, from the almost universal experience of astronomers, that the much and very unjustly calumniated "night air" will work us no kind of harm. Of course, we shall use the ordinary precautions against catching cold; and our instrument will require equal attention, for object-glasses have a very inconvenient facility in catching dew. If brought uncovered suddenly into air of a very different temperature, this is pretty sure to happen, just as it does to a glass of cold water brought into a heated room; and in a dewy or frosty evening it will take place from radiation. The best mode of obviating this is to take off and ultimately replace the cap of the object-glass in the air in which it is used, and to provide it with a "dew-cap," a cylinder of pasteboard, light thin wood from a hat-box, or bright tin blackened in the interior, two or three times the length of its own diameter. On the removal of the brass cap, this should immediately be substituted for it, and remain till the last; and when the brass cap is about to be replaced, it will be advantageous to warm it previously. Where there is a finder it should be provided with a dew-cap also. If dew should have accidentally settled upon an object-glass, it is a good plan to unscrew it, and hold it before the fire; this will diminish the necessity of frequent wiping, which should be avoided, as the polish is very liable to injury; but the removing and replacing of an object-glass of any size demands a careful hand. After all, little specks will be formed in time, and occasional cleaning will be required; this may be safely done by dusting the glass with a camel's hair pencil, breathing upon it very slightly, and wiping it gently with very fine wash leather, or a real silk handkerchief, both of which should be free from grit and dust, and kept for the purpose. Foreign glass will sometimes become discoloured even from the contact of loose particles which may have long lain upon it; no amount of friction will remove these stains which will not endanger the polish. If objects appear dim and foggy on a clear night, damp has, in all probability, settled on the surface of the eye-lens; this may be immediately dissipated by taking out the eye-piece, and holding it before the fire: the eye-piece of the finder is especially subject to this annoyance, as it is less frequently protected by the application of the eye: if the fire is not conveniently accessible, a bit of wash-leather may be kept at hand.

As no positive or Ramsden eye-piece (which has the plane surface of each of its lenses outwards) is achromatic, and even

Huygenian or negative ones are not always perfectly so, in estimating the colours of double stars the image should be kept in the centre of the field: for a similar reason such objects should never be examined near the horizon, when instead of a circular disc, they will show a coloured and flaring spectrum.

It may be occasionally advantageous to know the diameter of our field; this may be roughly estimated from the proportion it bears to the diameter of the moon, which may for very ordinary purposes be taken at half a degree. But it will be more satisfactory to note the time which a star near the equator occupies in crossing it; such as δ in Orion (the uppermost of the three in the belt); or γ Virginis (the method of finding which will be given under No. 10 in the catalogue), especial care being taken to make the star's passage as central as may be. The time thus given will be minutes and seconds of Right Ascension; these multiplied by 15 (since $15° = 1$ hour) will be converted into minutes and seconds of space, by which celestial distances are most usually measured. The reason of the employment of an equatorial star (a planet or the moon in the equator will answer equally well) will be at once apparent; the distance between the meridians, or hour-lines, decreasing continually as they recede from the equator, corresponds less and less with the same number of absolute degrees of space, which are always considered of the same value with those measured on that circle.

A general idea of the position of the meridian will always be of service; it may, of course, be obtained from a common compass, allowance being made for the declination of the needle, now amounting to about 21° W.; or from the gnomon of a good sundial, or from the position of the sun at noon by the dial, that is, uncorrected by the equation of time.

A few words may be added as to weather. With regard to wide double stars, which may be well seen with a low power, a choice of nights is not very important, the only essential point being that there shall be no haze capable of obscuring the smaller companions. But the matter is entirely altered when we attempt the separation of the closer pairs. Astronomers well know that a high degree of transparency may be combined with a most annoying amount of unsteadiness, and that what is called a brilliant night may hence prove perfectly useless for all delicate investigations: and thus we find Herschel II. speaking of such a night as "the worst possible for vision, though superbly clear." Higher powers becoming necessary as the components are nearer together, every atmospheric defect is magnified in the same proportion. At one time no care in focal adjustment will sharpen up the diffused blot to the semblance of a star; at another, the comparatively defined discs will be *rippled over,* as it were, as though they lay at the bottom of a rapid stream; at another, "flares" and distortions of various kinds and degrees will task the observer's patience, if they do not wholly frustrate his expectations. It is almost impossible to form a conjecture beforehand as to the prospect of a good night. Easterly winds have borne perhaps a heavier share of blame than they deserve; at least, I have noticed that when we have a *warm* breeze from the N.E., it usually brings sharp definition: and Herschel II. speaks of three nights of unexampled perfection (March 28, 29, 30, 1830), as ushered in by an east wind. His illustrious father states that dry air is unfavourable; frost sometimes favourable, sometimes not; thaw may be expected to be unfavourable, from the conflict of cooler and warmer currents. But, strange as it may seem, the unvarying experience of observers speaks strongly in behalf of a slight fog or haze, not, of course, for the detection of evanescent points of light, but for that steady definition which, with large apertures especially, is so seldom to be met with, and so very beautiful when it is attained. It would be easy to cite instances. Sir J. Herschel, speaking of March 28, 1830, says, "such a night for measurement I never witnessed, yet to the naked eye the stars are very dull (*stellis acies obtusa*), and no small ones (below 4·5 mag.) visible;" and the new dusky ring of Saturn was discovered by Bond, in America, in a sky so hazy that to the naked eye only the brighter stars were perceptible. Herschel I. states that vision is generally very perfect in windy weather; but a very steady stand will be necessary to avail ourselves of it. In the winter, his son tells us that distinct vision often comes on an hour or two before midnight. It is a singular fact, but attested by the concurrence of many observers, that a twilight sky is often favourable to the definition of difficult objects; the spurious discs seeming to be diminished upon a brighter background.

The objects in the following list are numbered for convenience of reference, but no regular arrangement has been adopted; the easiest and most instructive take the lead, but any stated classification would be too much complicated with considerations of absolute and relative magnitude and distance, and would have to be subordinated after all to the season of observation, which will cause the postponement of many pairs otherwise entitled to precedence. For the student's convenience the present series has been restricted to objects visible with the naked eye, and in easily recognized positions, as well as within the reach of ordinary telescopes; the directions given for finding them will probably supersede the use of maps; but should such illustrations be desired, the Larger Star Maps of the Society for the Diffusion of Useful Knowledge, sold by

Stanford, Charing Cross, can be strongly recommended, both for accuracy and extraordinary cheapness. Their chief defect arises inevitably from the attempt to represent a sphere by a cube, so as to comprehend the whole in six maps; in consequence of this the corners become very much distorted, and the squared-out degrees of the centre are there transformed into a kind of lozenge-shape; this must be carefully borne in mind in comparing those parts with the heavens. A Moveable Planisphere, by Smith, Strand, is also spoken of as very useful in showing the principal stars above the horizon at any given time.

We may now proceed to our little working catalogue.

1. ζ *Ursæ Majoris. Mizar.* Distance 14″·4. Position 147°·4. Magnitudes 3 and 5. Colours, white and pale green. Struve makes them both greenish white. Relatively stationary, but probably with common proper motion. There are several reasons why this star may properly head the list. It is very readily found, being the sixth in order of the seven stars of the Great Bear, or the centre one of the tail; it is at a sufficient height above the horizon during the whole year (though unfortunately rather awkwardly elevated during the spring months); it is within the grasp of very small instruments; and from its association with a third star, called Alcor, bright enough and distant enough from the irradiation of its neighbours to be visible without a telescope, it furnishes a peculiarly apt means for training an untutored eye. Amateurs may be expected to have at first confused and inadequate ideas of magnifying power; and those who have never before viewed double stars with the telescope will sometimes even imagine that they can distinguish them without it, though it is found that, for this purpose, they ought, generally speaking, to be four minutes of space asunder, a distance from eight to eighty times greater than that of the generality of stars in the present list. Another source of mistake may be that the great increase of brightness in the telescope does not render itself at once intelligible to the inexperienced eye. Erroneous impressions from these causes may be effectually corrected by means of Mizar and Alcor. Let these two be alternately viewed, in and out of the telescope, a low power being used to include Alcor in the field, and the inversion in the instrument being borne in mind; and it will be readily perceived how great is the effect of magnifying power in separation, as well as of aperture in increased brightness. It will be at once seen that no unaided eye could possibly separate Mizar into its components, and the idea will never be revived of the possibility of distinguishing double stars without the telescope, excepting under circumstances of unusual distance.

Alcor is of the fifth magnitude, and is distant 11′ 30″ from Mizar. It is known as the "rider upon the horse;" the middle one of the team of three, in the figure of Charles's Wain, as Ursa Major has been popularly called in this country. This name must be very ancient, long before Shakespeare's time, for we find from Admiral Smyth that it is familiarized from the Gothic Karlwagen, the *charl* (*ceorl*, Saxon) or peasant's cart. Alcor seems to have formed a trial of sight among the Arabians, according to their proverb, "Thou canst see Alcor, yet canst not perceive the full moon;" they gave it also the name of Saidak, the "test"; and hence Arago thinks a change may be inferred, as it is now so readily visible: it was also known amongst them, as the Admiral tells us, by the term Suhà, and implored to guard its viewers against scorpions and snakes; why, it does not appear.

Mizar seems to have been a strange stumbling-block to observers in the last century; and for no intelligible reason, as it is so easy an object. Its duplicity was discovered by Riccioli, nearly in the middle of the seventeenth century: it was again noticed in 1700 by Gottfried Kirch and his scientific wife, Maria Margareta, who was subsequently, in her widowhood, astronomer to the Academy of Sciences at Berlin: and it was observed double by Bradley in 1755: yet Flaugergues used to try his telescopes upon it about and after the year 1750, without perceiving the companion till 1787: and even then he fancied that the pair gradually widened to three or four times its original distance; which, as Smyth remarks, "must have been merely the effect of becoming better acquainted with the object before him." Even such men as Delambre and Mechain have been suspected of overlooking the smaller star: and there is a strange story told about Mädler at Dorpat as recently as 1841, when, on observing this star by day, he was astonished to find it single; he waited till after sunset in vain, perceiving in the meanwhile distinctly several other pairs difficult to be observed in twilight; but, within an hour afterwards, he found it double in all its splendour. One is tempted to think that he must have been previously looking at the wrong star, but he does not seem to have suspected this himself. The Roman astronomers in 1842 described an imaginary *comes* lying nearly between the two stars; but this was not their only blunder of the kind. Their telescope—a very fine one, with a $6\frac{1}{3}$-inch object-glass by Cauchoix, had this imperfection, and they, unfortunately for their reputation, published its defects as discoveries. Sestini, De-Vico's assistant at Rome, gave the colour of the smaller star yellowish with the Cauchoix telescope. Admiral Smyth has republished in his Ædes Hartwellianæ, a detailed comparison of the colours of 109 stars as noted once by Sestini, and twice by himself and his friends. The discrepancies are occasionally very strange, and some of them will be given in our present list; but, on the whole, many of the Italian observations *of that date* seem more valuable as illustrations of individual peculiarity than as evidences of fact.

It has been suspected that Alcor, together with Mizar and its companion, may be mutually connected as one grand ternary system. Several minute stars will be found in the field, the largest of the eighth magnitude. Mizar has of late years been photographed no less than 86 times with the great achromatic of 14¾ inches aperture at Harvard College, U. S., in order to measure the image instead of the object—a much more convenient process, which seems to promise some great advantages.

2. *α Ursæ Minoris. Polaris.* 18″·6. 210°·1. 2½ and 9½. Yellow and dull white. So Struve. Sestini and Dawes make 9½ blue, and so I have thought it. This is the *Pole-star*, so called, not from its occupying the polar point, from which it is distant about 1° 25′, or somewhat more than 2½ diameters of the sun, but from its being the nearest to it perceptible by the naked eye. The mode of finding it by a long line passing through the Pointers, or right hand stars of the Great Bear, is well known, and once found it will not be lost, as it stands comparatively alone in a wide space. The *comes* has long been referred to as a test of the goodness of small glasses. It was formerly proposed as a standard of eyes and instruments by Dawes, who considered that in most instances two inches of aperture would be scarcely sufficient to show it steadily. Smyth, however, saw it distinctly with his 5$\frac{9}{10}$-inch object-glass reduced to that size. The celebrated Dorpat achromatic of 9½ inches exhibits it even while the sun is above the horizon, and Kitchiner saw it with a power of 18 applied to a 7-inch object-glass by the elder Tulley. In the case of minute points which approach the *minimum visibile* in a telescope, the device of *oblique* or *averted* vision, by which the image is made to fall on a more sensitive part of the retina, will often give the first intimation of their existence; and when their position is once known, they frequently become much more perceptible.

Polaris seems to be merely an optical pair, their proximity being the effect of perspective alone, and their real distance being incalculable and incomprehensible. We shall find, however, as we proceed, that magnitude is a much less safe criterion of distance than was supposed in former days.

A small amount of parallax has been ascribed to the large star. If correct, it shows a distance which light, reaching us in 8¼ minutes from the sun, would not traverse in less than *thirty years.*

3. *α Ursæ Majoris. Dubhe.* 6′ 20″·6. 203°·8. 1½ and 8.

Both yellow. I have thought 8 violet with a $3\frac{7}{10}$ object-glass, lilac with $5\frac{1}{2}$ inches. This is the most northerly of the Pointers. It is a very wide object, and of little scientific interest; but it appeared to me of sufficient beauty to merit insertion, especially as the yellow hue of the large star is very fine.

4. *a Geminorum. Castor.* 4″·7. 258°·8. (1830·95). 4″·9. 248°·1. (1849·17). Fletcher found 5″·309. 245°·66. (1857·28). 3 and $3\frac{1}{2}$. Bright and pale white; greenish, according to Struve; greenish yellow and greener, Dembowski. This is the most northerly of the two large stars which mark the heads of the Twins, and which will be found declining towards the W. at the beginning of May. Castor is an intrinsically glorious pair, and especially interesting as being, in Sir John Herschel's words, "the largest and finest of all the double stars in our hemisphere, and that whose unequivocal angular motion first impressed on my father's mind a full conviction of the reality of his long-cherished views on the subject of the binary stars." That it is binary—a superb system of two neighbouring suns, there can be no doubt; but there is some difficulty in ascertaining its period, although it has been watched from an earlier epoch than most objects of this kind. Sir J. Herschel has assigned 253 years, Smyth 240; the result is not entirely satisfactory, but of the revolution round a common centre of gravity there is no doubt. "This," as Admiral Smyth says, "is a great fact, and an astronomical revelation which, in all probability, Newton himself never contemplated." In the case of undoubted binary pairs, more than one of Smyth's epochs will be given as above, for comparison. The earliest observation, that of Bradley and Pound in 1719, made the angle 355°53; a very little experience in estimating positions will show how great has been the intermediate change. A power of 80 should bring out this pair well. I have divided it with 55, and an aperture of $5\frac{1}{2}$ inches.

5. *ζ Cancri.* 5″·4. 149°·4. (1832·23). 4″·8. 144°·1. (1853·17). 6 and $7\frac{1}{2}$. Both yellow. Sestini makes the small star white; yet he calls Castor yellowish and yellow. This easy double star is apparently in slow motion, in an orbit of possibly 500 or 600 years; none but very fine telescopes are now capable of showing, what was more easily distinguishable twenty years ago, that the larger star has another of seventh mag. almost in contact with it. A very fine five feet achromatic may possibly detect some elongation. This close pair is in rapid motion, but with a period as yet undecided; and the whole triple combination, if such it be, with all its intricate relations and movements, is a truly wonderful object. To find it, run a line from Castor through Pollux, and continue it between two and three times the distance of those stars; it will pass a little above ζ, when W. of the meridian.

A little to the E., somewhat N., of ζ, and consequently just above it, as it declines towards the W.,* lies the famous cluster *Præsepe,* visible to the naked eye as a nebulous spot. It scarcely comes within the scope of the present list, belonging rather to the class of Groups and Clusters, of which it is one of the most conspicuous. However, as we are so near to it, we shall probably feel disinclined to let it pass. Our lowest power will be required to enlarge the field, and comprehend at once as much as we can of this magnificent cluster, which, after all, will probably much exceed our limits.

6. *ι Cancri.* 30″·1. 307°·8. 5½ and 8. Pale orange and clear blue. Herschel I. made the smaller deep garnet, 1782, February 8; bluish, December 28; blue, 1785, March 12. Relatively stationary, but there seems to be a common motion in space. A beautifully-contrasted pair, in which, as usual, the hue of the larger component is taken from the less refrangible end of the spectrum, an arrangement too general not to indicate the footsteps of some unknown law. To find it, a line is to be drawn from Præsepe to Polaris, bearing a little to the left; where another line passing between Castor and Pollux would intersect the first at right angles, we come upon this star, which, though not bright, is the most conspicuous for several degrees around.

7. *ε Hydræ.* 3″·4. 198°·4. (1837·11.) 3″·6. 203°·2. (1843·14.) Fletcher, 208°·52. (1852·96.) 4 and 8½. Pale yellow and purple. The small star in this beautiful object was missed by Herschel I., and Dawes therefore suspects that it may be variable. Struve discovered it, and his measure confirms the idea that it may be in orbital motion, with a possible period of 450 years. It may be found thus:—a line drawn from Polaris through Pollux, will fall upon Procyon, a 1st magnitude star in Canis Minor. Another line carried from Procyon to Regulus passes just above a little group of stars, rather nearer to Procyon of the two, marking the head of Hydra. The most northerly of these is ε.

Here we suspend for the present our selected list of double stars, proposing to resume it in our next number, together with other matter of special interest during the month.

* The student may be reminded that N., S., E., and W. are always understood as expressing the bearings of objects *when they are on the meridian*, and that, in proportion as they are removed from it, they cease to be synonymous with *above, below, to the left or right.*

HAUNTS OF THE CONDOR IN PERU.

BY WM. BOLLAERT, F.R.G.S.

There are three routes by which Iquique, the scene of the following adventures, may be reached. The first, and most general, at the period adverted to (1826), was by "doubling" Cape Horn, and then pursuing a north course in the Pacific; the second, by the River Plata, braving its fierce pamperos, taking a gallop of a thousand miles over the pampas to the once smiling Mendoza—lately destroyed, with nearly all its inhabitants, by a fearful earthquake—making the passage of the mighty Andes, descending to Chile, and embarking at Valparaiso for the coast of Peru; the third, which is the one now usually followed, is by steamer from Southampton to the West Indies, and across the Caribbean Sea to Colon (a distance of about 4800 miles) the Atlantic port of the Isthmus of Darien; here we find a railroad forty-eight miles in length, over which one is whisked, through one of the most beautiful, natural, and tropical gardens in the world to the city of Panamá. Off you go again, by steamer, towards the south, crossing the equator, and if not cloudy you may get a peep at Chimborazo, and remain a couple of days at Lima, founded by Pizarro, and where he was assassinated, and long celebrated as the "heaven of women, purgatory of men, and 'other place' of jackasses"—the meaning of which is that the Limeñas are beautiful, the men are enslaved by them, and the donkeys cruelly cudgelled by their negro drivers.

Leaving Callao, the port of Lima, you pass the considerable ruins—more ancient than Manco Capac and his dynasty—of the city and temple of Pachacamac, built by rulers called Curysmancus, the last of whom were conquered by the later Incas; you look in at the Chincha Islands, from which so much guano is extracted, and may get a peep at the volcano of Arequipa. You continue along a high arid coast, seldom or never watered by the slightest shower of rain, and steam through a most pacific sea, which, during the hot summer months, looks like a saline, half seething, cauldron.

In latitude 20° 12′ south and 70° 14′ west, you arrive at Iquique, now well known as being the principal port for the shipment of nitrate of soda, which is found in very great quantities a few leagues up the country, on a table-land 3000 feet above the level of the sea. It is the principal harbour of the province of Tarapacá. In 1826 it contained only a few fishermen and their families: it now shelters a population of 5000 souls, and according to recent accounts could boast of an Italian opera, although it is situated on a complete saline,

shelly, and sandy desert. No fresh water can be got by digging, so water for drinking is distilled from that of the ocean, and food is supplied principally from Chile. The history of this place—its hospitality, customs, and manners—would make a curious and interesting chapter, the more particularly as its rapid growth has been the consequence of the discovery of nitrate of soda in the adjacent region.

The writer of the present paper, with his old and valued friend, Don Jorge, when there, in 1826, superintending the working of a silver mine at Huantajaya, were the only foreigners in the province. These mines, like the majority in this district, are in the desert mountains of the coast, at an elevation of from 3000 to 6000 feet high, where there is neither moisture nor vegetation. Water had to be brought to them from a distance of thirty miles, in bags made of sheep-skins; and this journey through a broiling sun did not tend to increase the palatableness of the liquid.

Water for the use of man being so scarce, it was at times next to an impossibility to allow it to animals; and the writer has often had to trudge on foot from Iquique to Huantajaya, which, although only seven or eight miles, is a most fatiguing journey, over a burning plain, up a wearisome sandy ascent, along the base of the high escarped mountain range, and finishing with a grand tug up the "caracol," or zig-zag road, the summit of which is nearly 2000 feet above the level of the sea, with yawning chasms and jagged peaks on either side. The track then goes along a most desolate-looking route, covered with patches of salt in cakes and nodules, and sun-incinerated stones; and to the left, among other ranges, is that of the silver mountain of Huantajaya, sometimes called the Potosi of Peru.*

The silver produced from 1726 to 1826 was worth about fifteen millions of pounds sterling. Since 1826, and in consequence of labour being diverted to the extracting, refining, and carrying the nitrate of soda to the coast, the annual yield has fallen to about six thousand pounds. The mines of Santa Rosa, within sight of Huantajaya, have likewise afforded considerable supplies of the same metal.

The ordinary route from the mines down to the coast is not difficult, most of it being an easy descent; but there is a "short cut" by the Lomas of Guantaca, and very much steeper than the other. It was by the former that Don Jorge and myself arranged to go to Iquique, our object also being to explore the country and behold the reported "panizos," or indications of metallic veins in the mountains.

So, one morning, each with his *alforjas*, or saddle-bags, containing a gourd full of water and some "provend," slung

* The original Potosi is in Bolivia.

over the shoulders, Don Jorge with his sketch-book, myself with geological hammer and chisel, we sallied forth from Huantajaya, a town built of *caliche*, or salt and earthy matters found on the surface, and supplying the readiest material at hand. Not the slightest vegetation was to be seen—it was a very picture of utter desolation.

Journeying up the ravine of San Guillermo, we halted to survey the old silver mines and ruins of Coronel, and the thick beds of a kind of fossil oyster shell, at nearly 3000 feet above the sea—the silver veins having apparently pierced this ancient mass of organic matter. Then followed a couple of hours more trudging under a burning sun and cloudless sky, up and down, and crossing ravines, and along sandy *laderas* or sides of mountains, stopping to examine here and there the protruding edges of silver veins, and wondering how so much salt, generally in nodules, could have got there. The unlearned said it had been left there when the sea retired from the land. This is improbable; but after some research in these regions it would appear to the writer that the great quantity of salt, which is on the surface only, is most likely formed by infiltration from the Andean regions, where he has seen interminable salt plains at 14,000 to 15,000 feet above the sea. He has succeeded in tracing the salt percolation downwards to a lower country, say to 3000 feet above the sea, the saline waters keeping near the surface, and containing, in addition to the chloride of sodium, boracic, iodic, chromic and other salts.* This saline water has been met with in one of the mines of Huantajaya.

Salt was then found in such quantities that ship loads were taken from the vicinity of the silver mines of Santa Rosa, and thirty years afterwards there was another crop on the same ground. One proof that this salt is not of oceanic origin is, that it is nearly a *pure chloride of sodium*, and as it appears to be brought by infiltration from the Andes, it may claim a volcanic origin by the direct combination of chlorine and sodium.

We will rest awhile, take a little bread and *charqui* (sun-dried beef), a draught of water, and a cigar, in the ruined *corales* of Guantaca. These *corales*, or enclosures, had been used by the Indian fishermen of the coast when out hunting

* NITRATE OF SODA.—In 1830 only 900 tons were exported, but in 1859 there were nearly 79,000 tons. In 1860 it was calculated that there was some 63,000,000 tons of native nitrate on the ground, so that at the present rate of extraction it would take about 1400 years to work it up.

It would appear that common salt brought down by ravines and percolation from the Andes, in process of time undergoes nitrification, being now in company with lime and the nitrogen of the air, by a process at present not easily explained—the chlorine of the sodium going to the lime, forming chloride of calcium, and a nitrate of soda being produced.

huanacos, which, during the spring months of these regions, called by the natives "El Tiempo de Flores," roam about in search of the spare pasture occasionally found on the summits of the mountains of the coast. This peculiarly-placed vegetation—constituting the flower spots of the desert—consists of some twenty to thirty species of plants, many of them small bulbs producing white and blue flowers. There is also much of the oxalis, and some giantic cacti, thirty or forty feet high and ten or fifteen in girth, with yellow blossoms.

The morning breeze had died away, and the scorching sun was in its zenith, when we commenced the ascent of the steep ravine of Guantaca, deeply strewed with angular stones, formed by the breaking away of its rocky walls, which are composed on one side of granite and on the other porphyry. On the granitic side of this sombre and melancholy-looking spot, grew here and there the gigantic cactus trees of the kind just mentioned; and at their bases lay small heaps of dead bulimi, whitened by exposure, and on the leaves others in a live state, with shells of a brown hue; there were three or four species of them. There were no cacti on the porphyritic rocks; and the greater fertility of the granite arises from its containing so much soluble alcali as to be more easily decomposed by the dews at night and the intense heat of the sun during the day, and thus affording a comparatively nutritious material for the plants—soil it can scarcely be called.

The stillness of the scene was most impressive; all that we heard was our tramp over the track, and now and then the slight chirrup of a little slate-coloured bird, the "come sebo," or fat-eater.

Instead of continuing our course up the ravine to its pass, and then descending by the ordinary track to Iquique, we bore off to the right, picking our way over and through masses of granitic rock for a considerable time, not with the intention of making a "short cut," but to explore the "Lomas," or summits of the mountains of the coast. This we did to our heart's content, having traversed a district probably never before visited by a white man.

From some of the passes and summits we had a glorious view of the wide expanse of the Pacific Ocean; from our elevation and proximity we appeared to be looking into it, not along it; and the horizon being on a level with the eye, appeared like a line almost within our grasp. A little to our left stood Iquique and its guano island, which we could see as if it were in plan, and two small guano vessels in the offing were at such an angle that we thought we could perceive the very decks.

After fasting our eyes upon so peculiar a sight, we meditated about our descent to Iquique, which we anticipated would be rather amusing, for it was sure to be steeper than the Guantaca track. Having had some experience in clambering about the badly-worked mines of Huantajaya, we imagined ourselves fit for any emergency. Now and then we called out to one another, "Take care;" "Mind that piece of rock you are standing on, it looks rather loose;" or "That lump of rock above does not want much of an earthquake-shake to send it down;" for earthquakes are almost of daily occurrence in that region. Onwards we went, having to pick our way with the greatest caution; above us were the rugged peaks, below us the abrupt declivity going down to the very ocean. Had giddiness seized us and caused a false step, it would have been our last.

My companion was in advance, and as he had been to sea in his younger days, he had a better knack of balancing himself whilst progressing and springing over bad places. At length this *paseo*, or ramble, began to tire us, and although Iquique appeared as if at our feet, we were not in a position to make anything like a straight course to it; and, after a little time, we got into a most awkward position as the mountain became much rounded on the steep descending slope; our footway was of decomposing granite, which we felt had only to be heavily trod on, and then away would slide down a portion of the coating of the hill. Occasionally pieces of rock would fall, and the way they made their descent showed too plainly how we should go if we fell.

Our course became worse. I was brought to a stand still, and not being able to ascend or descend, was obliged to poise myself most carefully. I now commenced cutting foot holes, working myself round a projecting bluff, when I came in sight of Don Jorge scrambling up to a withered cactus, astride of which he got, so as to take a rest. He soon shouted, "Look out, Don Guillermo, here come a lot of condors, we must take care of ourselves." I looked up and around, and sure enough I saw the condors whirling round in circles, the circles getting smaller as they approached us. Other condors were in the distance, all apparently of the same flock. They had doubtless seen us for some time from one of their look-outs, probably the Morro of Tarapacá, about nine miles off, in a straight line, and some 3000 feet higher than we were.

Two of the largest of the condors would approach at intervals, in rather too close a proximity to my friend, when he would shout his loudest, and bang stones at them, sometimes hitting our enemy; this seemed to astonish the birds, and we could see them gently shake their wings.

I had some hovering about me, but one kept itself in a line, as if it intended to come butt up against me. These were fearful moments for us both. I could observe Don Jorge's exposed situation, and that, if the decayed branch of cactus gave way, he would be hurled down and dashed to pieces. As to myself he could see that a portion of my body was projecting over a precipice.

I stood on the defensive with the geological hammer in my right hand, whilst my left was stuck in a hole in the loose granitic stuff for support. If I had been compelled to have struck an assailing condor with my hammer, the chances were that such a movement would have dislodged me, and down the rock I must have gone. I had previously, and have since been, in personal "difficulties," but never so near being rolled down a precipice, dashed to pieces, and made food for condors.

Whilst this skirmishing was going on, my companion cried out, informing me that at the bottom of the not very deep break that separated us, there was a collection of sand, and the only way of extricating ourselves from our present perilous situation, was to do our best and jump into the sand below. Once there, we should be a better match for the condors, pelt them at our ease, and then see who would have the best of the fight.

Watching an opportunity when his assailant had veered off a little, he left his somewhat uneasy position on the cactus, which still retained a quantity of its spines, took a jump, and landed without broken bones on the patch of sand beneath.

I now left my cramped and awkward berth, putting myself into a jumping attitude, whilst Don Jorge stationed himself below so as to break my fall. I took the leap, or rather a sort of flight, coming lengthways upon my face, sliding some distance down in the sand. Thankful, indeed, were we, that we had been thus protected from an untimely death.

Once on the sandy spot we sat down, and could observe without fear the bold and graceful whirling course of the condors, and when any of them darted, out of their circle of flight, to approach us, we could pelt at them; although few if any of our missiles reached them. We watched and pelted at these kings of the feathered tribe, until they concluded that we were not designed for their consumption, and slowly drew off in the direction of the Morro de Tarapacá, where doubtless they had their resting place during their visits to the coast, and from whence they could, with their wonderfully far-seeing eye, scan on the desert tracks below, carrion, in the shape of a dead mule, or ass, or the body of a defunct whale on the sea-shore.

It is hoped that the scenes I have attempted to delineate will assist my readers in picturing the condor at home. The wild creatures of the forest or the desert cannot be understood and appreciated if severed from their natural surroundings; and now that I have endeavoured to show the character of their haunts, I may be permitted to add a few particulars which I collected while residing in their vicinity.

The condor, or *Sarcoramphus gryphus,* the huitre of the Spaniards, is one of the largest of the vulture tribe. Its breeding places are in the Andes of South America, at great elevations. Its food is carrion, but it will attack lambs and goats, or the young of the llama genus. Two, it is said, will fight a llama, a heifer, or even a puma. In Chili they are known to roost on trees, when the guasso, or countryman, climbs up and lassoes them. It is reported, that the condor, makes no nest, that the female lays two large white eggs on a bare rock, like most raptorial birds, and the young are unable to fly before a year.

Tschudi, who had good opportunities of studying the habits of this bird, tells us, that it hatches its young in April and May. The full grown bird measures from the point of the beak to the end of the tail, from 4 feet 10 inches to 5 feet, and from the tip of one wing to that of the other, 12 to 13 feet, When flying it cannot carry a weight of more than eight to ten pounds.

The condor passes the greater portion of the day in sleep; hovering in quest of prey chiefly in the morning and evening. While soaring at a height beyond the reach of human eye, the sharp sighted bird discovers his quarry beneath him, and darts down upon it with the swiftness of lightning. Tschudi kept a young one at Lima, and to prevent its escape, when it was able to fly, fastened a chain to its leg, to which was attached a piece of iron of six pounds weight. When it was a year and a half old it flew off, with both chain and iron, and perched upon the spire of a church, whence it was scared away by the carrion hawks. On alighting in the street, a negro attempted to catch him, upon which the bird seized the negro by the ear, and tore it off. The condor then attacked a negro child of three years old, threw him on the ground, and knocked him on the head so severely that the child died. This bird died on his passage to Europe.

The writer's first acquaintance with condors was in Chile, in 1825, whilst hunting the puma in the Cordillera, above the hot baths of Colina. Thereabouts this fine bird may often be seen descending from the Andean regions, hovering in the air and on the look out for dead cattle. In Peru they range from the sea coast to an elevation of 16,000 or 17,000 feet in the Cordillera; the writer particularly noticed them when he ascended the Andean peak of Tata Jachura, in the province of Tarapaca, with his friend, Don Jorge. This peak is 17,000 feet high at least. His next meeting with them was in the attack at Iquique, and he has since observed them in the desert of Atacama.

It is generally asserted that condors are only seen in groups of three or four, but never in large companies, like vultures. This is hardly the case, for in our narrative it may be observed that the attack was made by a rather large flock of them. In 1854, the writer saw a group of fifty condors, near the *Caracol*, or zig-zag road at Iquique. He was also informed that a hundred or more may be seen hovering over the cattle estates in Chile. In 1820-3, when there was whale-fishing off Coquimbo, the offal would float on shore, and as many as two or three hundred would collect to gorge on the remains. I was once exploring with Don Jorge the mountain of Molle, near the nitrate of soda works of La Noria, on the summit of which there is an abandoned silver mine. Having entered it to rest and get out of the intense heat of the sun for awhile, we very soon had to make our exit in consequence of becoming thickly covered with what we afterwards learnt were the lice of the condor. Such a locality is called their *alojamiento,* resting-place, or look-out. On another occasion, exploring some high mountains overlooking the great saline table-land of Tamarugal, and where the newly discovered salts of borax exist, we came upon another condor *alojamiento,* on an exposed rocky crag, but here we only observed a collection of their ordure. It is from such a spot that the condor watches for dead and dying mules, on the tracks to or from the various *oficinas* or nitrate works.

I once observed a young condor perched on the sore back pecking at the wound of a mule who had just strength enough to slowly crawl along. I drove the bird away, and shot the mule.

In 1852, whilst Don Jorge was travelling from Iquique to the Noria, a condor fell from a great height, just before him and his party, and was quite dead; had it fallen on any of them, the individual must have been unhorsed and bruised.

It might be expected that such a remarkable bird would make its appearance in the local mythologies, and we find that the worship of the condor, together with that of serpents, and other animals, was celebrated in the early times of Peru. On the pre-Incarial monuments of Tia-Huanaco, situated to the south of Lake Titicaca, are sculptured the heads of large birds, most probably intended for the condor, and likely to have received the adoration of the builders of those most ancient remains.

M. FAYE ON SOLAR REPULSION.*

It follows from a consideration of all the facts relating to the acceleration of comets, and of the forms they assume, that there exists in celestial space a repulsive force, exerted by the surface of the sun; that this force is due to incandescence, and operates like attraction at all distances. The physical phenomena which surround us afford striking indications of a force of this nature, and we can put them in evidence by causing an incandescent surface to act under the conditions which are revealed to us by the study of astronomical effects. There is thus an identity between the two forces which have their origin in heat, just as there is an identity between celestial attraction and terrestrial attraction, as shown by the fall of heavy bodies in the celebrated experiments of Maskeleyne and Cavendish. But repulsion exerted at a distance by an incandescent surface cannot be a different thing from the molecular repulsion which is equally due to heat, the force to which physicists attribute the phenomena of dilatation, of changes in the state of bodies, and their elasticity in the gaseous form. We arrive, then, at the conclusion that there exists in nature a force not less general than attraction, and which, like attraction, manifests itself in celestial spaces as well as in molecular intervals.

There is, however, a difficulty which seems to oppose this complete identification. The molecular repulsion due to heat has always been considered as a force which disappears at any appreciable distance from its centre of action, and it has this character, whether we admit with Newton an interruption of continuity, or prefer to have recourse with Laplace to the remarkable hypothesis of forces whose sphere of activity does not extend to sensible distances. . . . . Laplace thus expresses himself on this subject. After having calculated the pressure in a gaseous mass, bounded by a spherical envelope, in accordance with the hypothesis of a repulsive force with an indefinite sphere of activity; he shows that the law of repulsion adopted by Newton is far from representing the conditions which this constant pressure exhibits, and he then remarks, "This great geometer does indeed assign to this law of repulsion an insensible sphere of activity; but the manner in which he explains its wants of continuity is little satisfactory. We must, without doubt, admit a repulsive force between the molecules of the air, which is only operative at imperceptible distances. The difficulty consists in deducing from it the laws of elastic fluids, and this can only be done by the following considerations." These considerations take for their point of departure, the formulæ

* Translated from the *Comptes Rendus*, 10th March, 1862.

by which the mutual attraction of spherical bodies is determined, and a simple change of sign enables us to pass from a case of attraction to one of repulsion.

No one will deny the necessity for this narrow limitation of the sphere of activity assigned to molecular force, but must we therefore conclude with Laplace that it is a special force, distinct from the great forces of nature which operate at all distances? No. It is easy to see that the repulsion due to heat, and defined by its astronomical characters, exhibits precisely the phenomena of forces with an insensible sphere of activity, although in free space it operates at all distances. That which conceals the true explanation, is that our minds, for a long time habituated to speculations on Newtonian attraction, experience a difficulty in considering forces of a totally different nature, and if we speak of repulsion we conceive of it only as an attraction with a change of sign, and philosophers like Bessel only see a negative attraction in the repulsion so visibly exerted by the sun. But it is not so; solar repulsion as exhibited in the movements and figures of comets, differs widely from a negative attraction, first by its successive propagation, and secondly, that it does not pass through matter as the attractive force does. It is in this last characteristic that we find the key of the difficulty, and it is in harmony with all the evidence collected in my researches, and on which I have had to insist so often during the last three years. For if we consider the essential character of the repulsive force we shall easily perceive that it assumes in all bodies the conditions of a force with an insensible sphere of activity. Each molecule of a body is in fact surrounded, at an inappreciable distance, by other molecules which receive its repulsive influence, and at the same time behave to it like a screen. And as these molecules are not mathematical points, and as their dimensions are considerable when compared with the intervals which separate them, the repulsion due to heat—an action of surface, exhausting itself on the surface of the body which it affects—will find itself sensibly reduced beyond the limits of the molecules surrounding each centre of action. We may further conceive that the radius of this boundary, that is to say, the sphere of activity of each molecule, may be equal to a definite number of times the interval between the several molecules, and thus, belonging to the same order of minute magnitudes as they do, may be equally inappreciable. To this remark M. Faye adds in a note that instead of being an absolute quantity this radius may depend upon temperature, and he then observes: Thus the repulsive force which acts at all distances in celestial spaces, finds itself reduced in the interior of bodies to an action at insensible distances, and consequently in all that concerns the mechanical action of heat, a special hypothesis, like that of Laplace, is useless, as everything is explained on the supposition of a force distinct from Newtonian attraction, but not less general in its operation. Is it not remarkable that we have had to seek in the heavens for the essential characteristics of the two great forces which govern the material universe?

HYBERNATION OF FUNGI—THE GENUS SCLEROTIUM.

BY THE REV. MILES JOSEPH BERKELEY, M.A., F.L.S.

Up to a very recent date the science of Mycologogy was overlaid by a host of spurious genera and species, destitute of every trace of fructification, and often of most uncertain origin and affinity, and in consequence quite unworthy of admission into any arrangement professing to be natural. The eyes of one or two first rate mycologists were first well opened to their true character about forty years ago, when Fries propounded the wise rule that no fungus should be admitted into the system whose fruit was wholly unknown, or whose affinities were so doubtful, that the nature of the fruit could not be readily divined. He did not indeed always keep himself to his own rule, and perhaps it was impossible for him, at that time, to do so, but the great host of mycologists, whether of greater or less consideration, instead of profiting by his advice, still clung to their own "mumpsimus" and burdened science with multitudes of *Himantiœ, Rhizomorphœ,* and other equally imperfect organisms. It was easy enough, indeed, for any one who was inclined to make use of his eyes, to see that many of these were merely the spawn of various fungi, in imperfect conditions, or arising from abnormal places of growth. A morning's search after fungi in our woods and forests could scarcely fail to convince one that many a white *Himantia* was due to the common species of *Marasmius,* which occur on oak leaves, or to some well-known Agaric, such as *Agaricus dryophyllus,* and as little could it escape notice that *Phlebomorpha* was merely the early condition of some *Trinchia* or allied genus. Still such genera were retained by authors with the utmost tenacity, and perhaps for one reason amongst others, that they were easy to recognize by some empirical process, without any of the difficulties which almost always attend the precise determination of genuine species.

Though Fries, with that peculiar tact which has characterized his career as an observer and has assigned him one of the highest places amongst modern botanists, was eagled-eyed about the greater part of these spurious productions, with one or two exceptions, the most prominent of which will be noted presently, he was strangely misled by Unger and others as to the nature of those rust-like parasitic fungi which grow on living leaves, and constitute one of the greatest scourges of the cultivator. Though in reality amongst the most interesting of fungi, and most instructive in regard of affinity, as well as in other important respects, he regarded them as scarcely worthy a botanist's notice; and, indeed, though at times impressed with more or less of philosophic doubt, he was inclined with Unger to regard them as mere abnormal developments of the cellular tissue of plants, analogous in plants to the exanthemata of animals.

Our business is not, however, with such productions at present, but with those compact fleshy or horny cellular bodies which occur so often in the guise of little flat cakes, irregular tuberiform masses, or seed-like organisms of a more or less definite form on decayed plants, whether more or less naked or buried in the midst of their pith, or other tissues, and more rarely on animal substances, which have been referred by authors to *Sclerotium*, and one or two allied genera. Fries still adheres to the notion that many of these are autonomous, and I have myself ventured to express an opinion that though the greater part are spurious, there may possibly be some which bear fruit, and are not mere conditions of other fungi, though the more the matter is considered the less reason there is to believe this possible.

In the *Systema Mycologicum*, while Fries confesses that they have affinities with every order of fungi, he states as his opinion

FIG. 2.—Thin slice from surface of *Sclerotium complanatum* highly magnified.

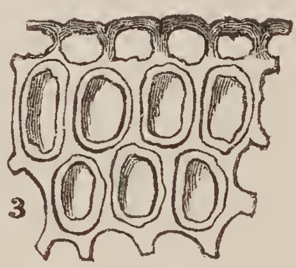

FIG. 3.—Thin vertical slice of *Sclerotium minutum* highly magnified.

that they are, according to the "notio idealis," *Coniomycetes* congested into a sort of hymenium. The notion was perhaps the most unfortunate that he could have formed, for with the exception of *Sclerotium betulinum*, and about three allied species, none of which are properly *Sclerotia*, they have no relation at all to *Coniomycetes*. In the year 1824 the cellular structure of the cuticle of *Sclerotium semen*, and more especially the waved superficial cells in *S. complanatum*, so like those of the cuticle of many leaves, convinced me that there was much to make out about these plants, and soon after Dr. Greville's attention was called by me to the subject. A few years afterwards, on commencing an active correspondence with Fries, I pointed out to him the origin of *Sclerotium pyrinum* from the common *Penicillium*, and the necessity of modifying his notions as to their affinities. This *Sclerotium*, moreover, though evidently derived from the *Penicillium*, consisted, like other legitimate forms of the spurious genus, of a compact mass of cells, and not merely of close packed threads capable of being resolved by careful manipulation into the original flocci, which appears to have been the case with some supposed *Sclerotia* of similar origin, which were, in fact, nothing more than unusually compact examples of that state of *Penicillium* which has received the

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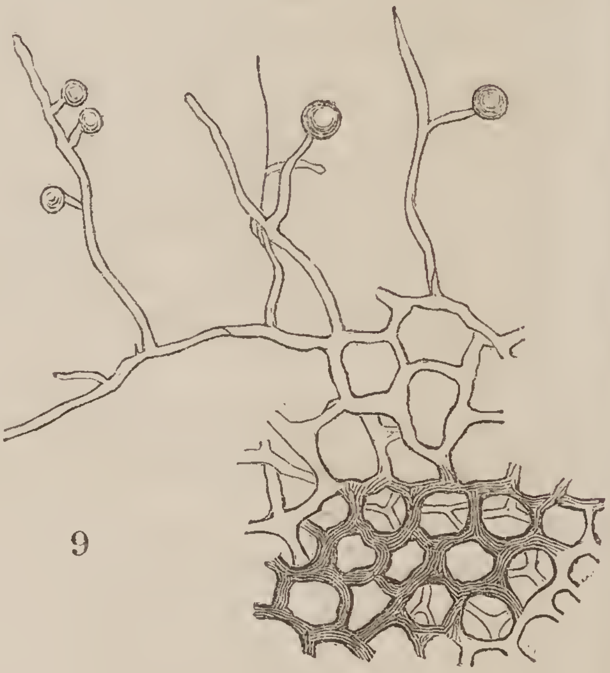


Fig. 8.—*Mucor Subtilissimus* springing from the tip of an Onion whose bulb was covered with *Sclerotium Cepæ*, highly magnified.

Fig. 9.—*Mucor Subtilissimus* springing from a thin slice of *Sclerotium Cepæ* placed in a drop of fluid in a closed cell, highly magnified.

name of *Coremium*. In 1848, in conjunction with Mr. Hoffmann of Margate, I succeeded in making a thin slice of the minute *Sclerotium* (*S. Cepæ, Libert*), which occurs sometimes in myriads, like the grains of coarse gunpowder, on onions, vegetate in a closed cell; and the result was the production of a minute species of mould which is figured in the *Journal of the Horticultural Society of London* for that year, under the name of *Mucor subtilissimus*. This was, of course, a step in the same direction as the tracing the origin of *Sclerotium pyri-*

num to the *Penicillium.* It had, however, been observed for some time that various hymenomycetous fungi were constantly connected with *Sclerotia,* and, in some cases, as in *Agaricus tuberosus, Typhula erythropus,* and *Peziza tuberosa,* the connection was so intimate, that it was matter of doubt whether the one was not a mere condition of the other. It has been left for modern observers to confirm this notion completely, and it is now well ascertained that plants of various affinities are capable of assuming a sclerotioid condition, in which they pass a greater or less time, according to circumstances, until a favourable opportunity arises for their complete development.

FIG. 5. *Typhula erythiopus,* nat. size.

Though many observations have already been made, much remains to be done, and we can scarcely conceive any more full of interest to the mycologist than those which may be made amongst these curious productions.

Sclerotia occur everywhere amongst decaying vegetable matter. The surface of the stems of our large herbaceous plants yield more than one; their pith, as for example, that of the sunflower or bulrush, yields others; several may be found on carrots and other roots, or tubers heaped up in cellars, and two at least on bulbs of onions in the garden. The tan of our stoves is frequently productive, the cow dung which has been exposed to the weather in our fields, decaying leaves, in woods and gardens, bletting or mouldy fruit, the roots of mosses, but more especially large decaying fungi like *Lactarius adustus,* which are driven about by the winds in our woods, afford a multiplicity of subjects for experiment. It may be remarked that many *Sphæriæ* in an early state of growth, as *Sphæria phæocomes,* for instance, appear under the form of *Sclerotia.* Indeed, many of the compound species either assume at times sclerotioid character, or the parts of the stroma which are ultimately destined to produce the asci, consist at first of a uniform cellular mass. This is especially observable in the genus *Dothidea* and *Hypocrea,* imperfect individuals of which might be referred without violence to the genus.

Nor must we pass unnoticed the productions of a similar nature which occur on anatomical preparations left for maceration or preserved in weak spirit. Even living bodies are not entirely without such organisms, or at least some which simulate them very closely. The fungus-foot of India, of which such an interesting account was published by Dr. Carter of Bombay, last year, is a case in point, though we are not certain whether the dark truffle-like bodies, some of them as large as walnuts, which fill up as a bullet in its mould the more or less globose cavities which are hollowed out in the carious bones, consist of tissue so intimately compacted as to lose the character of threads entirely, and to justify their association with true *Sclerotia*. The specimens kindly forwarded by Dr. Carter in spirits, were perhaps more in favour of such an association than the drawings made from the specimens when fresh.

The greater part of these productions may be made to yield their proper fruit, either by covering them lightly with soil in a well-drained garden pot, and preserving them at once from too rapid evaporation, or from a degree of damp likely to generate mould by a bell glass either entirely closed, partially open above, or gently tilted. It will be necessary also to modify the light according to circumstances, the degree in which this may be needful, being entirely matter of experience. In other cases it will be better not to cover the *Sclerotia* with soil at all, but to place the leaves and sticks which bear them as nearly as possibly in their natural condition, while in others, the lower part of the mother-plant may be immersed in water in a wide mouthed bottle, the orifice being more or less completely closed, as may be judged best. Any one who has succeeded in raising the curious fungi of which ergoted grains are a condition, from the black spur-like bodies, will at once see what a fund of amusement is before the observer. Sometimes an Agaric or Coprinus will reward his care; sometimes a *Clavaria*, sometimes a *Peziza*, not unfrequently a *Pistillaria* or *Typhula*, while sometimes he must content himself, as in the case of *Sclerotium durum* and its varieties, or closely allied forms, with some humble mould. If he is in warmer countries than our own he may chance to have a good crop of edible fungi, though we must exclude the far-famed *Pietra Fungaja* which is so prized in Italy for the excellent fungi which spring from the tuberous masses of earth and spawn when moistened, because it is not really a *Sclerotium*. Ergot must also be excluded, as it has several material points of difference, though the cultivation for the production of its more perfect form is precisely similar to that mentioned above. If he has been diligent in collecting specimens from decayed

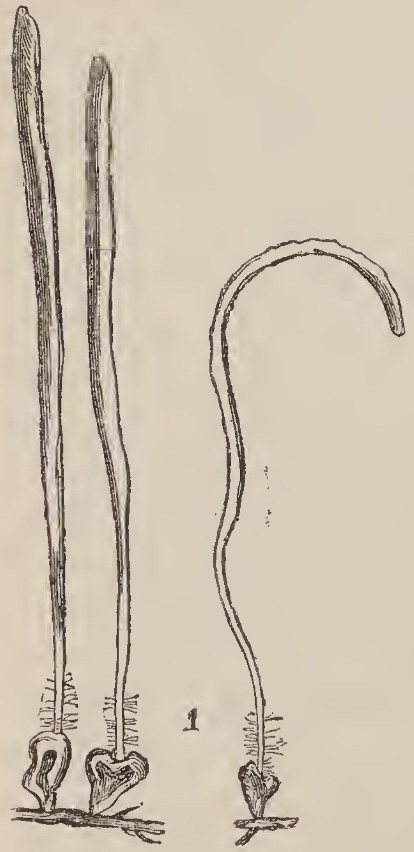


Fig. 1.—*Clavaria juncea* on *Sclerotium complanatum*, nat. size.

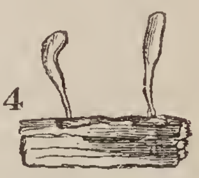


Fig. 4.—*Pistillaria quisquiliaris*, nat. size.

agarics, he may be fortunate enough to raise *Agaricus racemosus*, which is one of the most singular species of fungi ever recorded, presenting him with two distinct forms of fructification on the same root.

FIG. 6. *Agaricus racemosus.*

As an instance of the pleasure derived from this source, we may instance the success of Mr. Currey, who is doing so much for fungi, in raising a beautiful Peziza from the little pink fleshed *Sclerotium Kneiffii* which occurs not unfrequently in the pith of *Scirpus palustris* and *Juncus conglomeratus* when fallen to the ground, and constantly saturated with moisture. But this is not the only pleasure which the mycologist may anticipate. He will soon perceive that the attentive cultivation of these *Sclerotia* will enable him to discriminate satisfactorily many closely allied species. *Sclerotium complanatum*, and *S. scutellatum*, for example, both produce a *Pistillaria*, and the two at first sight may be considered as identical, but cultivation will doubtless give a nicer discrimination than we have at present respecting them. So again there is a *Peziza* which springs from a white fleshed *Sclerotium*, very like *Peziza Curreyi*, which, as said above, is due to a pink fleshed kind, and other instances might be adduced. Much information will be found on the subject in Tulasne's new work, *Fungorum Carpologia*, which contains a mass of information unequalled in any work with which I am acquainted. One of the most curious instances that he adduces of a fungus appearing in a dormant state under a sclerotioid form, is that of the cobweb-like *Corticium arachnoideum*, which is common in almost every wood on fallen sticks, forming a very thin white film, spreading over, but not adhering, like so many of its relations, to the matrix, the very last fungus perhaps one would suppose likely to assume such a form. From the sterile threads there arise sometimes in great numbers, sometimes more sparingly, little velvety white heads, which gradually become smooth, acquiring a light red or bay tinge, and, in fact, are so many globose or irregular *Sclerotia* of various dimensions, from that of a poppy seed to that of a hemp seed, or even more. These are at length of a deep chesnut or somewhat variegated, and consist of an extremely solid mass of cells. They remain either attached to the matrix or fall to the ground, and when the proper season comes round reproduce the web-like fungus. Tulasne remarks further that it will be matter of wonder to many that a delicate byssoid fungus, such as *Corticium arach-*

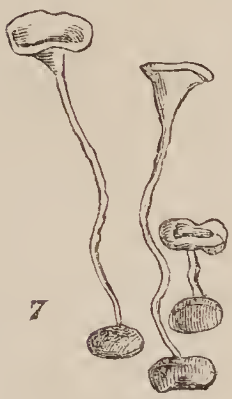


FIG. 7. *Peziza Curreyi* on *Sclerotium Kneiffii*, nat. size.

nöideum, should be capable of cultivation. A quantity of these *Sclerotia* on dry bark, were collected by himself, in conjunction with his brother, in winter, and in the following April were placed in sand. They remained dormant till the end of summer, when the surface of the sand began to be covered with a very delicate web, which in the middle of September had spread in every direction, and continued to do so for months, though individual *Sclerotia* dug up in the month of October, seemed quite unaltered in size, colour, or density. He remarks, moreover, that the formation of a previous mycelium from the *Sclerotium* is without example so far as his observations go, the fungus arising in other cases immediately from the *Sclerotium;* though Léveillé makes a different statement in his paper on *Sclerotia* in the 20th volume of the second series of *Annales des Sciences Naturelles*, which will be found well worth attention.

A taste for the cultivation of cryptogamic plants in general is gaining ground in this country very fast. Not only are ferns favourite objects of cultivation, but houses are now devoted to mosses and liverworts, many of which grow admirably when guarded against the attacks of the white mycelium of a little scarlet *Nectria*, which if not constantly rubbed off, soon makes dreadful havoc amongst them. That fungi admit of extensive cultivation cannot be doubted, when the luxuriance of such agarics as *A. Cepæstipes*, *A. clypeolarius*, and *A. volvaceus*, and, I may add, their beauty in our stoves is taken into consideration. The Australian *Aseröe rubra*, one of the most interesting and beautiful, though not the most sweet scented of fungi, once made its appearance at Kew, as did the lovely *Marasmius hæmatocephalus* with its blood-red pileus, slender fawn coloured stem, and cream coloured hymenium. Many species could undoubtedly be imported, and especially those which in a dormant state assume the condition of *Sclerotia*. Our native *Sclerotia* will not indeed produce many species of brilliant colour, but their progeny often exhibit an elegance of form and delicacy of tint which command admiration from every lover of the intrinsically beautiful. We trust, then, that the time may not be far distant, when there may be, besides the ordinary mushroom bed, a fungus-house as well as a fern and moss house in every first-rate establishment.

ROMAN MINING OPERATIONS ON THE BORDERS OF WALES.*

BY THOMAS WRIGHT, M.A., F.S.A.

Our history of the first establishment of the Romans in Britain is very imperfect and very obscure. After a short campaign under Claudius, A.D. 43 and 44, which appears to have been carried on chiefly in the south, we find the Romans exercising a superiority over all the eastern and central States, including that of the Brigantes, and suddenly carrying nearly all their forces to the borders of Wales. When Ostorius Scapula was sent, in the year 50, to take the command of this distant province, and to suppress the disorders which had arisen in it, he made the Avon the base of his operations, and then marched into the country of the Cangi, who evidently inhabited the districts lying on the northern coast of Wales. Beyond their territory, the Romans came upon the sea that looked towards the island of Ireland. They were called back from this conquest, first by a revolt of the Brigantes, and then by the more resolute hostility of the Silures of South Wales, which led to the defeat and capture of Caractacus. Under the government of Suetonius Paulinus, in the year 61, the spirit of insurrection was again active in Britain, and the Romans appear attaching the same importance to that district of the Cangi; for his grand exploit was the reduction of the island of Anglesey, because it was by the Britons assembled there that the Cangi were continually urged into revolt. The multitude of the Roman troops was still collected in this quarter, and it was from thence that they were taken to repress the more formidable insurrection of Boadicea.

We might naturally inquire what was the particular circumstance which drew the attention of the Romans, at this early period, so strongly to this distant part of Britain; and a rather curious antiquarian discovery furnishes the reply. In 1783, a Roman pig of lead was found in Hampshire, bearing the inscription—

NERONIS . AVG . EX . KIAN . IIII . COS . BRIT

intimating that this lead was taken from the mines in the country of the Kiangi, or Cangi, in the fourth consulate of the Emperor Nero. Now Nero's fourth consulate began in the year

* Since this article was written, we learn that Mr. More of Linley Hall has contributed to the International Exhibition a very elaborate model, on a large scale, with plans and sections, of the Shelve mining district, in which all the remains of the Roman mines are shown, and that he will exhibit in the same case the various objects which were found in or in connection with the latter.

60, so that this pig was probably cast in the year before Boadicea's revolt. It is clear, therefore, that it was the metallic riches of the mountains on the border, and on the northern coast of Wales, which drew the Romans thither at so early a period. Britain had long had a celebrity for its richness in metals, derived from the treasures carried from the south, and the Romans would no doubt be attracted by any report of mountainous districts. They had thus at a very early period fixed upon the peak of Derbyshire; and in the mountains of the Welsh border, their richness in metals must have been visible on the surface, and would have caught the eye of the Roman metallurgists at the first glance.

There are evidences of a much more definite character, which show the extent to which the Romans laboured on these metalliferous regions, and which will repay well the labours of the scientific inquirer in exploring them. The attraction of these researches is increased by the fact that the most imposing remains of the Roman mining operations are scattered through by far the most lovely scenery of the Welsh border. We may trace them from the wild country of the Forest of Dean, and the beautiful Wye scenery in the south, through the hills of Shropshire and Montgomeryshire, Cheshire, and the countries of Flint and Denbigh, and through the ancient country of the Cangi, or Kiangi, up to the shores of the Irish Channel. We can only, in the space here allowed us, review this extent of country briefly, but we will begin with the iron district in the south.

The best position from which to visit the Roman mining districts of the forest of Dean is Ross or Monmouth. Nearly the whole country for some extent on both sides of the river Wye, between those towns, has a deep substratum of the scoriæ from the Roman iron works, sometimes lying close upon the surface. I am told that in places the depth of scoriæ has been found to be from twelve to twenty feet, and I have myself traced it on the surface over a considerable part of the district. Coins and pottery of the Romans, and other objects, found frequently among the scoriæ, leave no room for doubt that the latter were deposited there by that people.

Nor are their cinders the only remains of their iron works, which that extraordinary people have left behind them in this district. In a turn of the river Wye, amid the beautiful scenery between the ruins of Goodrich Castle and Monmouth, rise two massive hills, called the Great and Little Dowards. They consist of mountain limestone, resting on the old red sandstone, in the former of which the iron ore is here found. Both hills have been largely mined by the Romans, and their manner of proceeding on this occasion is explained fully by the entrance to one of their mines, which still remains on the site of the Great Doward. They had excavated a large cavern into the side of the hill, and wherever they came upon the vein of iron ore, they followed it into the heart of the mountain. Thus from the cavern, as it still exists, rude galleries run in more than one direction, leading to successions of chambers made by the extraction of the iron ore. The entrances from the outer cave are now much clogged up, but they are said to have been entered and explored to a great depth underground. They are, as is frequently the case with such remains, the subject of many popular legends of fairies which dwell in them, hidden treasures, and the like, and the entrance cavern is called in the locality "King Arthur's Hall." On the adjacent Little Doward there is an ancient entrenched inclosure, which had probably some connection with the mines.

The Romans had, in this district, another method of mining, or rather a modification of the same, which was caused by the character of the ground. It is seen to most advantage in the neighbourhood of Coleford, on the Monmouth side of the Forest of Dean. Coleford is reached most easily from Monmouth, through a country of mountain and forest of the greatest beauty. It is situated upon the same mountain limestone which here skirts the Forest of Dean, and in which the iron ore is found; but here, as the ground lies more level, and cannot be entered from the side of a hill, the Romans began their operations by sinking a large pit—in some cases these pits are from twenty to thirty feet in diameter—and when at the bottom of this pit they came upon a vein of ore, they followed it just as they did the veins from the cave in the Great Doward. These pits as they now remain are popularly called *scowles*, a word the origin or meaning of which I have not been able to discover. They have, as may be supposed, rendered the ground on which they are situated very uneven, and unfit for cultivation; it is thus always overgrown with copse and brushwood, and it requires some care on the part of the explorer not to fall unawares into a pit. They are seen to most advantage not far from a farm house, called, from them, the Scowles Farm, about a mile to the westward of Coleford. In one of these scowles which I examined, the round pit, was nearly twenty feet deep, at which depth the Romans had come upon a vein of ore, which they had followed by a shaft, the entrance to which looks now something like the mouth of a large oven. Without a light, and the other necessary accoutrements of a miner, it was not advisable to enter beyond a few feet; but a stone thrown in could be heard rolling down for some seconds; and the cottagers stated that some of these mines extended two or three hundred feet underground, and that they could easily descend them with lanterns, and generally found clear water at the bottom. The ore is of fibrous appearance, and so rich in metal that it often looks like malleable iron, and pieces of it are picked up plentifully about the Roman mines. That they are Roman we can have little doubt, from the frequent discoveries of Roman coins and pottery in and about the scowles.

Space will not allow of any detailed description of the scoriæ which are found in such marvellous quantities over this district, but which, nevertheless, present many circumstances worthy of remark. There can be no doubt that wood was used in the smelting, as pieces of charcoal are often found imbedded in the cinders. The Roman process of smelting was evidently very imperfect, for they still contain so much ore, that in the seventeenth and eighteenth centuries they were carried away and re-smelted on an extensive scale, and large quantities of iron were thus obtained.*

This incredible quantity of the scoriæ shows the immense activity of the iron mines in this district during, no doubt, the whole Roman period. They are traced also, I believe, in some parts of Monmouthshire, but its neighbour Radnorshire is not a mining district, and we find no further traces of the eagerness of the Romans to profit by the existence of metallic treasures till we reach the lead and copper fields of Salop and Montgomery.

The most important group of the Shropshire lead-producing mountains is that of the Stiperstones and its dependents, especially that which is known as Shelve Hill. My head-quarters for exploring this district have always been at the hospitable mansion of an esteemed friend, the Rev. T. F. More of Linley Hall, one of the most lovely spots in this island. Mr. More takes in his mining property all the interest of an antiquary and of a man of science. The park of Linley runs from the hall, first northward, and then bending round to the west, along a narrow and beautifully picturesque valley, between ranges of mountains, a distance of about three miles, at the end of which we enter the high road from Newtown and Bishop's Castle to Minsterley. Two miles along this road, towards the latter place, brings us to a long mountain, extending nearly north and south, and parallel to the Stiperstones, at a distance of some two miles to the west, which is called, from the name of the parish in which it is situated, Shelve Hill. This hill, the property of Mr. More, is full of lead ore, which runs in almost horizontal veins from east to west, turning a little towards the north-west, and when

* A more full account of the Roman ironworks in the Forest of Dean, and also of those of the weald of Kent and Sussex, will be found in a little volume by the author of the present paper, entitled *Wanderings of an Antiquary*, published in 1854.

the Romans came to these parts, all these veins cropped out on the surface on the western side of the hill. The Romans, who considered lead as a very valuable metal, were not likely to overlook so open a manifestation of great wealth, for the ore in this locality is particularly rich, and this locality was without doubt the scene of some of their earliest mining operations. Lead is the only metal produced from the British mines of which we find the pigs bearing the imperial marks, and these pigs have been found in rather considerable numbers. All such pigs of the Roman period hitherto found under circumstances which would lead us to suppose that they came from the Shelve hill mines bear the same mark, that of the Emperor Hadrian (A.D. 117—138), in the simple form—

IMP . HADRIANI . AVG

from which it would appear that the mines were in great activity in the earlier part of the second century. Three of the pigs of lead with this inscription are well preserved; one found on Mr. More's own property is to be seen among the curiosities at Linley Hall; another, found in the parish of Snead, near Linley, is now in Mr. Joseph Mayer's museum, at Liverpool; and a third, found in the last century at Snailbeach, is deposited in the British Museum. With these facts before us, it is more than probable that it was to this locality that Pliny referred, when, writing before A.D. 79 (when he died), he says, that lead (which he calls *nigrum plumbum,* to distinguish it from *plumbum album,* or tin), was found in Britain so plentifully on the surface of the ground, that it was thought necessary to pass a law to limit its extraction.*

The remains of the Roman workings on this spot are of a very remarkable character. Pliny's description of the lead as found *summo terræ corio,* on the very skin of the earth, was here literally true, for some eight or nine parallel veins came out upon the surface of the rock, and all these the Romans worked, beginning apparently from the bottom of the hill, and following the vein into the rock, as far as they could trace it. The remains of their labours are visible along the whole surface of the hill, like irregular cuttings along a large cheese; but it presents the most remarkable appearance at a spot near the northern end, where, at the foot of the hill, a mine called the Roman Gravel Mine is now in operation. The way in which the Roman miners followed the veins of ore is here exhibited in the most remarkable manner. Where it did not appear to run deep they soon stopped, and have left but a

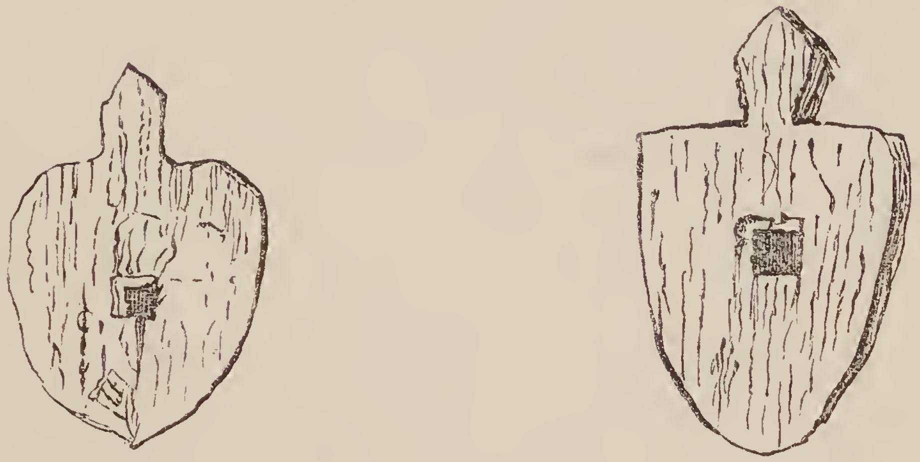
* Nigro plumbo ad fistulas laminasque utimus, laboriosius in Hispania eruto totasque per Gallias, sed in Britanni summo terræ corio adeo large, ut lex dicatur ne plus certo modo fiat. Plin. *Nat. Hist.* lib. xxxiv. cap. 17.

shallow cutting. In some places the cutting is wide; while in others it is at the same time very narrow and very deep, in one instance sinking to a depth of, I believe, forty yards, yet not wide enough for more than one man to work in it. In other places the vein of ore had been more massive, and in following it the Romans had hollowed in the rock cavern-like chambers, from which galleries ran in different directions, which are now blocked up by rubbish. The entrance to one of these caverns is shown in the accompanying engraving, made from a very excellent photograph by Mr. Colley of Shrewsbury. The Roman miners also sunk shafts. In one of the largest of the caverns on the line of the vein I am describing, near the brow of the hill, the vein has been followed downward by a shaft of great depth; in its present state a stone is heard rolling down for several seconds. It is not easily examined from its position, but having been carried up to the surface of the rock above, no doubt for the purpose of more easily raising weights up and letting them down, we were enabled to ascertain that it was a square shaft of small dimensions. We have, however, still better evidence of the extent to which the Roman miners perforated the mountain. I have just stated that at the bottom of the hill, just under these large Roman surface workings, there is a modern mine, which was begun some years ago, but, for some reason or other, was soon abandoned. This mine has been recently taken by a most respectable company, which has taken the name of the Roman Gravel Lead Mining Company, who in the prosecution of their own works have met with numerous Roman shafts and galleries to a considerable depth.* The antiquity of these mines has been proved, not only by the Roman pigs of lead already mentioned, but by Roman coins and pottery found from time to time among the old rubbish. Early mining implements also have been found, but none have been preserved, with the exception of a curious description of spade, two examples of which, in the possession of Mr. More, are represented in the accompanying cut. These spades are formed of laminæ of oak timber, roughly split, and cut into the shape here exhibited, with a very short stumpy handle, and a square hole, sloping on one side in the blade. This hole was evidently intended to receive a short staff, which might be used as a lever

* When we consider the facility which nature gave to the ancients to obtain the higher metal from the surface, and the length of time they no doubt worked the mines, and the fact that we learn from ancient documents that mines were worked here in the middle ages, and at various more recent times, and that during the last seventy years an unceasing large supply has been raised, although not a fifth of the ground has been explored, we may imagine the richness of this district in ore. Immediately under one part of the ancient workings, about fifteen years ago, one pipe of ore produced two thousand tons in eleven months at a depth of eighty yards.

to give force to the movement of the hand; and the implement itself was no doubt designed for shovelling the broken stones containing the lead ore in narrow passages where there was not space for giving much movement to the body. The dimensions of the two spades here represented are nearly 8½ inches by 16, and 8½ by 11. It is worthy of remark that similar spades have been frequently found in other parts of our island in the remains of mines which no one doubts to be Roman; and these confirm us in believing them to be of the Roman period. They furnish a remarkable proof of the great durability of sound oak.

No traces of the washing and smelting places attached to these Roman mines have yet been met with; but they are accompanied



11 inches by 8½. 16 inches by 8½.

OAK SPADES FOUND IN ROMAN MINES.

by other monuments of a very important description. The remains of a very extensive Roman villa have been discovered, occupying the southern part of the park at Linley and part of the adjacent fields, and standing in a very commanding position. This great mansion, which covered the space of a small town, had no doubt some connection with the mining works in the mountains above. Again, to the north of Shelve, at the extremity of the Stiperstones, and in the parish of Minsterley, is the Snailbeach mine, one of the most productive lead-mines in this kingdom. It also had been extensively worked by the Romans; and the miners, I believe, still speak of the upper part of it as the Roman level. Two or three miles distant, in the fertile country below, the remains of a fine Roman villa have also been found in the parish of Pontesbury.

Westward of the Stiperstones mountains, and through the county of Montgomery, copper and lead are found in abundance, and we trace everywhere the presence of the Roman miners. Roman mines have been found in Newtown Park, and were re-opened a few years ago. They were found productive in copper and "silver lead;" to explain which, it may be stated that the lead ore found in this country has always an alloy of silver, varying in quantity, and particularly rich in the latter metal as we go westward into Montgomeryshire. At present the alloy of silver is considered rather as a defect than otherwise, as it is not worth the trouble of extracting; but the Romans, who set greater value on silver, extracted it with care, of which many of the Roman pigs of lead found in England bear testimony by the words in the inscription—EX. ARG., or LVT. EX.ARG., or MET.LVT.EX.ARG., the latter of which has been interpreted as meaning *metallum lutum ex argento*, metal washed from silver, in accordance with Pliny's account of the process of extracting the more precious metal from the other; but LVT. has also been interpreted, perhaps rightly, as referring to a mining town or district in Derbyshire, named by the Romans Lutudæ. I believe that among the miners on the borders of Wales, the lead ore is still sometimes called silver. Most of the Roman mines in Montgomeryshire, as far as they have yet been observed, are formed by shafts sunk from the surface, or from caves made in the bank. In the park at Newtown, they thus sunk shafts for copper, and appear to have been very successful, to judge by the report of the resumption of these excavations in 1856.* About six miles westward from Newtown, on an elevation on the banks of the Severn, are the remains of a rather important Roman station, called by the Welsh Caer Sws, probably a mining town, in the neighbourhood of which I believe that remains of Roman mines are also found, and by which runs a Roman road, called in Welsh Sarn Swsan, which is said to run by way of Rhaiadyr through this mining district towards Chester. At the western extremity of the county of Montgomery, in the park of Machynlleth, a Roman mine was also re-opened in 1856, which produced copper and "silver lead." Like most of these ancient excavations, it had become an object of superstition,

* An account of the re-opening of this mine was communicated to Eddowes's *Shrewsbury Journal*, in October, 1856, by a mining captain at Llanidloes, Mr. William Vivian, who says—"The interest excited in Newtown by the opening of the old mine at the Park, near that place, has caused me to direct my attention to that interesting spot. I have this day inspected the ancient work, and find that, in clearing out the level, an old shaft has been discovered, sunk, it is supposed, upwards of a thousand years ago. The men are now employed night and day in clearing the shaft, and they have already arrived to the depth of ten fathoms, but have not as yet reached the bottom. Amongst the stuff now being brought up are some ancient pieces of oak timber, and, strange to say, also large quantities of bones, supposed to be those of the deer, which, owing to their having been lodged in mineral water, are in perfect preservation and freshness. The lode at this part of the shaft is about four feet wide, composed of barytes, intermixed nicely throughout with copper ore, just diverging into silver lead; at which point the lode and branches (which are about ten feet wide) fall altogether into the main vein, showing perhaps one of the finest lodes at the same depth in this or any other country; indeed, had such a lode been discovered in the mining districts of Cornwall or Devon, it would have been considered of immense importance."

was believed to be the dwelling of the fairies, and had obtained the popular name of the Ogo-Gwyddsyg, or Witch's Cave.† Machynlleth itself has been supposed by antiquaries to stand on the site of a Roman town, but about two miles from it, at a place called Cefn Caer, on the ridge of the city, are the undoubted remains of an extensive Roman settlement. In the neighbourhood of Llanrhaiadyr, on the borders of Montgomeryshire and Denbighshire, the Romans appear also to have had extensive mines, and at no great distance from this place probably stood the Roman station of Mediolanum, on the great Roman road from Uriconium (*Wroxeter*), which passed hence over the mountains of North Wales to Segontium, near the modern town of Caernarvon.

To the east of the Stiperstones copper is found, but not in such quantity as to pay for the labour of mining, as far as it has yet been discovered. I am informed by Mr. More that the little stream, which enters his park under Radley Hill, which is marked in the Ordinance Survey map as the Black Brook, and which runs southwardly at the eastern foot of the Stiperstones, divides the lead district from the copper. The hill in Linley Park, opposite Radley Hill, certainly contains copper; and there are traces of copper over the whole district between Minsterley and the Stiperstones on one side, and the Long-Mynd on the other. Copper has also been found, though in no great quantity, in Lythe Hill, facing the entrance to the Church Stretton Valley. Hence the copper district turns northwardly. To the north of Shrewsbury we meet a flat country with a broken line of eminences, represented by Grinshill and the Hawkstone hills, which all contain copper. My friend Mr. Samuel Wood informs me that there are traces of mines which had been worked

† The following paragraph appeared in the *Shrewsbury Journal*, May 14, 1856:—"OGOGWYDDSYG, OR THE WITCH'S CAVE.—In the park near to the town of Machynlleth is a deep pit, known by the above name, attached to which are many legends of ghosts, hobgoblins, and fairies; and occasionally pranks have been played off on old crones and timid maidens as they passed at night, so that the road has been shunned as haunted. The scene has, however changed in one short week; and however it might be shunned after nightfall, it is the great attraction of the neighbourhood by day. An active miner, Morris Williams, conceiving this to be an old Roman mine, applied for a take-note to Sir Watkin W. Wynn, which being promised, he commenced, with the aid of Mr. Weston, a gentleman residing in the town. As the water was reduced they came to some woodwork, and an old shaft was soon developed, which was dried, and at the bottom was discovered a second shaft about eighteen feet deep, also timbered; but owing to the obstructions and danger attending the getting the water out of it, it was resolved to drive a level upon it. This is now in progress upon the course of a fine lode, from which there have already been taken some fine stones, rich in silver and copper. At the foot of the work flows the little stream called Nant-yr-Arian, or the Silver River, a name, doubtless, arising from the knowledge, in days of old, of the precious metal through which it flowed, though, till now, its origin has been long unknown. The quiet town of Machynlleth has been roused into a state of unusual excitement by this unexpected discovery."

by the Romans at the Clive near Grinshill, and he is of opinion that the well-known grotto in Hawkstone Park, with its dark passage of eighty yards, was certainly formed by the Romans in working for copper ore. From this spot the traces of Roman mining disappear until we arrive at the hill of Llanymynech, on the northern borders of Shropshire and Montgomeryshire, in an isolated part of Denbighshire, a few miles from Llanrahaiadyr, already mentioned. Llanymynech Hill is a mountain of limestone of considerable extent, arising from the plain at some distance in advance of the edge of the mountain district of Denbighshire. Between the strata of lime occurs a very tenacious smooth clay, with orange-coloured ochre and green plumose carbonate of copper. It was the latter which attracted the Roman miners; and the remains of their extensive works are found on the north-west side of the hill, consisting of shallow pits, the debris from the excavations of which are full of small pieces of copper ore. In the neighbourhood of these pits are found traces of vitrification which show that here the Romans smelted their copper on open hearths. Their excavations, however, were by no means confined to the surface, for there still remains a very large cavern, known popularly by the Welsh name of Ogo (the cave), from which run irregular winding passages, connected with which are the remains of air-shafts. The Ogo at Llanymynech, like so many of these monuments of primeval times, is popularly believed to be inhabited by fairies and similar beings; a lad, whom I once took for my guide thither, knew all about these spirits of the mine, and gave me an account of one of the miners, with whom he was acquainted, who, coming over the mountain rather late at night, had seen the fairies dancing on the sward. But, though not very easy of access at the commencement, the Roman workings in the interior of Llanymynech hill have been explored more than once, and are better known than those in any other locality. In the latter half of the last century they were entered more than once by miners in search of copper, who found a number of Roman coins, some mining implements, and, it is stated, culinary utensils, and several human skeletons and scattered bones—one of the skeletons having a bracelet on the left arm, and a "battle-axe" by his side.* Some of the mining implements were deposited with other antiquities in the library of Shrewsbury School, but they have long disappeared. I possess a drawing of one, which was a roughly made iron implement resembling a pick, except that it had only one limb, and which had evidently been used for pulling out the rock after it had been cracked and broken. At a later period, a man well known

* See *Pennant's Tours in Wales*, edit. of 1810, vol. iii. p. 218, and *Nicholson's Cambrian Traveller's Guide*, under *Llan y Mynach.*

in the literary history of Shropshire, J. F. M. Dovaston, explored the Roman workings as completely as it could be done, taking the precaution of carrying a piece of chalk with him to mark his way. Some of the shafts, or passages, which were extremely sinuous, extended as far as two hundred yards, sometimes they were so small that it was necessary even to creep through them, but they were usually from a yard to three yards wide, and from time to time became developed into broad and lofty chambers, where the ore had been found in larger quantities. They had all been cut through the solid rock, and in many places the marks of the chisel were distinctly visible. "Long passages," we are told in the account of this exploration, "frequently terminate in small holes about the size to admit a man's arm, as if the metal ran in strings, and had been picked out quite clean, with hammers and long chisels, as far as they could reach." It may be added that the roofs of these caverns were covered with pendent stalactites, which glittered brilliantly in the light of the torches. So many human bones were found scattered about, that it was conjectured that these caves had become a place of refuge in the troubled times which followed the overthrow of the Roman power, and that the fugitives had perished there. Roman antiquities of various kinds, and especially coins, are often found on Llanymynech Hill; of the latter, a friend in Shrewsbury, Mr. Henry Pidgeon, well known for his zealous and successful investigations of Shropshire antiquities, possesses about twenty copper coins found here, ranging from the earlier emperors to a tolerably late period of the imperial sway in Britain. The metal which was taken from the mines I have been describing was no doubt copper; but the Romans obtained also from this hill lead and calamine. Llanymynech Hill still produces both copper and lead, though, I believe, not in very large quantity.

The Romans seem not to have been aware of the existence of iron in Shropshire; but there can now be no doubt that they discovered the Shropshire coal-field. It has been long suspected that they used mineral coals in Britain, though different circumstances rendered it very difficult to substantiate the conjecture; but the question has been set at rest by the recent excavations at Wroxeter, on the site of Uriconium, where mineral coal is found in abundance, both unburnt and in cinders, and under circumstances which can admit of no doubt. It appears to be, generally, a coal of inferior quality which they found near the surface, and which is still spoken of as surface coal.

When the Romans came into Britain, the metals in these parts of the island were probably as yet undisturbed, and they found employment enough where the existence of ore was plainly indicated on the surface of the earth. From the copper and lead of Shropshire we find few, if any, traces of their labours until we reach the mountains of Flintshire, where copper and lead again presented themselves on or near the surface. We are now, no doubt, in the country of the Cangi, which, stretching along the coast districts to Bangor, is full of mineral wealth; but I must pass over it briefly. The remains of Roman lead-mines are met with in almost every part of this district, and they usually present features similar to those observed at Shelve, in Shropshire. It is a remarkable circumstance that, in the latter locality, and similarly in the mining districts of Montgomeryshire and at Llanymynech, we are so entirely ignorant of any deposits of scoriæ, or slag, that we might suppose that the ore had been carried away to be smelted elsewhere, were not this hypothesis contradicted by the discovery in the immediate neighbourhood of the pigs of lead ready for exportation. This is not the case in Flintshire, where the land bordering on the coast to the west of Flint is covered with thick layers of lead scoriæ, deposited in the same manner as the iron scoriæ on the borders of the Forest of Dean. These scoriæ are found chiefly at Croes-Ati, a kind of eastern suburb of the town of Flint, and in the adjoining parish of Northop; and, like the iron scoriæ of the south, the process of smelting had been performed so imperfectly that in the time of Pennant, who is our chief authority on the traces of old mining operations in this part, people collected them and subjected them again to the process of smelting, and thus obtained large quantities of metal.* Pennant further informs us that rudely made pick-axes had been found in the Roman mines in Flintshire; and that distinct marks of fire were found in the deep parts, as though the rock had been heated and cold water thrown on it while hot to make it crack†—a process which is alluded to by Pliny. Pennant had an iron wedge, thickly incrusted with lead, which had been found in the ancient workings in the parish of Dysearth.

From the quantity of scoriæ found at Croes-Ati and Northop we are justified in supposing that the lead-ore was brought down from the Flintshire mountains to be smelted at this spot; and the activity of the miners of this district is proved by the great numbers of Roman pigs of lead, all belonging to early emperors, and bearing the mark DE.CEANG, which have been found in the adjacent county of Chester. One of these was found in 1838, at about a mile from Chester, in excavating for the railway to Crewe, and bore the date of the third consulate of Vespasian, A.D. 74. In the time of Camden no less than

* *Pennant's Tours in Wales*, vol. i. p. 71. † *Ibid.* vol. i. p. 74. See also, vol. iii. p. 58.

twenty pigs of lead were found together at Runcorn, on the Cheshire coast, near the mouth of the Mersey, all bearing the inscription DE.CEANG; some of them bearing date in the fifth consulate of Vespasian, A.D. 76, and others inscribed with the name of Domitian, A.D. 81-96. Another, with the mark of the Ceangi, or Cangi, and the date of the fifth consulate of Vespasian, was found in 1772 on Hirst's Common in Staffordshire, near to Watling Street, where it had been left in its transit from the mining district to the south. It is a remarkable circumstance that nearly all the pigs of lead found in Britain bearing the imperial mark, belong to the early emperors, and the absence of any of a later date perhaps implies some great change in the system of administration of the mines.*

The Romans found lead again in the limestone mountains behind Abergele. On the side of one of these, which, from some ancient intrenchments on its summit, is called Castell Cawr, the vein of lead appears to have cropped out on its surface as in Shelve Hill; and in following it the Romans have cut a trench across the mountain of such vast depth and width, that the cuttings on Shelve Hill are mere scratches in comparison to it. After the departure of the Romans, this country had been left so wild and unfrequented that the caverns of the Roman miners became the haunts of beasts of prey; and the trench of which we are speaking received from the Welsh the name of Ffos y Blaiddiaid, or the Wolves' Ditch. More recent attempts at mining have showed that the Romans had penetrated deep into the hill, and had cleared away the ore. They are thus recorded in the local guide-books: "In driving a level into the mountain some years ago, the miners discovered that the Romans had been deep in the bowels of the earth before them. They had followed the vein where it was large enough to admit a small man, and where it opened out into a larger chamber, they had cleared it quite away. When the vein became too small to admit a man, they were obliged to relinquish the ore. Some curious hammers and tools, but almost decayed into dust, were found in these chambers."

We are now leaving the borders of Wales, whatever limits might be given to them, but we may still pursue the Roman mining operations through the country of the Cangi. They found copper in the Great Orme's Head, and worked it successfnlly; and when digging for the foundations of buildings in the town of Llandudno the modern excavators came upon the soil

* A complete and valuable list of the Roman pigs of lead found in this country, was contributed by Mr. Albert Way to the *Archæological Journal*, and another will be found in a paper by Mr. James Yates, "On the Mining Operations of the Romans in Britain," published in the *Proceedings of the Somersetshire Archæological and Natural History Society*.

of the Roman level, coloured by the washings of the ore. I believe that in the neighbourhood of Caerhen or Caerhun, supposed to represent the ancient Conovium, about five miles to the south of Conway, there are also traces of ancient mining. Here was found, in the last century, a mass of copper in form like a cake, but weighing forty-two pounds, which had evidently come fresh from the smelting. It bore two singular inscriptions, which have not been satisfactorily explained; one was SOCIO ROMAE, the other NAT SOL, supposed to be for *natale solum*. It is, I believe, still preserved at Mostyn. The Romans found copper in the mountains of Anglesey, and although they failed to discover the immense mass of that metal which has given celebrity to the Parys mountain, the remains of their mining operations are found in its immediate neighbourhood.

A comparison of these various remains give us a tolerably complete view of the manner in which the Romans obtained metals from the earth. It is more than probable that, in these districts at least, no miners had preceded the Romans, who therefore found the veins of metallic ore on the surface, and first worked upon them there, until, when they were obliged to trace them further, they followed them by shafts and galleries. They evidently preferred, where it was possible, to make a cave on the side of a mountain, or sink a pit in the ground till they came to a vein, and then follow and clear away the vein itself. They worked with rude implements, including wooden shovels and wedges, and chisels of stone. It was the work of slaves and condemned criminals, and was no doubt laborious and slow, but at the same time productive, because they found the metallic ores where they were abundant and often easy of access. The ore itself they seem to have worked out with chisels and axes, and when they had to deal with the hard rock, they cracked it by the application of fire, and then split it further with wedges of iron or stone, and pulled it apart with rough iron picks. In smelting, they evidently used nothing but wood; coals seem not then to have been found in sufficient abundance, and the smelting was performed on the spot and very imperfectly.

This inquiry also leads to very important results throwing light on the condition of Roman Britain, and these results will be more important as we trace the Roman mining operations through the interior of Wales. We shall find the whole of that country, even into the districts which have hardly been approachable since the Roman period, in the peaceful occupation of the imperial colonists, and covered even in the wildest mountain districts with excellent and numerous roads, and with towns, stations, country villas, and settlements of all descriptions, quite contrary to the old popular notion, that here the Britons continued to retain their independence; and at the same time we understand why, at so early a period of their conquest, the Romans established permanently at the southern and northern extremities of the border of this mountain district two of the three legions which occupied the island. It was not to hold in check independent and turbulent natives, but to overawe a large population of slaves and condemned criminals who were employed in the extensive mining operations. Many of the numerous early entrenched inclosures which are scattered over the mountains in which the mines were situated, and which our antiquaries have so hastily and so injudiciously called camps, contained probably villages of miners, or places for works in connection with the mines, or possibly posts which were occupied from time to time by detachments of troops when their presence happened to be necessary.

METEOROLOGICAL OBSERVATIONS AT THE KEW OBSERVATORY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BY CHARLES CHAMBERS.

INTRODUCTION.

The situation of the Kew Observatory, in the north western part of the Old Deer Park, is on the whole well adapted to afford true indications of meteorological phenomena. The building, which was erected about eighty-five years ago as a private astronomical observatory for George III., stands on a slight elevation surrounded by a flat grassy surface, and is freely exposed to winds from every direction, the nearest obstacles being three elm trees 170 feet to the south-east. The Thames sweeps close past the boundary of the park, approaching very near to the observatory, which it surrounds on all sides but the east; a circumstance which may render the moisture of the air somewhat higher at Kew than at other places in the same locality, its effect being evident in an extreme prevalence of fogs.

BRIEF DESCRIPTION OF THE INSTRUMENTS.

Barometer.—This instrument, which is one of Newman's construction, is placed in the east room, on the first floor of the building, with its cistern at a height of about thirty-four feet above the level of the sea. The internal diameter of the tube measures 0·55 inch. The temperature of the mercury and of the scale is observed by a thermometer immersed in mercury contained in a tube of the same bore as the barometer, and placed alongside of it. Newman's standard has been found to accord with the two large standard barometers of the observatory which also agree together.

Thermometers.—These are supported in a wooden frame, or cage, opposite the north entrance of the observatory, at a height of eleven feet above the ground. The sides of the cage are like venetian shutters, consisting of flat bars of wood placed horizontally with the upper edge inclining inwards, each bar overlapping the one beneath it, yet so as to leave an inch of clear space between them. The objects of this construction are to exclude rain, while interfering as little as possible with the free circulation of air, and to avoid any possible error arising from radiation. In order still further to guard against the latter source of error, the cage is surrounded by another of similar construction; they are nearly cubical in form with inclined close roofs, and open at the bottom. During the heat of the day they are defended from the direct rays of the sun by the observatory building, from the north wall of which the thermometers are eight feet distant.

The instruments are five in number; two, the ordinary dry and wet bulb thermometers, placed vertically, with their bulbs six inches apart, and the others, which are self-registering, placed horizontally. The highest temperature is shown by a Phillips' maximum thermometer, in which a small column is separated from the body of mercury by a speck of air; on increase of temperature the column is forced forwards, but it does not recede when the temperature diminishes, thus forming an index of the highest temperature attained. The lowest temperature is observed by a Rutherford's spirit thermometer (with glass index) of the ordinary construction, and by a Casella's new mercurial minimum; the indications of the latter being remarkably consistent with those of the spirit thermometer.

Rain Gauge.—This instrument is placed on a level with the ground, about eighteen feet above the sea, and exposes a surface of 100 square inches for the collection of rain. The position selected for it, to ensure freedom from obstructions to the falling rain, is near the middle of an enclosure of an acre of land attached to the observatory, where it is 110 feet removed from the nearest obstacle, and 200 feet from the observatory.

Anemometer.—This is Robinson's arrangement, which consists of four hollow hemispherical cups attached to horizontal arms projecting at right angles to each other, from the top of an easily moveable vertical axis. The cups are so placed, that in revolving about the axis the convex side of each of them precedes the concave from whatever direction the wind is blowing, the velocity of rotation being nearly equal to one third of the velocity of the wind. By the intervention of suitable toothed wheels, the axis (a portion of which forms an endless screw) communicates its motion to a cylinder covered with paper, and a pencil is driven by clockwork from end to end of the cylinder in twenty-four hours; thus a curve is traced upon the paper by the combined motions of the pencil and cylinder, from which we can ascertain the space passed over by the wind from one moment of time to another. The hemispherical cups project two feet above the dome of the observatory, which is fifty feet above the ground. As an indication of the delicacy of this instrument, it may be stated that it is the rarest possible occurrence to find the cups stationary even for a moment, happening perhaps not oftener than twice in a year, at which time; *alone* the wind is too feeble to overcome the small amount of friction of the axis in its bearings.

Wind Vane.—The vane consists of a hollow parallelopepid without ends, fixed to the top of a vertical rod, which is capable of rotating freely about its axis, and to which is attached a divided circle with numbers, indicating the direction of wind. The vane is two and a-half feet above the dome.

EXPLANATION OF THE TABLES OF OBSERVATIONS.

With the aid of the following remarks the headings of the different columns will be found sufficiently intelligible. The second and third columns contain respectively the mean barometric pressure, and mean temperature of the air, for each day, reduced by means of Mr. Glaisher's tables from the individual observations, and corrected for the errors of the instruments.

The tension of vapour is calculated, from the numbers given in the second and third columns, and from the corrected mean readings of the wet bulb thermometer, by the following formula of Dr. Apjohn:—

$$f'' = f' - \frac{d}{87} \times \frac{h}{30}$$

for reading of wet bulb thermometer above 32°; and

$$f'' = f' - \frac{d}{96} \times \frac{h}{30}$$

for reading of wet bulb thermometer below 32°; f'' being the elasticity of vapour required; f' the elasticity corresponding to the temperature of the wet bulb thermometer; d the difference between the dry and wet bulb thermometers; and h the height of the barometer. The labour of calculation has been abridged by the use of a sliding rule, adapted to Apjohn's formula, invented by the late Mr. Welsh, by means of which the dew-point and relative humidity were also obtained.

By the dew-point is understood the lowest temperature at which the whole of the moisture contained in the air can remain in the state of vapour, any further cooling producing dew. If we represent by 1·00 the greatest quantity of moisture which can exist in the air in the condition of vapour at the temperature recorded in the second column, the number entered under "relative humidity" shows the proportion of vapour present on the day of observation. When fog prevails the air is saturated with moisture, and this number becomes 1·00. The tension of vapour is the quantity by which the elastic force of air (represented by the pressure of the barometer) *at the place of observation* would be diminished by extracting all the aqueous vapour from the air without altering its temperature.

In the eighth column the number 10 denotes that the sky is entirely clouded. The daily range of temperature (11th column) is the difference between the numbers in the two columns preceding.

It must be remarked that though the reduction of the observations of the barometer and dry and wet bulb thermometers, by means of Mr. Glaisher's tables, will generally lead to an approximate mean value for the day, and to a result very near the truth when several successive days are grouped together; yet, while it is the only method open to us, it is strictly applicable only to averages extending over a period of a month, as is implied by the headings of the tables of corrections, inasmuch as these are derived from *monthly groups* of observations for several successive years. On this account the corrected numbers will occasionally present an anomalous appearance, which in the case of temperature will be evident in the tables of observations, the calculated mean temperature exceeding the maximum, or falling below the minimum of the day, or the reduced mean temperature of the dew-point exceeding that of the air. On such days the variations of temperature do not possess the general character due to the season in which the observations are made. Nevertheless, as in the calculation of the monthly means, these days should have equal weight with others, it has not been thought desirable to omit the reduced daily means on these occasions.

Hourly movement of the wind.—These numbers are obtained from tabulations of the anemometer registers. The mean daily variation of the velocity of the wind (without regard to direction) is shown by the numbers in the last column for each month, from which it appears that the strength of the wind is greatest about noon, and least about midnight; and that between the hours 10 A.M. and 4 P.M., its velocity is decidedly above the mean, and below it between 11 P.M. and 7 A.M. The total movement for each day is given at the foot of the several columns.

As few observatories possess the means of supplying information on this subject derived from the records of an instrument of such delicacy and reliability, it is thought that these results are of sufficient interest to justify a more extended report of them than is given of the more ordinary meteorological elements.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

862. Day of onth.	Reduced to mean of day. Barometer corrected to Temp. 32.	Reduced to mean of day. Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. Tension of Vapour.	Temperature of Air. Maximum, read at 9.30 A.M. on the following day.	Temperature of Air. Minimum, read at 9.30 A.M.	Temperature of Air. Daily Range.	At 9.30 A.M., 2 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	At 9.30 A.M., 2 P.M., and 5 P.M., respectively. Direction of Wind.	Rain—read at 9.30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
n. 1	30·389	32·2	30·3	·93	·187	39·0	30·1	8·9	10, 10, 10	NE, NW, NW.	·000
2	30·403	36·9	34·1	·90	·215	39·5	30·7	8·8	9, 8, 10	NE by N, NNE, NE by N.	·017
3	30·020	35·8	35·5	·99	·226	41·0	32·6	8·4	10, 10, 0	SW, W by S, WSW.	·010
4	29·868	37·5	30·0	·77	·185	40·8	33·3	7·5	1, 1, 1	NW by W, NW, W by N.	·018
5	...	...	...	...	...	44·9	32·0	12·9	...	... ...	·006
6	30·122	33·2	28·3	·84	·174	37·5	28·3	9·2	7, 4, 10	W, W by N, W.	·036
7	30·064	40·2	37·6	·92	·243	43·7	30·2	13·5	4, 10, 10	SW, SW, SSW.	·000
8	29·691	43·6	39·7	·87	·261	50·1	36·7	13·4	10, 10, 0	SSW, W by N, WSW.	·158
9	29·701	49·3	45·3	·87	·318	52·6	36 0	16·6	10, 10, 10	SW by S, SW, SW.	·200
10	29·786	47·7	43·5	·86	·298	51·7	43·3	8·4	2, 9, 2	SW by W, WSW, SW by S.	·037
11	29·412	48·3	40·8	·77	·272	52·2	45·0	7·2	8, 10, 10	SW by W, SW, WSW.	·073
12	...	...	...	...	...	47·4	36·2	11·2	...	... ...	·010
13	29·736	38·5	36·5	·93	·234	43·7	32·3	11·4	11, 7, 10	—, W, —, SW.	·013
14	29·628	40·0	37·7	·92	·244	42 3	33·8	8·5	10, 10, 8	—, ENE, NNE, —.	·130
15	29·975	36·8	32·2	·85	·201	38·4	36·8	1·6	10, 10, 10	NNE. NE by N, NE.	·032
16	30·074	32·2	28·0	·86	·173	36·6	30·8	5·8	6, 8, 0	SE by E, SE, SE.	·003
17	30·059	27·7	26·2	·95	·162	29·8	24·2	5·6	10, 10, 2	SE, E by N, E.	·000
18	30·080	27·4	...	...	...	30·8	21·5	9·3	7, 1, 1	ESE, SE by S, SE by S.	·000
19	...	...	...	...	...	28·2	19·8	8·4	...	... ...	·000
20	29·688	27·4	...	...	...	30·8	24·3	6·5	10, 9, 10	E by S, E, E.	·000
21	29·536	30·6	29·1	·95	·180	32·2	26·3	5·9	10, 10, 10	ENE, E by S, ENE.	·000
22	29·478	43·4	39·1	·86	·256	47·2	29·8	17·4	9, 1, 1	S by E, S by W, S.	·030
23	29·565	39·5	37·0	·91	·238	49·0	35·7	13·3	9, 10, 10	SE by E, SE, SE by S.	·043
24	29·469	48·2	40·8	·77	·272	49·9	38·6	11·3	8, 8, 2	SW by S, SW by S, SSW.	·072
25	29·751	42·2	38·9	·89	·254	45·0	43·5	1·5	10, 10, 8	S, NW by N, NW by W.	·095
26	...	...	...	...	...	...	27·6	...	...	... ...	} ·165
27	30·174	40·9	34·4	·80	·217	45·1	...	...	7, 3, 3	SSE, SSE, SE by S.	
28	29·819	43·1	39·3	·88	·258	39·0	35·6	3·4	10, —, 4	S, —, SSW.	·030
29	29·726	49·7	45·3	·86	·318	52·9	40·0	12·9	10, 10, 10	SW by S, SW by S, SW.	·032
30	29·682	46·8	43·6	·89	·299	54·3	47·9	6·4	9, 10, 10	SW by W, —, SW, —.	·082
31	29·776	52·9	45·7	·78	·322	54·6	45·1	9·5	9, 10, 10	W by S, W, W by S.	·345
thly ns. }	29·840	39·7	36·8	·87	·240			9·1			1·637

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.

JANUARY 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. 12																																
A. M. 1	8	8	3	11		9	2	17	15	17	13	17	9	4	6	4	9	10	10	6	21	15	10	14	16	5	2	10	13	16	24	10·8
2	8	9	1	10		8	2	15	17	17	17	16	5	6	7	4	12	11	11	6	19	20	8	12	12	3	7	10	14	19	26	11·1
3	8	10	2	9		8	4	18	14	14	20	12	4	8	7	4	11	11	7	6	17	18	10	19	14	5	7	8	15	19	32	11·4
4	8	9	3	10		9	4	22	12	13	21	8	4	10	4	4	11	9	7	6	18	17	9	20	14	5	6	12	15	18	29	11·2
5	7	8	5	13		6	2	19	13	11	22	8	3	10	3	3	11	8	8	5	25	18	10	24	11	5	11	13	14	20	28	11·5
6	6	6	6	14	123	5	2	19	18	12	22	8	5	10	2	2	11	9	7	3	21	14	11	23	10	3	11	12	16	15	27	11·0
7	5	9	6	13		6	4	18	18	12	25	6	4	6	2	2	8	9	10	2	23	13	8	26	5	3	11	11	19	20	28	11·1
8	5	5	8	12		5	4	22	19	12	31	5	4	3	3	4	12	8	8	3	20	16	7	26	3	3	11	4	17	21	23	10·8
9	6	6	7	13		4	7	20	21	12	34	2	4	1	6	2	11	8	10	7	16	14	8	25	4	2	12	17	20	15	22	11·2
10	6	5	8	19		5	6	19	21	14	33	5	3	2	4	7	9	10	7	10	20	16	10	26	5	2	12	16	24	13	22	12·0
11	4	8	10	19	14	6	5	16	22	14	32	10	5	3	4	10	8	11	9	9	16	14	9	23	5	3	15	11	30	15	17	12·2
12	3	7	7	18	12	6	9	14	20	14	38	12	10	7	6	8	11	16	11	9	19	19	12	25	3	5	18	16	31	17	18	13·6
P. M. 1	4	11	5	21	10	6	7	20	22	17	34	15	11	12	8	9	13	16	13	12	15	20	14	37	6	6	20	17	24	9	21	14·7
2	3	10	4	12	10	7	8	17	21	15	35	15	9	13	5	8	11	16	9	13	9	18	17	34	11	15	21	17	25	8	20	14·1
3	1	10	5	11	9	3	6	15	22	12	31	16	7	10	7	8	12	13	6	12	7	18	19	31	14	12	19	15	20	7	22	12·9
4	3	8	6	11	6	3	6	14	22	14	34	13	6	10	7	3	9	10	4	15	9	15	21	30	11	8	15	20	15	4	22	12·1
5	2	8	5	8	5	1	9	11	21	11	39	14	4	9	8	2	6	9	6	16	10	10	20	27	10	6	12	19	19	2	22	11·3
6	2	7	5	7	8	3	8	7	19	13	31	12	2	7	6	4	7	8	7	16	6	8	23	30	6	6	10	18	14	1	22	10·4
7	3	6	8		6	2	8	8	18	11	28	11	5	8	7	4	4	9	6	18	9	15	19	34	6	7	8	18	17	2	21	10·9
8	4	5	7		8	4	8	4	20	11	26	15	6	11	12	4	4	7	8	17	6	8	21	29	5	5	11	16	20	3	25	11·0
9	2	4	6		5	3	7	9	17	9	28	14	7	8	6	3	5	8	8	20	5	9	19	29	5	10	14	14	16	7	17	10·5
10	1	3	8		8	3	8	6	16	10	28	16	5	9	4	8	7	8	4	25	6	11	15	24	5	6	11	15	16	15	21	10·7
11	6	3	5		9	3	7	10	17	8	29	14	8	8	6	12	10	9	5	22	9	9	16	22	6	3	11	15	17	18	22	11·3
12	12	1	10		9	2	14	10	20	6	18	13	6	9	6	10	10	10	7	18	10	9	11	13	4	3	13	13	14	18	17	10·5
Total Daily Movement.	117	166	140	473		117	147	350	445	299	669	277	136	184	136	129	222	243	188	276	336	344	327	603	191	131	288	337	445	302	548	11·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

2.	Reduced to mean of day.					Temperature of Air.			At 9·30 A. M.; 2 P. M.; and 5 P. M. respectively.		
			Calculated.								
	Barometer corrected to Temp. 32.	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9 30 A.M.	Daily Range.	Proportion of Sky Clouded.	Direction of Wind.	Rain, read at 9·30 A. M.
	inches.	°	°		inch.	°	°	°			inches.
1	29·949	50·4	45·4	·84	·319	53·0	50·5	2·5	10, 10, 10	SW by W, W, W.	·000
2	...	...	...	...	...	51·4	47·1	4·3	...	...	·000
3	30·187	50·4	47·1	·89	·338	53·8	46·7	7·1	10, 10, 10	SSW, SW by W, SW by W.	·000
4	30·210	51·3	48·2	·90	·351	54·4	47·2	7·2	10, 10, 10	W, SW by W, W by S.	·000
5	30·030	48·7	43·9	·85	·303	53·3	45·3	8·0	8, 8, 5	WSW, WSW, WSW.	·000
6	29·976	44·2	38·4	·82	·250	48·4	41·8	6·6	6, 8, 3	WNW, NE by N, N.	·000
7	30·234	32·2	22·4	·70	·141	35·9	31·7	4·2	5, 1, 2	NE, WSW, NNE.	·000
8	30·616	28·1	23·2	·84	·145	31·6	25·4	6·2	1, 6, 2	NE by N, ENE, NE.	·000
9	...	...	...	...	...	37·3	24·0	13·3	...	...	·000
10	30·467	36·0	27·4	·74	·169	40·8	32·0	8·8	7, 1, 0	N, NNW, NW by W.	·000
11	30·226	36·5	34·5	·93	·218	41·7	25·7	16·0	10, 10, 10	SW by S, W, W by S.	·000
12	30·037	41·0	37·9	·90	·245	44·4	31·7	12·7	10, 10, 10	NW by N, NNE, NNW.	·010
13	30·090	35·7	32·3	·89	·201	38·0	35·3	2·7	10, 10, 10	NE by N, NE by N, —.	·008
14	30·106	36·0	32·8	·89	·205	39·5	35·2	4·3	10, 10, 10	ENE, E by N, NE by E.	·000
15	30·127	38·4	31·5	·78	·196	41·5	36·1	5·4	10, 10, 10	E by N, E, E.	·023
16	...	...	...	...	...	41·9	33·0	8·9	...	...	·000
17	29·442	39·8	40·0	1·00	·264	43·1	34·2	8·9	10, 10, 10	E by N, —, —.	·0 0
18	29·379	48·7	44·3	·86	·307	53·4	38·8	14·6	9, 7, 9	SSE, S by W, S.	·147
19	29·561	48·3	44·8	·89	·312	52·8	45·2	7·6	8, 10, 10	SE, S by E, SE by S.	·017
20	29·619	50·3	43·3	·78	·296	54·5	47·1	7·4	8, 5, 1	SSW, SW, SW by S.	·109
21	29·836	48·3	41·0	·77	·274	54·1	37·2	16·9	1, 2, 4	SSE, SE, SE.	·011
22	29·764	48·3	43·9	·86	·303	52·5	43·1	9·4	8, 10, 10	S, ESE, SE.	·000
23	...	...	...	...	...	50·7	45·2	5·5	...	...	·016
24	30·090	37·5	33·9	·91	·213	40·4	39·6	0·8	10, 10, 10	E by N, E, E.	,000
25	30·149	37·7	31·6	·81	·196	40·4	37·4	3·0	10, 10, 10	ESE, E, ENE.	·000
26	30·349	33·0	28·3	·85	·174	35·4	34·0	1·4	10 10, 10	NE, NE by E, ENE.	·000
27	30·186	33·2	27·3	·80	·168	35·8	32·6	3 2	10, 10, 4	E, NE, NE.	·000
28	30·018	35·2	27·9	·77	·172	39·3	32·9	6·4	9, 5, 10	ENE, ENE, NE by E.	·000
...ly ...s. }	30·027	41·2	36·3	·84	·240			7·3	...	...	0·411

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—FEB. 1862.

Day.	Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
	12																													
A. M.	1	20	10	16	12	12	14	4	12	2	10	4		8	7	3	10	18	8	13	15	8	13	6	5	22	22	23	22	11·8
	2	21	12	9	13	14	10	9	15	5	5	3		7	5	3	13	18	12	13	15	7	11	8	3	23	20	21	20	11·7
	3	20	13	13	13	20	11	17	15	4	8	5		8	4	4	13	20	12	13	16	7	12	6	11	24	19	24	22	13·1
	4	18	11	14	11	20	9	18	15	5	7	3		8	9	5	10	15	14	9	11	8	9	6	14	23	22	16	20	12·2
	5	17	11	15	13	16	10	20	15	8	6	3		9	9	5	14	14	16	12	8	8	8	4	20	25	19	21	25	13·0
	6	17	8	10	10	16	8	27	12	9	7	4		9	1	2	12	12	12	7	13	6	9	0	21	25	21	24	20	12·1
	7	20	7	10	11	16	7	23	9	6	7	3		9	6	2	10	13	10	7	16	4	10	6	24	23	20	20	22	11·9
	8	20	11	9	12	15	7	16	9	6	8	4		7	7	3	10	12	10	9	21	4	10	3	23	23	17	20	23	11·8
	9	25	13	8	12	20	11	20	9	7	7	4		7	7	3	14	13	15	10	22	6	10	4	22	27	18	20	24	13·3
	10	22	11	11	14	23	11	22	15	15	8	4		7	8	4	18	11	17	13	23	10	14	2	25	24	25	21	22	14·8
	11	22	18	10	14	20	10		15	16	10		5	5	10	8	15	11	17	18	24	14	12	0	26	26	26	22	23	15·3
	12	21	17	10	11	21	9		17	18	9		6	8	11	9	22	9	18	19	26	22	9	1	24	32	26	28	24	16·4
P. M.	1	26	20	15	11	18	11		15	17	13		9	5	10	12	21	9	16	18	32	22	6	3	27	32	25	30	23	17·2
	2	24	16	12	13	20	10	125	12	17	13		8	4	8	10	21	4	22	19	28	22	4	2	25	30	25	27	22	16·1
	3	20	14	13	14	15	10		11	15	10		9	5	7	9	23	3	20	16	28	22	10	3	28	34	25	29	26	16·1
	4	22	15	7	12	13	10		9	15	9		8	5	4	11	29	1	19	15	27	25	10	6	30	30	20	31	24	15·7
	5	18	12	7	13	15	6	13	7	14	8		10	2	5	10	25	3	12	15	23	23	11	2	32	30	23	29	24	14·5
	6	12	12	4	12	10	4	6	7	11	8		8	2	9	7	20	1	14	14	17	17	6	3	26	28	20	28	24	12·2
	7	13	13	9	12	12	6	5	5	9	4		5	1	5	10	16	3	16	16	18	16	3	2	31	32	20	26	24	12·3
	8	14	16	11	11	12	14	4	5	11	6		2	2	1	8	15	3	14	17	18	17	5	3	32	23	20	23	23	12·4
	9	9	17	4	10	12	10	6	5	10	5	123	7	1	2	9	15	3	10	19	13	12	3	2	27	24	20	22	27	11·3
	10	10	16	8	10	11	10	7	4	10	3		7	1	7	9	19	1	14	19	9	11	4	3	30	22	22	17	26	11·5
	11	12	19	12	12	12	8	12	4	10	4		10	1	10	9	19	2	15	20	10	14	6	3	34	20	20	21	25	12·7
	12	8	13	12	11	10	4	10	2	10	3		4	7	5	8	16	4	10	15	10	10	4	4	23	17	21	18	22	10·4
Total Daily Movement.		431	325	249	287	373	220	364	244	250	178	258		128	157	163	400	203	343	346	443	315	199	88	563	624	516	561	557	13·1

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 8″ N., LONGITUDE 0° 18′ 47″ N.

2.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9.30 A.M., 2 P.M., and 5 P.M., respectively.		
of ...th.	Barometer, corrected to Temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum read at 9.30 A.M. on the following day.	Minimum read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
1	29·951	35 5	26·5	·72	·164	41·5	33·6	7·9	10, 7, 6	NE by E, E, E by N.	·000
2	...	...	...	...	...	34·4	31·7	2·7	...	... ...	·000
3	29·260	31·3	25·3	·81	157	37·2	23·5	13·7	10, 5, 1	SW, NW, NNW.	·000
4	29·688	32·3	23·0	·72	·144	38·0	21·7	16·3	1, 3, 3	NW by N, NE, NW.	·000
5	29·807	36·7	26·6	·70	·164	43·1	22·8	20·3	3, 8, 10	S, S, S.	·000
6	29·522	49·5	47·3	·93	·340	54·4	36·1	18·3	10, 10, 10	SW by W, SSW, SSW.	·112
7	29·427	50·9	46·4	·86	·330	56·0	47·9	8·1	10, 7, 3	S W, SW, SSW.	·098
8	29·534	52·6	47·1	·83	·338	58·9	47·7	11·2	4, 9, 2	ENE, SE by E, SE by S.	·010
9	...	...	...	...	...	50·3	44·7	5·6	...	... ...	·020
10	29·946	47·5	42·8	·85	·291	53·4	41·4	12·0	10, 8, 6	W by S, W, SSW.	·151
11	29·762	46·2	46·6	1·00	·332	51·5	41·7	9·8	10, 10, 10	SW by S, SW, SW by S.	·250
12	29·690	47·8	40·3	·77	·267	53·2	44·8	8·4	10, 4, 3	SW by W, WSW, W.	·012
13	29·981	46·2	44·7	·95	·311	52·4	41·7	10·7	10, 10, 10	NNE, NE, NE by N.	·050
14	30·150	40·3	39·2	·96	·257	44·2	40·6	3·6	10, 10, 10	NE, NE, NE.	·031
15	30·098	40·5	38·4	·93	·250	46·4	39·3	7·1	10, 9, 10	NE by N, NE, NE by E.	·008
16	...	...	...	...	...	46·5	39·0	7·5	...	... ...	·000
17	29·772	39·2	39·6	1·00	·260	46·5	40·4	6·1	10, 10, 10	SE, SSW, SW.	.400
18	29·738	41·0	38·8	·93	·253	46·1	37·7	8·4	10, 9, 8	SW, NW by W, NW by W.	·220
19	29·572	41·9	35·8	·81	·228	48·8	30·7	18·1	10, 4, 3	NE by N, NE by N, NE.	·005
20	29·354	34·6	33·6	·97	·211	38·6	37·8	0·8	10, 10, 10	NNE, NE, NE.	·030
21	29·521	33·1	31·1	·93	·193	38·0	32·8	5·2	10, 10 10	NNE, N, N.	1·144
22	30·003	36·6	27·6	·73	·170	41·1	34·1	7·0	10, 10, 9	N by E, —, ESE.	·032
23	..	...	...	...	...	52·5	36·0	16·5	...	... ...	·175
24	29·514	53·3	48·9	·86	·359	60·8	36·9	23·9	10, 9, 1	SW, —, SE.	·363
25	29·448	51·9	51·4	·98	·391	59·0	45·0	14·0	10, 10, 10	SSW, E by S. E.	·008
26	29·461	47·2	47·2	1·00	·339	53·2	44·3	8·9	10, 10, 10	E by N, E, E.	·063
27	29·352	51·1	49·3	·94	·364	58·9	44·2	14·7	10, 8, 9	S E by E, NE by N, E.	·116
28	29·186	44·5	43·6	·97	·299	49·5	45·4	4·1	10, 10, 10	NNW, NNW, N.	·093
29	29·261	42·5	39·3	·89	·258	48·1	41·4	6·7	10, 10, 10	NNW, W, —.	·000
30	...	...	...	...	...	52·3	42·0	10·3	...	... ...	·000
31	29·586	48·6	45·0	·89	·314	56·2	44·3	11·9	10, 3, 8	W, WSW, SW.	1·081
...nly ...s.	29·638	43·2	39·4	·88	·269			10·3			4·472

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—March 1862.

Day. Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
A.M. 12–1	26	8	4		6		21	17	19	12	6	5	3	22	12	13	7	9	2	17	22	13	17	11	1	5	7	7	7	1	3	10·4
1–2	22	5	3		5		20	15	15	11	7	6	2	17	12	14	7	7	1	20	20	11	14	10	1	3	6	7	8	4	4	9·6
2–3	20	4	3		4	286	20	19	13	8	7	7	2	15	14	13	8	7	1	19	20	12	16	15	2	5	4	8	7	7	3	9·8
3–4	20	7	6		4		24	18	12	4	10	8	1	19	15	18	10	6	2	20	18	15	14	16	2	3	3	3	7	10	4	10·3
4–5	22	8	5		4		19	8	15	5	11	6	2	16	13	16	7	7	2	21	17	11	15	15	3	2	1	6	6	6	6	9·6
5–6	22	7	3		0·5		21	10	15	6	13	5	4	19	16	15	7	4	2	24	18	8	11	9	1	3	1	4	6	4	3	9·0
6–7	18	8	5		4·5		24	8	18	6	17	5	4	20	18	15	6	4	1	22	20	7	12	8	2	6	1	3	6	6	4	9·6
7–8	23	6	5		8		23	8	20	5	20	8	5	18	16	16	5	4	3	31	17	9	15	12	2	11	2	4	8	8	5	10·9
8–9	20	3	7		11		29	9	22	7	21	10	10	17	19	16	5	5	9	26	20	11	15	8	3	10	3	6	5	6	5	11·7
9–10	28	4	6		19		24	13	24	8	19	9	10	15	16	14	7	4	12	27	20	12	15	8	3	10	2	6	8	4	6	12·2
10–11	21	6		9	23	26	30	14	34	8	18	11	9	18	18	15	9	5	15	27	16	11	18	9	4	10	1	5	8	3	11	13·7
11–12	22	6		5	31	25	30	15	34	8	20	11	11	20	18	13	13	4	15	29	19	6	17	10	5	6	1	4	7	2	12	14·0
P.M. 12–1	25	5		4	35	26	34	15	30	6	15	10	12	17	18	10	9	5	12	28	22	1	13	6	3	9	3	5	5	2	11	13·2
1–2	25	5		4	36	30	31	17	30	4	14	3	10	16	17	10	16	7	16	31	21	2	15	4	3	10	4	6	5	4	10	13·5
2–3	21	5		5	27	28	32	25	32	5	8	10	15	17	19	11	15	8	17	31	17	3	13	6	5	18	7	6	7	6	8	14·2
3–4	25	5		6	28	27	33	19	39	2	14	11	16	17	18	10	13	7	19	27	13	6	10	9	8	18	8	7	4	6	9	14·5
4–5	23	6		4	33	31	30	19	34	4	8	7	14	17	19	13	12	8	16	25	22	6	9	7	9	14	9	9	5	8	9	14·3
5–6	21	4		1	28	32	30	17	26	4	7	5	15	16	21	8	10	5	14	26	18	6	8	7	6	16	8	7	3	7	8	12·8
6–7	24	5		2	33	35	26	19	29	5	8	5	17	17	20	12	11	2	12	25	18	5	18	5	9	15	11	5	2	4	12	13·7
7–8	22	5		4	30	27	24	20	27	8	7	3	21	18	17	11	11	1	15	28	19	9	17	4	5	14	12	7	5	4	9	13·5
8–9	10	2		3	33	25	22	23	23	4	8	4	21	18	13	10	13	1	19	27	17	8	19	4	4	13	14	10	3	4	9	12·8
9–10	7	3	200	5	36	23	22	26	21	5	9	3	17	18	13	13	11	1	17	25	16	9	15	1	2	10	17	10	3	2	9	12·3
10–11	7	5		6		27	24	30	16	7	7	3	19	14	14	12	10	1	16	18	14	10	15	2	3	12	13	9	4	6	10	11·5
11–12	9	4		5		23	17	21	8	5	6	1	17	14	13	8	7	1	15	22	14	13	14	1	8	7	8	6	2	6	10	9·8
Total Daily Movement.	483	126	310		1110		610	405	556	147	280	156	257	415	392	306	229	113	253	596	438	204	345	187	94	230	146	150	131	120	180	12·1

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*March* 19.

The Last Elevation of the Central Valley of Scotland, by Archibald Geikie.—After alluding to the position and nature of the raised beach which, at the height of from twenty to thirty feet above the present high-water mark, fringes the coast-line of Scotland, the author proceeded to describe the works of art which had been found in it. From their occurrence in beds of elevated silt and sand, containing layers of marine shells, it was evident that the change of level had been effected since the commencement of the human period. The character of the remains likewise proved that the elevation could not be assigned to so ancient a time as the Stone Period of the archæologist. The canoes which had from time to time been exhumed from the upraised deposits of the Clyde at Glasgow clearly showed that at the time when at least the more finished of them were in use, the natives of this part of Scotland were acquainted with the use of bronze, if not of iron. The remains found in the corresponding beds of the Forth estuary likewise indicated that there had been an upheaval long after the earlier races had settled in the country, and that the movement was subsequent to the employment of iron. From the Firth of Tay similar evidence was adduced to indicate an upheaval possibly as recent as the time of the Roman occupation. The author then cited several antiquaries who from a consideration of the present position of the Roman remains in Scotland had inferred a considerable change in the aspect of the coast-line since the earlier centuries of the Christian era. He pointed out also several circumstances in relation to these Roman relics, which tended to show a change of level, and he referred to the discovery of Roman pottery in a point of the raised beach at Leith. The conclusion to which the evidence led him was that since the first century of our era the central parts of Scotland, from the Clyde to the Forth and the Tay, had risen to a height of from twenty to twenty-five feet above their present level.

ROYAL SOCIETY.—*March* 20.

Exhibition of M. Plateau's Films.—Dr. Frankland exhibited before the society a series of very beautiful experiments with the solutions and apparatus of M. Plateau, designed to show the optical and mechanical properties of thin films. The films are obtained by means of a solution of one part of pure oleate of soda in fifty of water; three parts of this solution are then mixed with two parts of glycerine. The liquid thus obtained is capable of being blown, by means of a common tobacco-pipe, into bubbles of very large size and great permanency. Dr. Frankland stated that he had succeeded, by means of a blowpipe bellows, in obtaining a bubble nearly nineteen inches in diameter. When inflated with air these bubbles often last more than twenty-four hours; but, when the breath is employed, the oleate of soda is slowly acted on by the carbonic acid expired, and their duration is limited to three or four hours.

A series of these bubbles, about six inches in diameter, were placed on a number of glass rings situated in a line, and on a ray of light from the electric lamp being transmitted through the series, their beautiful irridescent colours were developed in the most magnicent manner.

Other bubbles were inflated with a mixture of eight parts of air and one part of coal gas, which, by overcoming the specific gravity of the film, enabled the bubbles to float in the atmosphere so as to be wafted by the slightest current. The tenacity of the film was shown by allowing drops of water to fall through the bubbles which could be accomplished without breaking them.

By dipping small wire cages forming the outlines of geometrical solids, into the mixture of oleate of soda and glycerine, plane films were produced intersecting each other in various directions in the interior of the wire frames. Many of these offered very remarkable geometrical combinations; the wire outline of a tetrahedron, for example, on being withdrawn from the solution, was shown to contain six triangular films, all meeting at the centre of the figure.

The films, formed in the cages which represented the outlines of short rectangular prisms, were in several cases bounded by curved lines, the mathematical properties of which have been closely investigated by M. Plateau.

SOCIETY OF ARTS.—*April* 2.

Oxidized Oil as Substitute for the Elastic Gums.—Mr. F. Walton described the manufacture of a new substitute for gutta percha and india-rubber, consisting of oil oxidized by exposure to the air in thin films, and subsequently either dissolved in a volatile solvent, or worked up in a solid form. By these means an elastic solid is obtained, possessing in a great degree the properties of rubber in its various conditions, and applicable to similar purposes.

LINNEAN SOCIETY.—*April* 3.

On the Fertilization of Certain Orchids.—Mr. C. Darwin described some remarkable peculiarities existing in certain orchids, specimens of which were in the possession of the Linnean Society. In the plants belonging to the genus *Catasetum*, it not unfrequently happens that two, and sometimes three, supposed distinct genera exist on the same spike. Thus the *Catasetum tridentatum* is intermixed with the flowers of the *Monocanthus viridis* and those of the *Myanthus barbatus*.

Mr. Darwin has ascertained that the *Catasetum tridentatum* is the male form, the flowers bearing pollen masses only; that in the so-called *Monocanthus* the pollen masses are rudimentary, the inferior ovary being well-developed and twisted as is usual in orchidaceous plants, and, further, that the so-styled *Myanthus barbatus*, which is borne on the same plant, is merely the hermaphrodite form.

Mr. Darwin remarked on the very extraordinary mechanism which was necessary to ensure the fertilization of the orchids of the unisexual flowers of the genus *Catasetum*. The pollen masses are attached to elastic fibres, held down by a membrane, and each is furnished with an adhesive disk. The flowers are furnished with antennæ; when these are touched by any object, as an insect, the elastic fibres project out the pollen mass with such force that its adhesive surface adheres to the insect, which, in its search for honey, conveys it to the stigmatic surface of the pistil bearing flower.

Mr. Darwin stated that the position of the excitable surface of the flower varied in the different species, but that the projection of the pollen mass was, in all cases, in such a direction as to cause its attachment to the insect passing over the irritable surface.

Total Amount of Australian Gold introduced into England.—Professor Tennant exhibited some rich specimens of auriferous quartz from Nova Scotia, and also the first specimen of Australian gold that was brought to England. This nugget was exhibited at the Great Exhibition of 1851. Since that time 1000 tons of gold have been imported into this country from Australia, the value of which cannot be estimated as less than about £143,000,000.

ENTOMOLOGICAL SOCIETY.—*April* 7.

Silk-producing Moths of Asia.—Mr. F. Moore exhibited a magnificent collection of the various silk-producing moths of India, with specimens of their cocoons and samples of the silks in their raw and manufactured states. The best silk is yielded by the common silkworm, the *Bombyx mori*, which is now so generally cultivated; it is an annual, and feeds on the mulberry. Many other species of *Bombyx* are also known and cultivated, some yielding several crops of silk every year; specimens of eleven distinct species are contained in Mr. Moore's collection.

The genus *Attacus* contains several species of silk-yielding moths. The Tusseh cloth of China is said to be produced by the *A. atlas*. And the *A. Cynthia*, which is known as the *Eria*, or the *Ailanthus* silkworm, from feeding on the leaves of that plant, exceeds six inches in length in China, where it has been cultivated for centuries, and clothes large masses of the people.

The *Eria* has been introduced into the south of Europe, and has been successfully cultivated in many parts of France, as has also a hybrid between it and the Bengal Eria, *Attacus ricini*, this latter also feeds freely on the leaves of the castor-oil plant, *Ricinus communis*.

The *Actias selene* is domesticated at Mussooree, where it yields four crops of silk annually. The Moonga, *Antheræe assama*, is extensively cultivated in the open air in Assam; the silk forms one of its principal exports. There are generally five broods during the year.

The *Antheræa paphia*, or Tussur, or Tusseh silkworm of the Bengalese, is very widely distributed throughout India; its silk is a most abundant product; it is the most common in use of all the wild silkworms, millions of cocoons are annually collected in the jungles and brought to the silk factories near Calcutta. Other species of *Antheræa*, as the *A. Roylei*, feeding on different species of oak, have also been cultivated.

In addition to the moths above enumerated, the collection of Mr. Moore exhibited several others belonging to the genera *Cricula*, *Salassa*, *Saturnia*, etc., etc., many of which, it is evident, may be made largely available for the production of different silks, having various qualities likely to render them useful to man. This unique collection will be shown in the Indian department at the International Exhibition.

ZOOLOGICAL SOCIETY.—*April* 8.

THE LEPIDOSIREN.—Dr. T. Spencer Cobbold, F.L.S., gave a minute description of the bones of the skull of *Lepidosiren annectans*, which animal differs so materially from that of the American species (*Lepidosiren paradoxa*) that some have placed it in a distinct genus, under the title of *Protopteris*. The New World species, discovered by Natteur, has been carefully anatomized by Bischoff and Hyrtle, whilst the one under consideration has been dissected and described by Owen, Melville, M'Donnell, and others. The osteology of *Lepidosiren annectans*, however, is still incompletely understood. Dr. Cobbold observed that three, or at most four, bones only were concerned in the formation of the cranium proper, whilst four others formed the face, two of them belonging to the jaws. He stated that there were no true superior maxillary bones, the upper massive jaw being in reality made up of the enormously developed palatine bones. The most remarkable cranial elements are the pair of horn-like bones which stretch backwards to form the vault of the skull. Bischoff says they are altered molar bones, but Dr. Cobbold considers them to be the frontals, and he observed that "their presence more than any other of the osseous elements imparts to the skull its unique character." There are many striking differences in the skeletal element of *Protopteris annectans* as compared with *Lepidosiren paradoxa*.

NOTES AND MEMORANDA.

Star Finder.—Messrs. Horne and Thornthwaite have supplied a want widely felt by the possessors of telescopes, in producing a small, portable, and elegant instrument, by which celestial objects may be easily found from the data given in the *Nautical Almanack*, or any similar authority. It is, in fact, a miniature equatorial of accurate workmanship and very moderate price. We regret that the demands upon our space oblige us to postpone any detailed description, but it is due to our astronomical readers to give them the earliest intimation of a new and important aid to their favourite pursuit.

Taranaki Steel.—We have received from Messrs. Moseley a specimen of that very curious and interesting mineral, the iron-sand from New Zealand, which appears to realize all the expectations which were formed of its value in metallurgy. The chemical composition of this ore, for such it must be called, is eminently favourable for the production of the finer kinds of steel, as it not only contains no element of a deteriorating quality, but has the great advantage of possessing a considerable quantity of titanium. In appearance the Taranaki sand resembles bright grains of gunpowder, and is readily attracted by the magnet. Professor Herapath says it contains 16 per cent. of titanium, 6 of silica, and a trace of manganese. The deposit extends for miles on the beach, at the foot of the volcanic mountain Egmont, and when smelted yields 60 per cent. of iron of the first quality. Under the microscope it presents a beautiful appearanee, the grains exhibiting very irregular but polished surfaces, with a lustre between that of steel and silver. Here and there a grain will be observed, composed chiefly of silica, dotted with minute portions of the ore, but it is singularly free from impurities. The steel made from it is highly praised, and when we remember the extraordinary affinity of titanium for nitrogen at high temperatures, we call to mind the recent assertion of a French chemist on the action of the last-named element in changing iron into steel.

Links between Feathers and Scales.—Mr. Latham exhibited to the same society scales from the wing of the Catarrhactes papua, a penguin from the Falkland Isles. They appear intermediate between feathers and scales. This fact should be considered in connection with the discovery of the feathered reptile in the Solenhofen state.

The Mass of Jupiter.—M. Schubert expects to be able to calculate the exact mass of Jupiter from the disturbances he produces on the asteroid Leucothea.

Astronomical Photographs.—The beautiful photographs of M. Warren de la Rue are a most valuable contribution to astronomical science. By means of his labours we are obtaining a continuous history of the changes in the spots and faculæ on the face of the sun, more accurate and more instructive than could be preserved by any verbal description or ordinary drawing. By this means questions relating to the periodicity of these changes and their connection with terrestrial magnetism will be solved, and likewise those concerning the movements of the supposed ring of asteroids in the region of Mercury. Among the most remarkable of Mr. de la Rue's works are stereoscopic views of the larger planets. As it would be impossible to stereoscope objects so remote by the usual methods of operation, he has obtained the requisite change in the aspect of the two views by photographing the planetary disks in two positions at two different periods of observation.

The Sodium Spectrum.—Mr. Fizeau called the attention of the French Academy, on the 3rd March, to the character of the light obtained by burning the metal sodium in common air, when examined with the spectroscope. He observed, "the results differed entirely from those obtained with other flames in which the presence of sodium is revealed in a very constant manner by a yellow light, which, when observed in the spectrum, presents the double ray D detached from the background and very luminous. The effects produced with the burning sodium do not coincide with the expectation of a great development of the ray D, and we find with surprise that the spectrum it produces is continued after the red as far as the violet, with the exception of the double ray D, which detaches itself in shaded black (noir foncé) and like velvet on the brilliant ground of the spectrum. This appearance is the converse of that which is given by other flames containing sodium. With them, in fact, all the rays of the spectrum are wanting, with the exception of that which forms the ray D. With burning sodium all the rays are very brilliant except those of the ray D, which appear entirely absent.

This phenomenon only occurs when the combustion is vivid. When the metal begins to burn the ray D shines on a black ground; as the combustion becomes more active it developes in one part and another of the ray D, which it enfeebles, intense rays, which at first do not pass beyond its immediate vicinity, but which rapidly invade the whole expanse of the spectrum with ordinary tints as the sodium becomes completely on fire; and at last there is observed only the rays of the double ray D which detaches itself in intense black—that is to say, with the same appearance as in the spectrum formed with the light which emanates from the sun."

Trepidation of the Soil at Nice.—From a letter by M. Prost to M. Elie de Beaumont, published in *Comptes Rendus*, we learn that, during the late eruption of Vesuvius, tremblings of the ground occurred at Nice, varying suddenly in force and direction.

The Companion of Sirius.—Mr. Clark of Cambridge, U.S., has discovered, and Mr. Bond has verified, the existence of a companion of Sirius, distant 10″. It had been suspected by Bessel and Peters, on account of certain periodical perturbations in the right ascensions of the great star, and was conjectured to be a dark body, as it could not be found before Mr. Clark's fortunate observation with an 18-inch instrument. The companion of Sirius has been seen at Paris (since its discovery in America) with M. Foucault's large telescope, with a silvered mirror, 80 centimetres. It is visible only when atmospheric conditions diminish the radiation from the great star. Mr. Peters has written to *Cosmos*, stating that it cannot be identified with the body whose existence he suspects. The exact distance of the little star is 10″·5, angle of position, 85°.

Carbon and Hydrogen.—M. Berthelot, who has been long engaged in forming hydro-carbons by a synthetical process, has recently made a remarkable experiment by passing a current of hydrogen between the charcoal points of a Bünsen's battery of 60 elements. At this extreme temperature the hydrogen combined with the carbon producing a cetyline. The facts were communicated to the French Academy by M. Balard on the 17th March.

Vocal Fishes.—Dr. Dufossé communicates to the French Academy further researches into the vocal powers of certain fish, most of his observations being made upon species of *Trigla* and *Zeus* (gurnards and dories). He states the sounds to be produced by the vibration of the muscles belonging to the air-bladder, and that large gurnards may be heard at a distance of six or seven yards. Out of five or six hundred individuals of the species mentioned, their voices were comprised between si_2 and re_5 inclusive. The sounds were instantaneous, or prolonged for several minutes, sometimes as long as seven or eight minutes. The pitch often varies during a single "sonorous emission." The finest vocal performers appear to belong to the species *Morrude*, who surpass all their congeners in producing a great number of completely distinct sounds. "They sustain the simple sounds better, and modulate better the compound sounds; they render more distinctly long successions of sounds different in tone and pitch; in fine, there is less dissonance in the sonorous vibrations they produce. Other species, however, beat them in intensity.

Microscopic Writing.—The President of the Microscopic Society of London stated in his annual address that the beautiful machine presented by Mr. Peters has enabled the Lord's Prayer to be written in the 356,000th of a square inch—a space like a minute dot. The English Bible contains 3,566,480 letters. The Lord's Prayer, ending with "Deliver us from evil," 223 letters; so that the Bible is 15,992 times longer than the prayer, and if we employ round numbers we may say it could be written in 16,000 times the space occupied by the prayer, or in less than the twenty-second part of a square inch. In other words, the whole Bible might be written twenty-two times in one square inch. This wonderfully minute writing is clearly legible when placed under a good microscope. In using the machine the operator writes with a pencil attached to one end of a long lever; whatever marks he makes on a piece of paper are infinitesimally reduced in corresponding motions, by which a glass plate is moved over a minute diamond point. By means of Ibbetson's geometric chuck, beautiful geometric designs may be engraved on a similar scale of minuteness.

THE INTELLECTUAL OBSERVER.

JUNE, 1862.

LIFE CHANGES ON THE GLOBE.

BY HENRY J. SLACK, F.G.S.

An assemblage of facts concerning any branch of Nature's operations cannot fail to interest an intelligent being; but they do not constitute a science until they are arranged and co-ordinated, so as to mark the ascent from particular, to general, or universal truths, and thus contribute to that speculative philosophy which constitutes the noblest triumph which the human intellect can achieve. Regarded in this light, departments of physical inquiry are interesting in proportion to the amplitude of the views which they disclose, or in other words in proportion to the number and variety of special facts which they are able to refer to simple principles, or comprehensive laws. Modern discoveries concerning the correlation and conservation of forces show us the purely artificial character of the divisions which the limitation of our faculties compels us to make, and point to the conclusion that all spheres of activity, all realms of space would only exhibit the phenomena of a single science to a mind capable of grasping the majestic whole. In the direction of this goal, man, as the child of Time and the heir of Immortality, feels that he is progressing. It may be, probably must be, for ever afar off, and impossible to attain, but when we deal with infinities, an approach may be constant, a boundary never reached.

Among the sciences which at the present time exercise the profoundest influence upon the diligent searcher, and the casual collector of the golden particles of truth, geology must claim a noble rank, and although—dating its progress in time—it is one of the shortest of the many rivers of knowledge, it has become one of the broadest and richest through the confluence of a thousand tributary streams. At a very early period of its brief career, it connected the changes in the structure of the globe, with successive scenes of animated life, and extended the domains of what is commonly called "natural history," and other biological sciences, from the limited present to the immense, and incalculable, ages of the past. The natural arrangement of various strata necessitated the idea that some were ancient, and others comparatively new. The same fact of sequence in formation was testified by their structure, some being obviously composed of materials obtained from those of earlier date; but the various leaves of the great earth-book would have been comparatively blank pages, if they had not been written over with the hieroglyphic characters of once living beings. It was soon found that fossils, which some early observers thought to have been only freaks of Nature's "plastic power," were the most important records of terrestrial modification. Particular kinds were ascertained to have been connected with particular periods of the history of any locality which presented a succession of forms. Up to a certain point similar remains were discovered in analogous formations in different countries, and it was assumed that we were thus in possession of the means of establishing a comparative chronology universally applicable in our mundane world. The age, for example—giving geological latitude to the word—of Silurian slates and sandstones, coal measures, or chalk, was supposed to be the same all over the globe. If the characteristic fossils were found, they were presumed to decide the epoch to which the strata belonged, and few geologists, even in the recesses of their own minds, ventured to question the dogmas of a scientific orthodoxy which were not without convenience in application, and which were widely received. To Professor Huxley belongs the honour of boldly assailing the ground of this belief, and of recalling the whole tribe of stratigraphical decipherers to a just consideration of the wide distinction between facts arrived at through the genuine processes of inductive or deductive investigation, and the various fancies and figments by which men delude themselves into the notion that their knowledge extends to regions which in reality their inquiries have failed to reach.

Human egotism has been at the bottom of many speculative errors, and man has too often tried to dwarf the universe so as to bring it within the limits of his feeble faculties, and make its operations correspond in brevity of duration with the shortness of his mortal life. It is to this source that we owe many follies of cosmogony and geology, and it is very rarely that even the professed investigators of science can be induced to forego the idle effort to explain the history of our planet by theories prodigal in violence and parsimonious in time. From all such blunders English geologists, at least, might have easily emancipated themselves if they had followed to their legitimate conclusions the principles established by Sir Charles Lyell in his masterly examination of the connection between past facts and existing causes; but, notwithstanding the exhaustive reasonings which that distinguished philosopher embodied in a most fascinating style, it has been customary to represent the earlier epochs of our globe as periods of such continuous violence as to make us exclaim with Isabel, "nothing but thunder," and it has also been common to exalt negative evidence to a most unwarrantable position in the scale of proof. To get the world made and unmade as quickly as impatient professors desired, it was necessary to fancy that, comparatively speaking, no great while had elapsed since it "wandered lonely as a cloud" in the nebulous form. Condensation followed almost as rapidly as the drops fall from the condensed steam of the locomotive, and it spun round as a fluid fiery mass, getting sufficiently crusted at the surface to be a convenient lodging for such forms of life as require what the gardeners call a strong "bottom heat." Radiation enabled more and more of the molten material to become solid, and colder creatures appeared upon the scene. Still the central fires maintained their sway, every volcano was their outlet, and where no lava streams could burst forth, continents were upheaved with all the facility which characterizes the elevation of bubbles on the surface of a baking pie. These high-pressure movements soon exhausted and absorbed successive races of organized existences, and when the earth had been tossed and tumbled about, so that "chaos was come again," a fresh exertion of creative energy upraised new forests, and caused new creatures to bound or crawl beneath their shade. One apparent advantage of this school of geology was its supposed power to exhibit the first dawn of life, and the successive catastrophes by which systems were swept away, and a higher *fauna* and *flora* convulsively introduced. The general results of this mode of philosophizing are thus stated by Professor Huxley, the words in brackets being added by ourselves.*

"Animals and plants began their existence together, not long after the commencement of the deposition of the [earliest known] sedimentary rocks, and then succeeded one another in such a manner that totally distinct faunæ and floræ occupied the whole surface of the earth, one after the other, and during distinct epochs of time.

"A geological formation is the sum of all the strata deposited over the whole surface of the earth during one of these epochs; a geological fauna or flora is the sum of all the species of animals or plants which occupied the whole surface of the globe during one of these epochs.

"The population of the earth's surface was at first very similar in all parts, and only from the middle of the Tertiary epoch onwards began to show a distinct distribution in zones.

* *Quarterly Journal of the Geological Society*, May 1862.

"The constitution of the original population, as well as the numerical proportions of its members, indicates a warmer and, on the whole, somewhat tropical climate, which remained tolerably equable throughout the year. The subsequent distribution of living beings in zones is the result of a gradual lowering of the general temperature, which first began to be felt at the poles.

"It is not now proposed to inquire whether these doctrines are true or false; but to direct your attention to a much simpler though very essential preliminary question—What is their logical basis? what are the fundamental assumptions upon which they all logically depend? and what is the evidence on which those fundamental propositions demand our assent?

"These assumptions are two: the first, that the commencement of [that part of] the geological record [which has hitherto been deciphered] is coeval with the commencement of life on the globe; the second, that geological contemporaneity is the same thing as as chronological synchrony. Without the first of these assumptions there would of course be no ground for any statement respecting the commencement of life; without the second, all the other statements cited, every one of which implies a knowledge of the state of different parts of the earth at one and the same time, will be no less devoid of demonstration.

"The first assumption obviously rests entirely on negative evidence. This is, of course, the only evidence that ever can be available to prove the commencement of any series of phenomena: but, at the same time, it must be recollected that the value of negative evidence depends entirely on the amount of positive corroboration it receives. If A B wishes to prove an *alibi*, it is of no use for him to get a thousand witnesses simply to swear that they did not see him in such and such a place, unless the witnesses are prepared to prove that they must have seen him had he been there. But the evidence that animal life commenced with the Lingula-flags, *e.g.* would seem to be exactly of this unsatisfactory uncorroborated sort. The Cambrian witnesses simply swear they "haven't seen anybody their way;" upon which the counsel for the other side immediately puts in ten or twelve thousand feet of Devonian sandstones to make oath they never saw a fish or a mollusc, though all the world knows there were plenty in their time."

Having thus defined the nature of his inquiry, Professor Huxley shows that when the lias of England and that of Germany, or the cretaceous rocks of Britain or of India are said to be "contemporaneous," the word is most loosely employed, and that no evidence exists by which synchronism of formation can be demonstrated in either case. Taking for an illustration the computation of the late Daniel Sharpe that thirty or forty per cent. of the known Silurian mollusca are common to both sides of the Atlantic, and by way of allowance for undiscovered specimens, assuming that sixty per cent. are common to the North American and British Silurians, he avers that if contemporaneity or synchronism were assumed upon such evidence, we should fall into serious mistakes :—

"Now suppose that, a million or two years hence, when Britain has made another dip beneath the sea and has come up again, some geologist applies this doctrine, in comparing the strata laid bare by the upheaval of the bottom, say of St. George's Channel, with what may then remain of the Suffolk Crag. Reasoning in the some way, he will at once decide the Suffolk Crag and the St. George's Channel beds to be contemporaneous; although we happen to know that a vast period (even in the geological sense) of time, and physical changes of almost unprecedented extent, separate the two.

"But if it be a demonstrable fact that strata containing more than sixty or seventy per cent. of species of Mollusca in common, and comparatively close together, may yet be separated by an amount of geological time sufficient to allow of some of the greatest physical changes the world has seen, what becomes of that sort of contemporaneity the sole evidence of which is a similarity of facies, or the identity of half a dozen species, or of a good many genera?

"And yet there is no better evidence for the contemporaneity assumed by all who adopt the hypotheses of universal faunæ and floræ, of a universally uniform climate, and of a sensible cooling of the globe during geological time."

Looking fairly at the evidence before us, we can only come to the conclusion that "a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America, and with a carboniferous fauna and flora in Africa." What *was* the case we have as yet no means of knowing, and while grounds of decision are wanting, judgment should hold suspense. If we may compare the successive changes in various parts of the globe to the movements of a clock, we must not assume the starting-point of any series of operations to have been identical. Each country, so to speak, may have had its own clock—all the clocks going upon the same principle, and to a large extent with the same order in their motions, but the dawn marked by one may correspond in actual time with the noon on the evening of another place.

The extreme value so often assigned to negative evidence has materially assisted spasmodic theories. It has led to the unproved and improbable assumption that our very limited search for the remains of older periods enables us to decide authoritatively the proximate periods at which fish, reptiles, or mammals were introduced, and it has also induced many authorities to affirm in the most positive manner that the organized beings of two epochs have been *totally* distinct. As an instance of this common phraseology we may cite Professor M'Coy's declaration that in Australia as in Europe "the greater part of the country sank under the sea during the Tertiary period, and *every trace* of the previous creations of plants and animals were destroyed, and replaced by a *totally different set*."* We shall see how far this violence of expression is justified by Professor Huxley's investigations; but before dismissing the subject of negative evidence, let us call to mind Sir C. Lyell's remarks in 1851,† in reference to the dredging operations of Messrs. Forbes and MacAndrew between the Isle of Portland and the Land's End. During one hundred and forty dredgings, at various distances from the shore, they obtained a large quantity of marine invertebrates, but very few traces of vertebrate life, none of them referable to terrestrial animals. "If," says Sir Charles, "reliance could be placed on negative evidence, we might deduce from such facts, that no cetacea existed in the sea, and no reptiles, birds, or quadrupeds on the neighbouring land."

In comparing the fauna and flora of the two periods, or of two contemporaneous countries, the amount of agreement or difference which an observer will trace must depend very much upon the method he employs. If he is a profound believer in certain systems of classification, he may affirm objects to be totally distinct, or new creations, and so forth, while they are closely allied; and if we consider the pernicious influence of spasmodic theories in blinding the mind even to obvious facts, it is consoling to find so great an authority as Professor Huxley confirming opinions which are in conformity with the most probable deductions from general science. He tell us that, if we leave negative differences out of consideration, and regard the fossil world in the broad spirit suggested by comparative anatomy, we shall be struck with "the smallness of the total change." Out of "two hundred known orders of plants, not one is certainly known to exist exclusively in a fossil state. The whole lapse of geological time has as yet not yielded a single new ordinal type of vegetable structure." In the animal world the change has been greater; but still "no fossil animal is so distinct from those now living as to require to be arranged even in a separate class from those which contain existing forms. It is only when we come to the orders, which may be roughly estimated at about a hundred and thirty, that we meet with fossil animals so distinct from those now living as to require orders from themselves; and these do not amount on the most liberal estimate to more than about ten per cent. of the whole." The Protozoa, it appears, have not lost any known order, the Cœlenterata but one, the rugose corals—the Mollusca none, the Echinoderms three, and the Crustacea two, "making altogether five for the great subkingdom of Annulosa. Among vertebrates there is no ordinally distinct fossil fish: there is

* *Annals of Natural History*, Feb. 1862, p. 144.

† *Quarterly Journal of the Geological Society*, May 1851, p. 53.

only one extinct order of Amphibia, the Labyrinthodonts; but there are at least four distinct extinct orders of Reptilia, viz. the Icthyosauria, Plesiosauria, Pterosauria, Dinosauria, and perhaps another or two. There is no known extinct order of birds, and no certainly known extinct order of Mammals, the ordinal distinctness of the 'Toxodontia' being doubtful:"—

'The two highest groups of the Annulosa, Insecta and Arachnida, are represented in the Coal either by existing genera or by forms differing from existing genera in quite minor peculiarities.

"Turning to the Vertebrata, the only palæozoic Elasmobranch Fish of which we have any complete knowledge is the Devonian and Carboniferous *Pleuracanthus*, which differs no more from existing Sharks than these do from one another.

"Again, vast as is the number of undoubtedly Ganoid fossil Fishes, and great as is their range in time, a large mass of evidence has recently been adduced to show that almost all those respecting which we possess sufficient information are referable to the same subordinal groups as the existing *Lepidosteus*, *Polypterus*, and Sturgeon; and that a singular relation obtains between the older and the younger Fishes; the former, the Devonian Ganoids, being almost all members of the same suborder as *Polypterus*, while the Mesozoic Ganoids are almost all similarly allied to *Lepidosteus*."

With these facts before us, how are we justified if we retain the phraseology of the scientific *convulsionnaires*, or impute to the operations of nature, jerks, cataclysms, and violence, which are not evidenced by external facts, and which are highly improbable upon *à priori* grounds?

It is curious that the theories of spasmodic geology have readily allied themselves with development speculations, which, if valid in any shape, must demand such enormous periods of time, and such gradual processes of modification, as to have more real affinity with the philosophy that Lyell has traced. In common with most other physiologists, Professor Huxley comes to the conclusion that "positive evidence fails to demonstrate any sort of progressive modification towards a less embryonic or less generalized type in a great many groups of animals of long-continued geological existence." In such groups he finds abundant evidence of variation—none of what is ordinarily understood as progression," and he adds, "if the known geological record is to be regarded as even any considerable fragment of the whole, it is inconceivable that any theory of a necessarily progressive development can stand." If, however, the plan of creation involves progressive modification, then even what we commonly understand by "geological eras" will appear brief spaces of time when compared with the enormous periods during which modifications have taken place, and "the conclusion will inevitably present itself that the

Palæozoic, Mesozoic, and Cainozoic faunæ and floræ, taken together, bear somewhat the same proportion to the whole series of living beings which have occupied this globe, as the existing faunæ and floræ do to them."

Serious difficulties are experienced when it is attempted to convert geological into historical time; but the periods required for even minor changes in the earth's surface must greatly exceed those with which the records of human civilization have to deal, and no geologist of repute would contend that a small number of ages would suffice for the deposition of any considerable thickness of sedimentary rock, or for the denudation of an extensive area by aqueous and atmospheric action. When, therefore, we contemplate an epoch in the physical history of the globe, we must beware of assigning limits upon imaginary grounds; and if on the one hand we accept Professor Phillips's caution, to avoid random speaking about "millions on millions of ages," we must at any rate be equally on our guard lest we condemn ourselves to an erroneous mode of interpretation by refraining from the perception of the fact that the operations which geology traces could not possibly have taken place within any duration that our faculties enable us to appreciate. In astronomical distances our understanding is soon brought to a condition in which the multiplication of figures fails to produce a corresponding enlargement in our ideas, and we must not expect more success in the attempt to grasp the ages of the earth. Taking the whole group of statified rocks in the British Isles at 100, Professor Phillips assigns 79 to the Palæozoic, 18 to the Mesozoic, and 3 to the Cainozoic; and if the thicker formations absorbed a proportionably greater length of time, it would not be easy to imagine calculations that would transcend the truth. Life changes on the earth can only be imperfectly understood from the incomplete series of remains that have been discovered, but from them the authority last cited computes the rate of progressive change at $\frac{1}{79}$ for the Palæozoic $\frac{1}{18}$ for the Mesozoic, and $\frac{1}{3}$ for the Cainozoic time, and he adds, "The slowness of early changes has been ascribed to a greater uniformity of terrestrial temperature than is now experienced."

How and in what manner climates have altered is too large a question to be treated incidentally; but, in connection with the present inquiry, we may quote some remarks of Mr. Hopkins, which cut off the recourse to central fires and rapid refrigeration as causes which produced noticeable effects in a few thousands or a few millions of years. "The part of the superficial temperature due to primitive heat is very small, amounting to about one-twentieth of a degree of Fahrenheit. It must have been constantly diminishing for an immense period of time, and has now approached so near its ultimate limit, that if the earth's refrigeration should continue under the same natural conditions as at present, it would require, as shown by Poisson, the enormous period of a hundred thousand millions of years to reduce this small fraction to half its actual value. . . . . We are, however, more immediately concerned with past than with future changes. We should not be justified in supposing from what I have stated respecting the slow future variations of the earth's superficial temperature, that it has been equally slow for an equal period of past time; but it is still highly probable that some millions of centuries must have elapsed since the mean superficial temperature could have been greater by a single degree than at present, from the operation of the causes we are now discussing."* Changes in climate within the periods we trace, are to be accounted for as the results of varying configurations of land and water very gradually and slowly produced. They must have been important agencies in modifying the life upon the globe, but if ever the laws regulating the succession of animated beings are to be understood, the explanation must come from biological inquiries; and until physiology and kindred sciences have entered into their deductive stage, it is not probable that the question of the Origin of Species will be definitively solved.

As is usually the case with reformers, whatever may be the sphere of their labours, Professor Huxley neither stands alone in the opinions which he has enunciated, nor has he risen abruptly to be the pioneer of a new process of inquiry. As he himself remarked, others had felt similar difficulties, and cherished similar thoughts. He, however, has given clear and distinct utterance to what they hesitated to state, and although we think a few inaccuracies of expression occur in his admirable paper, further consideration only deepens the conviction produced upon all who were so fortunate as to hear the address delivered, that it exhibits that rare combination of the faculty of reasoning with ample knowledge of detail, which characterizes a work destined to be a landmark in the search for truth.

* *Quarterly Journal of the Geological Society*, February 1852, p. 59.

BEAUTIFUL EXOTIC BEES.

BY H. NOEL HUMPHREYS.

As will be seen by the species represented in the accompanying plate, some of the exotic bees are almost as richly coloured as the more gaudy butterfly tribe, and at the same time are of such conspicuous size as must render them very remarkable objects, winging their rapid and always musical passage among the exuberant vegetation of the tropics. A thoughtful spectator seeing for the first time in their native wilds these gigantic and magnificently tinted bees, robbing the nectaries of tropic flowers of sweets whose mere perfume seems almost too delicious, could scarcely forbear picturing to himself the produce of unknown kinds of honey, of a luscious sweetness and exquisite flavour, as yet undreamed of. If, (he might reflect) those mean little plants of wild thyme, trailing their humble stems among the scanty herbage of our bleak northern hills, can yield delicious honey to that poor little brown gatherer, the old hive bee, what may one naturally expect to be the result of honey-gathering by such a noble race of bees as these of the tropics, and with such exquisite flowers to gather from! Such might easily be conceived to be the exclamation of an observer of the flight of bees among the gorgeous plants in one of the natural gardens of some intertropical valley; and he would think of those bees mentioned by Amer which make natural hives of the cavities of rocks, laying up honey in large pouches, or cells, of the size of a pigeon's egg, and which being dark coloured, and hanging to the sides of the hive in clusters, look like bunches of delicious grapes, containing, in fact, a juice far more sweet:* he might think also of what Clavigero, the Spanish historian of Mexico, says of a bee, evidently of a nearly allied species, which abounds in Yucatan, and produces the famous honey of Estabentiem, the finest in the world, which is said to be taken from the bees every two months. These bees are, however, small inconspicuous creatures, evidently belonging to the same group as our own honey hive-bee, though distinguished from it by being stingless.

The most magnificent bees are, on the other hand, not of the true honey kind. They belong principally to the class of solitary bees, including a few of the humble-bee class and their relatives. These last, though it is true that many of them of the "social" kinds *do* collect honey, yet manipulate it in a very inferior manner to that of the hive-bee. Other kinds only collect pollen, which being exclusively intended as

* In wild hives of this kind, Captain Basil Hall found comb of the usual size made as cells for the larvæ.

food for the young larvæ, is generally rolled into little balls, or pills, one being placed in each of the cells in which an egg is to be deposited, so that the infant larvæ may find food ready prepared for immediate consumption; but very little is accurately known with regard to the preparation of the food for the infant bees. It is probable that different kinds of food are prepared for the different sexes; so that in the case of the social bees, in whose community there is a third, or neutral sex, and in some, a second kind of female, three or four different sorts of food may be prepared, just as cells of a distinctly different size are constructed for the males, females, and neuters. The influence of the peculiar food is no doubt very essential; and indeed some entomologists have supposed that all the larvæ are, while in that stage, perfectly neutral, the sex being eventually determined by the kind of food upon which they are fed.* Under the influence of this view of the subject, it has been asserted that a peculiar kind of honey prepared expressly to feed the larva destined to become a queen, or foundress bee, will, if given to another larva, not originally intended to become a queen, cause that other larva to develop itself into a queen; although, if fed upon the food usually prepared for it, it would have remained a neuter. Such is the wonderful power attributed to this "royal jelly," as the prepared queen-food has been termed. The feeding of a neuter with the royal food is a course which some have supposed (on perhaps insufficient grounds) to be resorted to in cases where the queen bee of a hive has died, or been accidentally destroyed. A larva is then selected, it is said, from among the cells of the neutral larvæ, neutral larvæ having been proved by dissection to be imperfect females, and fed upon the royal jelly, the cell being enlarged to suit the size of a queen, for whose bulk a cell originally constructed for a male, or a worker would be insufficient. Some of the handsomest of the exotic bees are parasites and, consequently, not either honey or pollen-meat producers. Some, however, of those which are at present assigned to this idle and worthless class may, with increased knowledge of the subject, be found to have been unjustly treated in being classed among parasites, and have eventually a place assigned to them among their more respectable confrères the harvesting bees.

The ground upon which the fiat of parasitism has been pronounced against certain bees, is founded upon peculiarities in their anatomical structure; such, for instance, as the absence of the large flattened hollow in the tibia of the hind leg, which appears absolutely necessary to the honey carrier. Among the andrenidæ, however, the genus prosopis, though destitute of the

* This view seems, however, inconsistent with the known fact, that the female bee only deposits certain eggs in certain cells, and not elsewhere.

usual apparatus for collecting honey, has been recently proved a honey producer nevertheless. Its nest has been discovered in tubes formed in the main stems of the bramble; and in the nest, filmy cells containing liquid honey. In the sub-family "acutilingues," also, the genus Sphecodes, though without the usual polleniferous organs, and consequently thought to be parasitic, has been watched by that indefatigable entomological observer Mr. F. Smith of the British Museum, while in the act of forming its burrow; an act which appears to afford conclusive evidence in favour of the non-parasitic habits of this genus of bees. Thus, some of the splendid foreign bees which have been pronounced parasitic on grounds similar to those above described may yet prove to be honey-makers, or at all events pollen collectors. Among the most conspicuous of the fine exotic bees figured in the annexed plate, is the truly splendid insect Xylocopa nobilis (No. 6), not one of the wood-boring, or carpenter bees, as they have been termed. This fine insect was captured by Mr. Wallis in the island of Celebes, an almost unknown collecting ground, from whence we may hope to receive many others new and splendid additions to our lists of exotic insects. The body of this fine bee is of the richest conceivable velvet black, bearing a rich brown bloom upon it—this deep ground colour is banded with transverse stripes of the richest gold colour—the two central stripes having a peculiarly bright and sparkling effect from their extreme narrowness. The wings are semi-opaque, and their colour modulates from a deep indigo-violet in the centre to a rich bronzy green at the extremities; the violet becoming nearly crimson where the wings join the body.

The terms, carpenter bees, upholsterer bees, mason bees, etc., which are, it must be owned, somewhat fanciful, were invented by the ingenious and indefatigable French naturalist, Réaumur, who intended by such names to convey the idea that his "carpenter bees" worked in wood, his "mason bees" in stone, or with stony cement, etc.

The amount of carpenter's work done, however, by the bees of the genus Xylocopa, a scientific term which conveys the same meaning as the popular name, consists merely in boring, or otherwise forming a burrow in wood; within which are formed separate cells, each destined to receive an egg, and a certain quantity of food for the young larva; some species sealing up the entrance with a cement formed of clay and a glutinous secretion mixed with it by the bee, as a security against the entrance of parasites. The carpenter bees do not live in communities, but in solitary pairs—the female doing all the carpenter work, and, as it would seem, every other kind of work also; the male leading a life of indolent pleasure. Nearly

BEAUTIFUL EXOTIC BEES.

1. Centris flavopicta.
2. Oxæa flavescens.
3. Euglossa analis.
4. Euglossa pulchra.
5. A new and unnamed species of Xylocopa.
6. Xylocopa nobilis.
7. Euglossa violacea.
8. Euglossa Brullei.

all the exotic bees of the genus Xylocopa are remarkably handsome. A new species from India, figured at No. 5 in the plate, is perhaps handsomer than the one just described. It is true that the unusually slender and elongated body is entirely black, but then the wings exhibit the most gorgeous iridescent colours that can be conceived. They are of a reddish tawny bronze at the ends, getting redder towards the centre, where the red suddenly but softly blends into a rich metallic green, followed by a portion of rich deep blue, which in its turn becomes violet at the base of the wings. This species has not yet been named, but some such name as iridipennis, rainbow-winged, might not be inappropriate in allusion to their rich prismatic effect, and at the same time showing its affinity to an allied species which has been recently named fulgidipennis, or fulged-winged.

Centris flavopicta, No. 1 in the plate, is a very beautiful bee belonging to another genus. It is one of the many fine insects recently received from an energetic collector on the banks of the river Amazon. This is another new species which, though named, has never before been figured. It is indebted for its specific name to the subdued yellow tone of the abdomen and legs—the latter being finely painted or marked with patches of dark brown.

Oxæa flavescens, No. 2 in the plate, is a remarkably brilliant insect, to which no engraving or painting can do the slightest justice. The abdomen is of the richest metallic orange, of the greatest richness, but entirely without gloss, striped transversely with bands of pale glittering yellow, which have the appearance of positive bands of the most highly burnished pale gold.

No. 3, Euglossa analis, is one of the pretty and gaily-coloured small bees of the Brazilian forests, which have been often described before; but few of the more recently discovered species surpass this one in brilliant metallic tinting. No. 8, Euglossea Brullei is another species of the same genus; as well as No. 7, Euglossa violacea, the rich violet colour of which offered the artist a tempting contrast to the orange and yellow tones of the other specimens, or, as a third well-known species of Euglossa, it would hardly have found a place in our plate.

There is, however, yet another species of Euglossa which claims a place, not only on account of its beauty, but also for its novelty—being a very recently discovered species, and one never figured till it made its appearance in the present plate. This exquisite insect, to which the most highly-finished representation would do but scanty justice, was purchased from a rich collection of Brazilian insects lately received. It has been distinguished by Mr. F. Smith, the well-known author of the Museum Catalogue of Hymenoptera, by the appropriate specific name "pulchra" (No. 4). The colour of the "face" is rich metallic apple green, contrasting finely with the ruddy brown of the large eyes. The thorax is of the finest velvety purple, appearing deep black in the parts which do not receive a direct light. The two upper segments of the abdomen are of a bright red violet, inclining to crimson; the remaining segments being of a vivid metallic straw colour, resembling the colour of electrum—that is to say, gold paled by an admixture of silver, a natural combination anciently found in the sands of the celebrated Pactolus, and from which some of the most ancient gold money of Sardis was coined. This new Euglossa is certainly the most beautiful of the genus, and at the same time the largest.

Many other exotic bees of very remarkable appearance might be described; some of the genus Chrysantheda being perhaps more beautiful than any insect figured in our plate. But in looking over various collections, the *embarras de richesses* became at last so great, that perhaps the very best choice was not always made. However, to choose eight as the most beautiful, out of several hundreds, was no easy task; yet, the selection may fairly be accepted as pretty complete for its extent.

A drawing, made at the same time, of another very fine bee (Centris denudans) is, however, now lying before me, which I may briefly describe, as our last specimen of Bee beauty. It is indeed extremely interesting on account of its curiously close resemblance to one of the great bee-flies described in a former paper, and is one of the very largest of the bee family. It has semi-opaque brown wings, a deep brown abdomen, and the legs are of the same colour; but the thorax is covered with a rich fur, resembling a deep plush velvet of a rich glossy tone, which might be defined as scarlet-brown, taking a flash of orange in a strong light.

The dipterous insect which so closely resembles it, even in its large size, is asilus ardens, which, even to the colour and character of the fur of the thorax, is so like the bee as to be easily mistaken for it at the first glance. This bee was received from the river Tapajos, a branch of the Amazon; and the great bee-fly, its counterpart, was taken near Para, not far distant—so that there is but little doubt that they will eventually be found together; the fly counterpart being, possibly, a parasitic attendant on the bee.

THE ART OF ELECTRO-PLATING AND GILDING.

BY RICHARD BETHELL.

It often occurs in the experience of collectors of coins, medallions, and works of art, that when *originals* are not to be had, models, facsimiles, and casts must be substituted; and in order to render them perfect, it is in very many instances desirable to finish them by a coating of silver, gold, or some other metal.

In most cases where gold and silver are thus applied, the impression will probably be first taken in copper by the electrotype, or in fusible metal by casting. But whatever method may be adopted for producing the first impression, the process of plating or gilding will be in each case the same, so that the production of the cast need not be further alluded to, except to note that, when the cast is taken in some non-metallic material, the operation becomes a little more complicated, as we shall presently see.

I purpose in this paper, giving somewhat minute details of the processes most generally approved, so that those unacquainted with the art may not meet with any difficulties which shall appear to them insurmountable; and I would strongly recommend all those who are making first attempts, to operate only on small articles; for, apart from the consideration of the convenience arising out of the use of light and portable apparatus, we have also to consider the question of cost, the materials used being expensive. When we remember that every pinch of oxide of silver that is used contains $\frac{108}{116}$ of pure silver, while the oxide of gold contains as much as $\frac{197}{205}$ of the noble metal, it will be sufficiently obvious that when we speak of using these oxides it is pretty nearly equivalent to speaking of so much pure gold and silver. Hence arises the necessity also of certain forms of battery apparatus by which the quantity of these costly materials is diminished, and every possibility of waste prevented.

As the plating and gilding processes are for the most part applied to *metallic* articles, and because they are much more readily covered by this means than non-metallic surfaces are, we will deal with them exclusively at first. Metals being good conductors of electricity, the labour of rendering them conductuous is unnecessary. It will soon be discovered by the experimenter that few difficulties present themselves in his efforts to obtain a deposit on his medallions or other objects; but on the other hand, he will discover by more mature experience, that his deposits are not equally firm and permanent. As a rule, he will find that when his surfaces are *perfectly clean,* his deposits will appear almost to enter the pores of the metal deposited upon; while if his surfaces are contaminated with grease, or with metallic oxide, although he may obtain a deposit to all appearance most satisfactory, it will be found to consist of a mere shell covering his mould, which, in some cases, may be easily removed, or will even separate of its own accord. Hence it becomes our first concern to know how metallic surfaces may be rendered perfectly clean, the cleansing process being a preliminary operation to every case of deposition. All dirt and impurity in reference to this subject, may be arranged under two divisions,—first, greasy matters; second, metallic oxides; and the means used to remove impurities of these two kinds will remove almost all others.

For the removal of *grease*, chemistry at once points out the use of alkaline solutions. Soda, potash, or ammonia in any form will answer the purpose, and convenience will generally decide which should be adopted in any particular case. It is, however, commonly found advantageous to use the above alkalies in the form of common commercial "soda," of pearl-ash, dissolved in clean rain water, or of hartshorn. If the form of the article be such as admits of rubbing up with a stiff brush, it should be well brushed, with the addition of fine sand or emery-powder, immediately before placing it in the plating solution. In many cases, as with copies of coins, the dry method—that is, with brush and sand—is not only sufficient but the best that can be used; care being taken, of course, to see that the brushes are free from grease, and that neither hand nor fingers touch the object on the parts to be deposited upon.

For the removal of oxides, the brush and sand or emery should be used whenever the form of the object will admit of it. If the object have crevices or recesses which cannot be reached by a brush or other means of dry cleansing, it will be necessary to have recourse to an acidified solution. Sulphuric, nitric, or hydrochloric acid, diluted with water, will answer the purpose; but it will be necessary to observe that, if the solution be strongly acid—as, for instance, half acid and half water—the object must not be immersed for more than a second or two without examination; if the solution be weak, it may remain a minute or more. When it is sufficiently apparent that the surface is cleansed from oxidised matters, it should be washed in several waters successively; a weak alkaline wash may then be applied for the removal of all traces of acid, and, finally, one or two more water-washings for the removal of any possible impurities that may yet remain.

In practice, it will be convenient in most cases to use both the above methods, or a modification of either, as the judgment and experience of the operator may dictate. It is especially useful when cleansing by means of sand and brush, to mix a little pulverized chalk with the sand, and to moisten it with hydrochloric acid; but a final scrubbing with the clean brush would in that case be necessary.

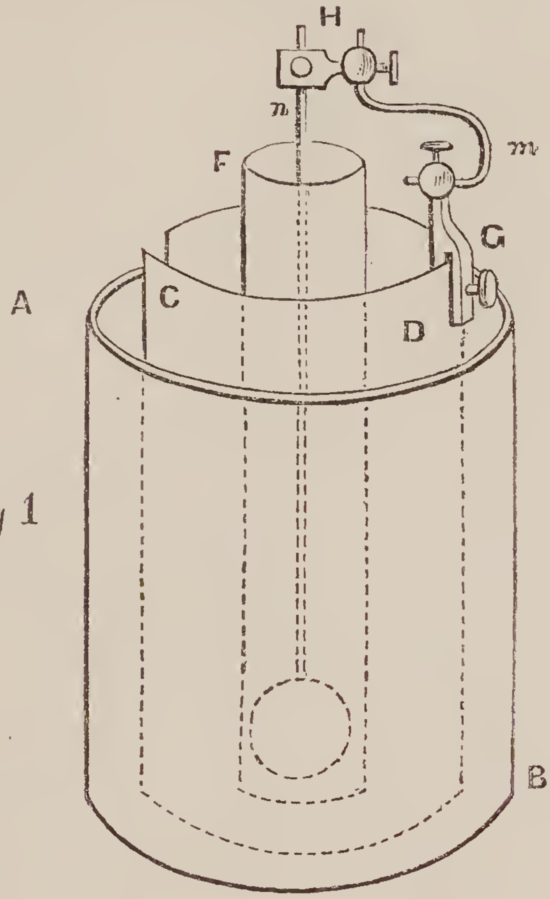


Fig 1

Fig 2

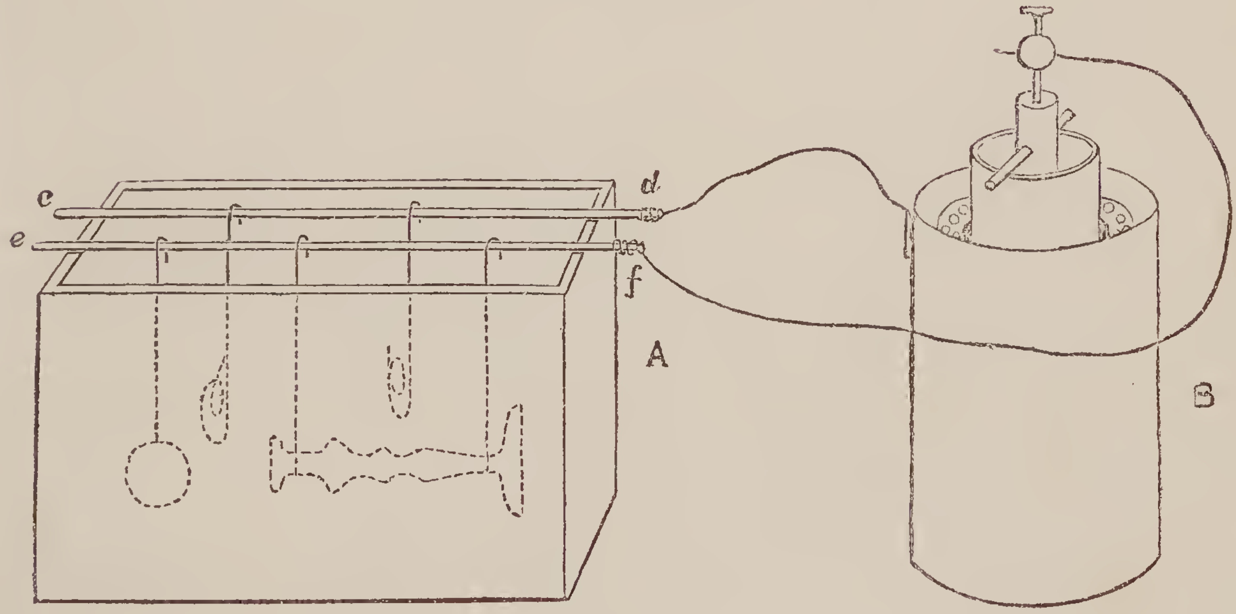


Fig.3

After the final cleansing, the object should be *instantly* immersed in the plating solution, and the manner of preparing this next claims our attention.

Several such solutions have been recommended by different chemists; of these, there is one more in favour than any other, and this alone I shall at present describe. It is that which I have used in making a great number of experiments, and is easily prepared :—Dissolve in half a pint of clear rain water (or distilled water) one ounce of cyanide of potassium, if any sediment subsides, decant the clear liquor and add one-eighth of an ounce avoirdupois of oxide of silver; when the oxide is completely dissolved the liquid is ready for use. A gilding solution is made precisely in the same manner, merely substituting oxide of gold for oxide of silver.*

Supposing our solutions thus prepared, we may now arrange our battery apparatus, which, it will be seen, is of an extremely simple nature. Let A B be an ordinary preserve jar. Turn a piece of common sheet zinc into the form shown at C D, and attach to its upper edge the binding-screw G. Within the cylinder of zinc, place a porous jar, sufficiently large to receive the articles to be plated; and over this place a binding-screw, supported by the wire *m*. To the lower end of the wire *n* attach the article to be plated, and fix the upper end in the binding-screw H. In attaching the object to the wire *n*, convenience is the chief thing to be studied. I have obtained a perfect coating to objects by soldering them to the wire, by twisting the wire round them, or by binding the wire as in fig. 2, and laying the coin upon it. In either case the conduction is sufficiently complete to answer every purpose.

To set the apparatus in action, pour into the jar A B water acidulated with sulphuric acid (1 acid to 30 water), and into the porous vessel F as much of plating solution as will completely cover the object. The apparatus may then be left to itself, and in half an hour, or even less, the article will be covered with silver—very thin, as may be supposed, but perfectly covered, if all has been well managed. Thin as it is, however, it will be sufficient for articles intended for the cabinet, as copies of coins and medallions, or, indeed, any other object not subject to wear and tear. For works of art exposed to the atmosphere and dust, and which will, therefore, want occasional cleaning, a thicker deposit will be required, and two hours would probably be none too much for them; while in the case of spoons or forks, four hours would be necessary.

Were the experimenter not previously apprised of what he ought to expect, he would doubtless feel some astonishment on removing his medallion from the plating solution for the first time. Instead of a bright, sparkling, silvery surface, he would find a dirty-white, chalky-looking object, altogether unlike what he is aiming after; and though he might wash and wash again in water, the most he would accomplish by these means would be to render the surface of the object a little cleaner, though it

* It is well to know that these oxides when sold by chemists who supply practical platers and gilders, are obtained fully 25 per cent. cheaper than by those who sell them merely for experimental purposes; a fact that may guide the tyro in the choice of a shop.

remained as dull and chalky as ever. The deposit, in fact, is what is technically called "dead," as distinguished from "polished." He will, however, be glad to learn that this dull surface only requires the application of the plate-brush or a lock of cotton wool with rouge, to make it perfectly bright, that is, if the surface of the metal before putting it in the solution was bright; or if the form of the object admits of it, he may apply the steel burnisher, or a piece of polished agate, to bring up the surface to the requisite degree of brilliancy.

It is not, however, a matter of necessity that the deposit should be of this dead character. When the surface of the object operated upon is smooth and bright, a few drops of *bisulphide of carbon* added to the plating solution will cause the deposit also to be smooth and bright. Hence, it is worth while to learn the art of using this liquid judiciously, as it saves a great deal of subsequent labour, when polished surfaces are required in every part. But in the case of jewellery and many ornaments, a dead surface is preferred to a great extent, and only certain portions are wanted to be "brought out." In these instances, the "dead" deposit is obtained, and the burnisher does the rest.

Thus far we have spoken only of the single-cell apparatus, which is very certain in its operation, and easily constructed. By using porous jars of different sizes and shapes, its use may be greatly extended, and articles of various forms may be successfully treated by its means. But when the experimenter comes to deal with objects too large, or otherwise unsuitable to this form of apparatus, he will have to adopt the combination represented in fig. 3, which consists of a battery, B, and depositing trough A. The trough may be made of glass or porcelain, and should be furnished with two wires, *c d* and *e f*, long enough to rest upon the edges of the trough. These two wires are to be connected, one with the negative, the other with the positive plate of the battery. The wire *e f*, on which the articles to be plated must be suspended, is connected with the zinc (or negative) plate; the wire *c d*, with the copper (or positive) plate. Small hooked wires descend from these; those on *cd* being of silver, to keep up the strength of the solution, by replacing the metal deposited on the object; those on *ef* may be of copper, and are used simply to suspend the articles operated upon.

For objects of medium size, one cell of Daniell's or Smee's battery will be sufficient, and for larger ones two. In gilding a rather higher battery power will be requisite, and gold wire or gold leaf should then be suspended on *c d*.

On reviewing the operations above-described, and noting their simplicity, one cannot help feeling what resources they add to the means at the disposal of that numerous class of persons who cultivate "Homes of Taste." By means of apparatus costing but a few shillings, a man of moderate means may surround himself with articles of elegance and beauty, or supply for the use of his family articles of a more serviceable nature. Spoons, forks, fruit-knives, candlesticks, medallions, casts, salvers, anything, in fact, which may be purchased in brass or white metal, and of the form desired, may be coated with silver or gold at a small additional expense, while its value, whether for use or ornament, would be immensely enhanced.

There is another way in which this process serves a most useful purpose, and, in pointing it out, I am enabled to answer a question frequently put to me: "Is it possible to plate *a portion only* of a spoon, or fork, or other article, without plating the whole?" Now, nothing can be easier. Suppose—as the case was put to me a few days ago—suppose it is desired to plate the bowl of a spoon which has been abraded and worn, while the handle has been left unimpaired, a case often occurring to those who use electro-plated goods. Take the apparatus (fig. 1), and fix the handle of the spoon in the binding-screw (H); then adjust the wire so as to depress the spoon till the bowl is covered by the solution, and leave it as long as may be deemed necessary. Of course it is essential to the success of the experiment that the bowl be thoroughly cleaned and polished before placing it in the solution.

It is probable that it is this last application of the art that will recommend it most strongly to amateurs. Electro-plated goods are accessible to persons of narrow incomes; but they are commonly avoided, because it is known that they cannot be used long without being disfigured by abrasions in parts exposed to the wear and tear of daily use. When it is generally known, and practically demonstrated, that these parts may be easily and cheaply renovated, the chief objection to this kind of ware will be removed, and another step will have been gained towards the diffusion of works of beauty among the masses, who have hitherto been excluded from the enjoyment of them.

Thus far we have spoken of the deposition of gold and silver upon metallic surfaces alone; and the extreme simplicity of the process, together with the facility with which it may be performed, will recommend it to those who have had but little experience in the art. It happens very frequently, however, that the experimenter wishes to cover other surfaces besides these with a coating of the precious metals, and then some new difficulties present themselves which must next be pointed out and overcome.

Of the various substances used in the formation of models and casts, the most common are plaster of Paris, wax, gutta-percha, and sulphur. Now, none of these are conductors of electricity, and there is, perhaps, no operation conducted by the electrotypist which taxes his skill and patience more than that of rendering the surfaces of his cast perfectly conductuous, and establishing an uninterrupted connection between the guiding wires and the surface to be deposited on. Spite of every precaution, and the most careful observance of prescribed rules, he is almost sure, in his early attempts, to have the mortification of seeing the silver deposited in abundance and perfection upon so much of the guiding wire as may dip below the surface of the plating solution, while his cast or model is as free from the smallest particle of the precious metal as it was before immersion.

Plaster of Paris (a material more commonly used, probably, than any of the above-named) requires preliminary treatment before applying the substance (blacklead) which is to make it more conductuous; for, if the blacklead be added to the bare plaster, it separates and peels off in flakes almost immediately after putting the cast into the solution. Various modes of preparation have been devised, but there is one which I have found very generally applicable, and which will most likely serve in a great majority of instances that come under the operator's observation. It consists in saturating the plaster-cast with a mixture of oil and wax. Take equal weights of beeswax and sweet oil, warm them sufficiently to reduce the former to a liquid state, and then place the plaster-cast in the mixture, moving it about so that every part of its surface may absorb a considerable quantity; when cold, the plaster will be found to possess a firm, tenacious, and somewhat adhesive exterior, admirably adapted for the reception of the substance next to be applied.

The cheapest and most easily accessible substance for rendering surfaces conductuous is plumbago, or blacklead, names which would suggest the idea that lead entered into its composition, whereas, when pure, they are quite free from that metal. Its correct name is carbide of iron,* and consists of carbon and iron. Neither the name or composition of the substance, however, is of any great consequence in so far as its present use is concerned, for we have to do with its conducting power, and not with its chemical properties. In applying it to plaster casts, a soft brush is the best implement to use, and with this it may generally be applied dry, especially if the cast be slightly warmed, so as to render the wax with which it is saturated a little adhesive; in other cases, breathing upon the object will do equally well: but a few hours' experience will aid the operator much more than whole pages of written instruction. When sealing-wax models require coating, they should be moistened with spirit of wine with the same view. Gutta-percha moulds take the plumbago readily without any

* According to some chemists; but later researches go to prove that the oxides of iron and manganese are in a state of mere mechanical admixture with the carbon, and form no definite chemical compound with it.

preparation, and a brush as stiff as a tooth-brush may be used upon them without injuring the impression.

Supposing the surfaces of the mould to have been properly prepared, another point of at least equal importance is the attachment to them of conducting-wires, by means of which the mould may be connected with the battery apparatus. Little instruction is here needed: the electric fluid passes along the metallic wire readily enough, and when once it reaches a well-prepared conducting surface, its diffusion over every part of it may be relied on. The main point, therefore, is the perfect union of the two. In wax, sulphur, or gutta percha, the wires are easily fixed by heating their ends, and then pressing them into suitable parts of the mould. To fix them into plaster of Paris, small holes must be bored in the cast, and the wires fixed into these with wax or cement. Then, to render the metallic connection perfect, blacklead is rubbed on to the joint freely, and finally brushed up to the well-known polish.

Another mode of rendering surfaces conductuous is often resorted to, and, though a little more tedious at first, is on the whole more effective. A piece of phosphorus is dissolved in about twenty times its weight of bisulphide of carbon; in another vessel a solution of nitrate of silver is prepared. It need not be saturated; or, if a saturated solution is prepared, it may be diluted with about two or three times its bulk of water. The cast is immersed for a minute or two, first in the phosphorus solution, and immediately on its removal from this is placed in the solution of nitrate of silver. The action of the phosphorus on the silver salt is so energetic that, in a few moments after it has been removed, and left to dry *under the action of daylight*, the metallic silver is separated from its combination, and forms an exceedingly thin metallic surface to the cast. The inexperienced operator must not be deceived by appearances here, for he *will be* deceived if he looks for silver in the form in which it commonly presents itself to his notice. Silver, when deposited from its solutions by this method, is *black*, and an unbroken black surface is the best evidence he can have that his experiment has succeeded.

Nor must a deposit on a surface prepared as above be expected so promptly as on surfaces purely metallic. A deposit often appears in the neighbourhood of the conducting-wire in the course of an hour or so after immersion, but even then it will sometimes take several hours to complete the coating over every part of the cast. When once the coating is complete, however thin it may be, the further deposition of course proceeds rapidly.

As to the battery apparatus to be used in these latter experiments, it will suffice to state that the forms described for medallions and coins will answer equally well for these.

PARASITES FROM THE ZOOLOGICAL GARDENS.

BY T. SPENCER COBBOLD, M.D., F.L.S.,

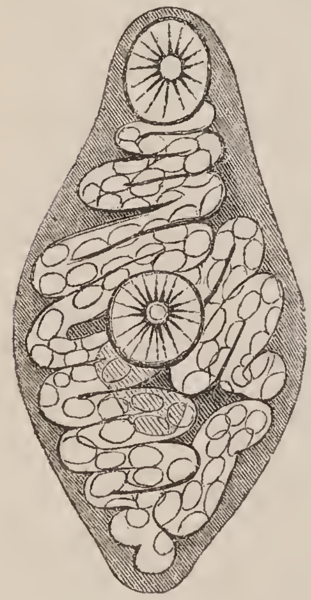
Lecturer on Comparative Anatomy, Zoology, and Botany, at the Middlesex Hospital Medical College.

HAVING during the four successive winters of 1857—60, inclusive, examined the carcasses of upwards of one hundred different species of *vertebrata* dying at the Zoological Society's Menagerie, Regent's Park, we are enabled to form a tolerably accurate estimate of the prevalence of entozoa in animals subjected to a condition of domesticity as compared with those living in a wild state. It is, we believe, very commonly supposed that tame quadrupeds and other beasts kept "cribbed, cabined, and confined," are much more troubled with parasites than those fortunate individuals who roam at large "o'er hill and dale" without any human being to molest them. This conclusion, in so far as *external* parasites are concerned, may possibly be true (which, by the way, however, we very much doubt), but, as regards the frequency of *internal* parasites, we have satisfied ourselves as to the erroneousness of the general belief. About one-third only of the birds, reptiles, and quadrupeds just enumerated were found infested, or thirty-eight species in all; and of these, nineteen were mammals, fourteen were birds, and five were reptiles. This is decidedly a small proportion, and the comparative scarcity of the parasites is especially marked when we limit the question of their number with particular reference to the presence or absence of the members of that remarkable group of entozoa which we call flukes. In all our carefully conducted examinations we have only found seven different kinds of flukes, or trematodes, as they are more scientifically called; and as some of these offer interesting types of structure, and at the same time give rise to curious suggestions, it accords with our present purpose to offer a more or less brief account of each of them, omitting such details as are interesting merely to systematists. It may be premised, however, that a true explanation of the cause of this comparative freedom from flukes, which the animals in the Society's menagerie appear to enjoy, arises out of the circumstance that the *larvæ* of Trematodes exist only in a limited number and kind of molluscan *hosts*, and consequently quadrupeds, and other vertebrates from foreign lands, are not so liable to swallow the *larvæ* suitable to themselves, seeing that the larvæ frequently exist in molluscs, and in other *hosts*, which are not to be found in this country. No doubt, as in the case of the *Fasciola hepatica*, some trematode parasites will take up their abode in a variety of animals; but, as a rule, applicable to adult as well as to immature forms, each fluke has a special liking for a particular *host*, though this "natural selection" is not always bounded by the consideration of the species, the genus, the family, or even, in some few cases, the order.

Without further prelude, we proceed to notice the seven flukes above referred to, in the following succession:—(1.) the *Distoma æquale* (Dujardin), from the alimentary canal of an American barn owl (*Strix perlata*); (2.) the *Distoma minutum* (T.S.C), from the duodenum of an oyster-catcher (*Hæmatopus ostralegus*); (3.) the *Distoma Boscii* (T.S.C.), from the lungs of an American snake (*Coluber*); (4.) the *Distoma coronarium* (T.S.C.), from the intestine of an alligator (*Alligator Mississippiensis*); (5.) the *Distoma conjunctum* (T.S.C.), from the liver ducts of the American red fox (*Canis fulvus*); (6.) the *Distoma compactum* (T.S.C.), from the lungs of an Indian ichneumon (*Viverra mungos*); (7.) the *Bilharzia magna* (T.S.C.), from the blood of the portal vein of the sooty monkey (*Cercopithecus fuliginosus*).

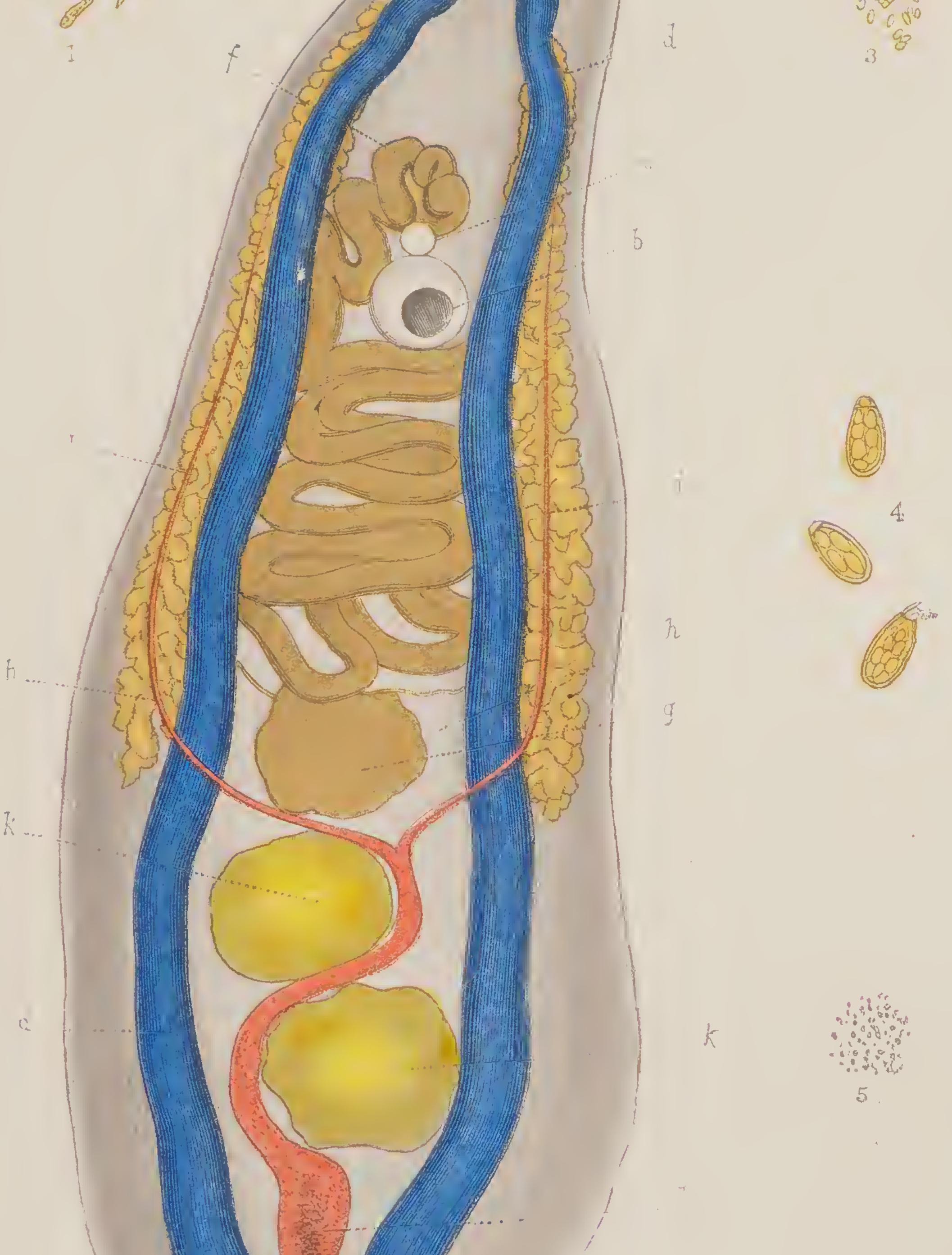
1. *Distoma æquale.*—On the 8th of January, 1858, nine examples were removed from the American owl. These little parasites scarcely exceed a line in length, but they exhibit a reddish-brown colour, in consquence of the numerous highly-coloured and extremely minute eggs which are seen through the transparent skin.

2. *Distoma minutum.*—This species is principally remarkable for its excessive minuteness, being barely discernible by the naked eye, and seldom exceeding the 1-100th of an inch in longitudinal diameter. Its form is entirely different from the *Distoma brevicolle* (Creplin), also described as infesting this bird, and in our early examinations we believe ourselves to have obtained satisfactory evidences of its sexual maturity. As, however, in so tiny a parasite, the appearances of true reproductive organs and ova may have misled us, we suspend further details regarding it until we have again had an opportunity of examining fresh specimens. Those we originally discovered were procured on the 19th of February, 1857.



Distoma minutum.

3. *Distoma Boscii.*—Though, like Bosc, we found a great number of these Trematodes occupying the cavity of the mouth, the larynx, and the lungs of an American coluber, yet we were not able to determine the precise *species* of snake from which our parasites were taken. There is no



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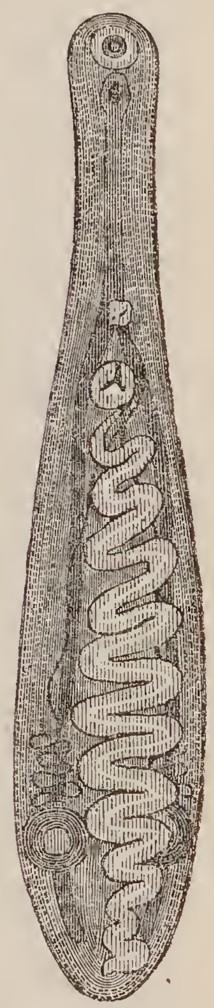
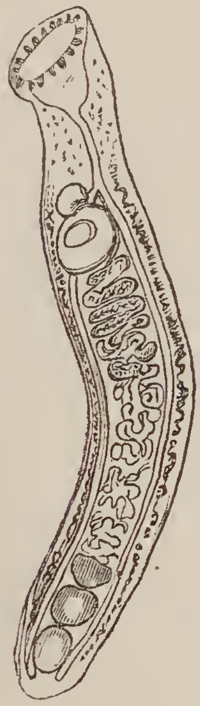
doubt, however, of the identity of our fluke with his *Fasciola colubri.* This trematode is much elongated in form, flat, covered with little spines, and about one-third of an inch in length, on the average. It is furnished with a well-marked œsophageal bulb, two simple digestive tubes, and largely developed reproductive organs. Our specimens were obtained on the 20th of February, 1857.



Distoma Boscii.

4. *Distoma coronarium.*—This species is rather a prettily marked one, owing to the presence of a well-defined coronet of twenty-four spines which encircle the so-called head and mouth. On the 25th of December, 1860, we took large numbers from the alimentary canal of an alligator. The general aspect and character of this species is admirably represented in the accompanying woodcut, which is copied from an original drawing made with the aid of a camera. This species has an average length of about one-fourth of an inch, but it is only about 1-30th of an inch in breadth. The body is linear, flattened, subconical in front, and somewhat attenuated posteriorly. The ventral sucker is less than one-half of the size of the oral opening, including the muscular cup. The body generally is smooth; the spines of the mouth being conical, pointed, and circumferentially disposed at the margin of the prominent lip. They form pretty microscopic preparations when preserved in glycerine.



Distoma coronarium.

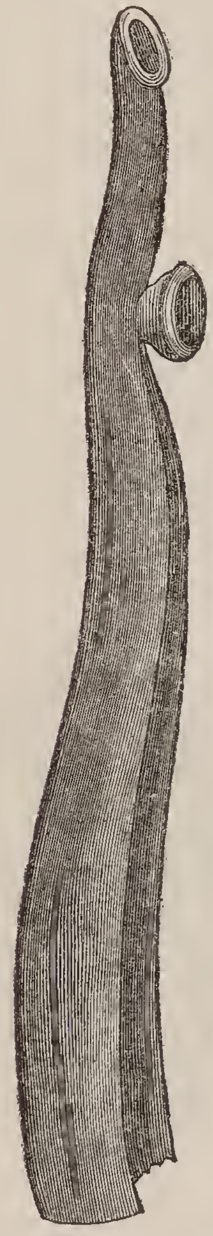
5. *Distoma conjunctum.*—On the 24th of December, 1858, a considerable number of small flukes were obtained from the liver of an American fox, and as the species in question forms an admirable type of the genus Distoma, we have not hesitated to give an enlarged representation of it in the accompanying plate. In group (Fig. 1) eight individuals are represented of the natural size, and the accidental circumstance of finding two of them united by their suckers suggested the specific name above indicated. We have seldom seen a Distome in which the visceral arrangements were so simple, distinct, and compact as in this; and therefore to facilitate the investigations of those who are desirous of commencing a study of the organization of these curious parasites, we invite attention to the character and disposition of its internal organs. In Fig. 2 we have a view of the ventral surface of one of the individuals magnified thirty-five diameters linear.

At the upper or anterior extremity of the body we notice the round oral sucker (*a*), which is almost as large as the ventral sucker, or *acetabulum* (marked *b*). The mouth, properly so called, is placed at the bottom of the oral sucker, and leads into a small oval muscular cavity, which is termed the œsophageal bulb (*c*), and this, again, directly communicates with the two long, cylindrical, digestive tubes (*d, d*), which widen out a little as they approach the caudal extremity of the body, where they terminate in closed, rounded, cæcal ends. This arrangement constitutes the simplest form of alimentary apparatus with which we are acquainted in the trematode parasites, and, associated with the disposition of the two suckers as here placed, it is eminently characteristic of the genus Distoma. Immediately above, and in contact with, the ventral acetabulum there will be observed a small, round papilla (*e*); this is invariably furnished with and usually exhibits two minute openings upon it, which are respectively the orifices of the male and female reproductive organs. One of these openings communicates with that set of wide, tortuous tubes (*f*), occupying the centre of the upper half of the body. The brown colour is a natural appearance due to the presence of multitudes of mature eggs (Fig. 3) which are crowded within this coiled uterine duct, the latter being also connected by a narrow channel with the ovary (*g*), and by two other minute ducts, passing, one on either side, to the so-called yelk-forming glands. These last-named organs form botryoidal masses on either side of the body, and, though varying considerably both in extent and arrangement, their presence is in a measure characteristic of this class of parasites. The letters *h h* refer to these organs, but the dotted lines have been prolonged by the engraver rather too far inwards; the glands are coloured yellow. In Fig. 4 the lid-like end of one of the highly magnified eggs has been represented artificially burst open. The ova have a long diameter of 1-750th of an inch. The male reproductive orifice, like the other, is not seen in the accompanying illustration, but it communicates with the reproductive glands (*k, k*) by the intervention of *vasa deferentia*, or channels of outlet, in the usual manner. The true excretory system of vessels is well marked in this fluke, and consists of two main trunks (*i, i*) lying immediately in front of the yelk-forming glands; gradually increasing in size, and passing in a nearly straight line downwards, they converge to meet at a point corresponding with the centre of an imaginary line separating the lower third of the body, and in this situation the common tube sweeps round and between the reproductive glands in the form of the letter *s*, after which it swells out into a contractile vesicle (*l*), which opens externally by a very narrow outlet at the centre of the so-called tail. The cavity of the vesicle contains a mulitude of highly refractive, glittering particles (Fig. 5) which, on their escape from the organ in a fresh state, display those curious and well-known phenomena of molecular motion in the greatest perfection. Finally, it is worthy of remark, that the flukes in question were found not merely here and there in single numbers, but in certain places they had accumulated to the extent of ten or a dozen, causing great swelling and cystic enlargement of the liver ducts, sufficient to have proved highly injurious, if not altogether fatal, to the animal they infested. A similar morbid change takes place in cattle where the *rot* has far advanced, and we have observed the same diseased conditions in a porpoise infested by another small species of the genus under consideration.

6. *Distoma compactum.*—Although flukes are most commonly found in the alimentary canal, and in structures associated with it, yet they are by no means unfrequent in the lungs, as our own investigations have proved. On the 19th of February, 1857, we obtained five examples from the left lung of an Indian ichneumon, which had been living in the Society's Menagerie for about a twelvemonth. They were lodged in cavities resulting from the inflammation their presence had excited, and thus, no doubt, contributed to the animal's death. This species is well marked, and easily recognised by the peculiar twisted condition of its digestive tubes, an arrangement very uncommon, and approaching the still more remarkable zigzag form of the same canals, which we found to occur in the fluke of the porpoise above alluded to. Another distinguishing feature in this species consists in the extended development of the yelk-forming organs or vitelline glands which almost entirely cover the lateral and dorsal surfaces; the reproductive papilla is here situated beneath the ventral acetabulum, and in the central line, a little below the papilla, the common duct of the vitelline gland on one side, is seen passing inwards to join its fellow of the opposite side before they enter together by a single trunk into the short and regularly folded uterine tube. A species of fluke, apparently distinct, but not unlike this, was long ago discovered by Natterer, at Matogrosso, Brazil, in cavities of the lungs of the American otter. Under the title of *Distomum rude*, Diesing has described and figured it in his *Neunzehn Arten von Trematoden*, published in the Transactions of the Vienna Academy of Sciences for the year 1856.

Distoma compactum.

Bilharzia magna.—This combined generic and specific name is applicable to a somewhat remarkable entozoon which we found on the 4th of December, 1857, in the portal blood of the sooty monkey. It is particularly interesting from the circumstance that it is the second species only of a peculiar and recently established genus of flukes, the original type of which was discovered by that indefatigable naturalist, Dr. Bilharz of Cairo. Up to the time of Bilharz's announcement of the existence of the *Distoma hæmatobium*, so abundantly found by him in the people of Egypt, almost all the flukes were considered to be hermaphroditic, or, in other words, each individual was provided both with male and female organs; the only exception being that of the *Distoma filicolle*, regarded by Rudolphi and Dujardin as a species of Monostoma. So common and numerous is the *Distoma hæmatobium* in Egypt, that in 363 examinations of the human body after death Griesinger found this entozoon present no less than 117 times, and it is quite certain that it gives rise to a very formidable disease. In consequence of the reproductive peculiarity just mentioned, associated as it is with the existence of a remarkable ventral groove in the male, the writer, a short while ago, formed a distinct genus for the reception of the Egyptian fluke, substituting the name of the original discoverer of the species for the generic title of Distoma. Since this was done he has observed that several foreign parasitologists have been led to act in a similar manner, and, as usually happens in such cases, they have adopted different generic titles, so that we are in danger of complicating the nomenclature, and exposing ourselves to the ready criticism of those who love simplicity. Thus Professor Leuckart of Giessen, says we must yield priority to Diesing of Vienna, who, in 1858, proposed the generic term Gynæcophorus, in reference to the so-called gynæcophoric canal of the male above-mentioned. Dr. Weinland of Frankfort subsequently formed his genus Schistosoma for similar reasons. Without, however, further dwelling on this question as to its proper name, we shall here employ the one first proposed by ourselves, directing special attention to the fact that the genus, in itself so peculiar, is only yet known to infest men and monkeys, and in these *hosts* the two species appear to be confined to Egyptians and the sooty monkey. Here is an interesting little circumstance, admirably suited to



Bilharzia magna
(upper two-thirds).

the taste of those who are on the look-out for affinities of habit between bimana and quadrumana. The *Cercopithecus fuliginosus* is an African monkey, and no doubt in its native haunts it procures the larvæ of *Bilharzia magna* from the same, or from similar sources as those from whence our brethren in Egypt procure the larvæ of *Bilharzia* (Distoma) *hæmatobium*. Animals lower in the scale do not appear to be liable to attacks from this strangely organized genus of flukes, and as yet we are uninformed as to the *hosts* which entertain it in its larval condition. The adult fluke from man never exceeds one-third of an inch, but the solitary example which we obtained from the monkey was about an inch in length. Griesinger conjectures that the young of Bilharzia exist in the waters of the Nile, in the fishes which therein abound, or even in bread, grain, and fruit; but, in our opinion, it is more probable that the larvæ, in the form of cercariæ, rediæ, and sporocysts, will be found in certain gasteropod molluscs proper to the localities from whence the adult forms have been obtained. Our sooty *host* was, we understood, imported direct from its native country, and was not bred in the Society's gardens; had it been otherwise he would not, in all probability, have been infested by *Bilharzia magna*.

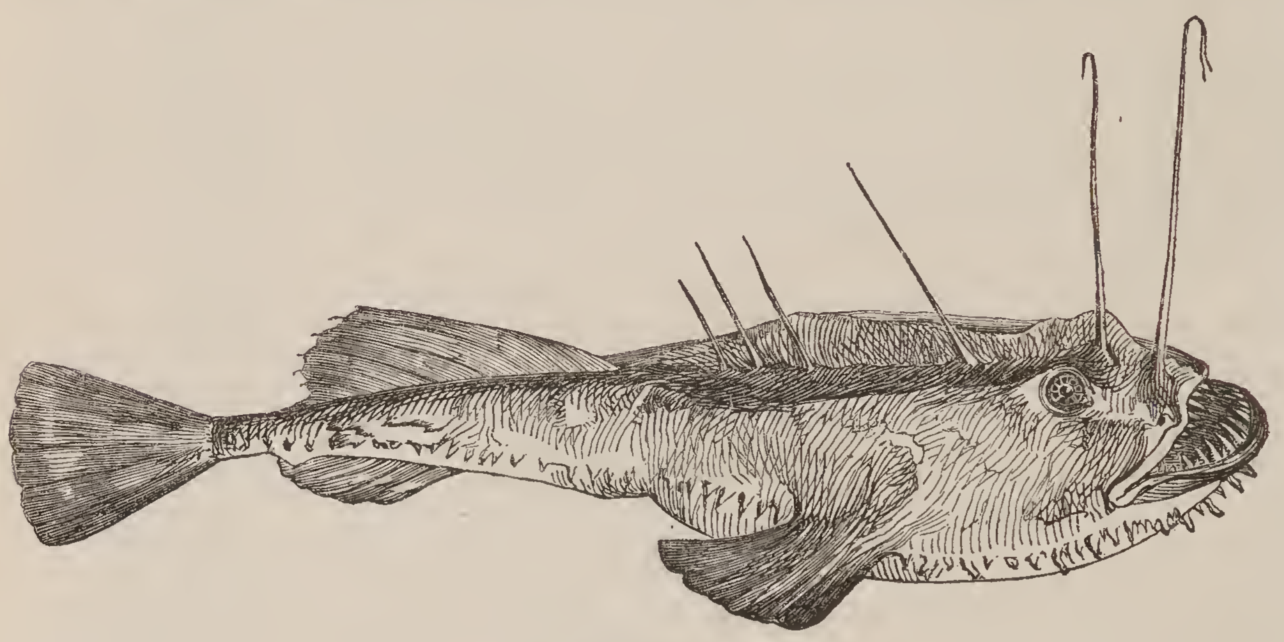
THE ANGLER.

BY JONATHAN COUCH, F.L.S., ETC.

This fish has been called the toadfish, frogfish, fishing frog-monk, and sea-devil. It is the rana piscatrix and rana marina of old writers, and lophius piscatrix of Linnæus and Cuvier. It appears also to be the fish which is described by Caius at the end of the work *De Canibus Britannicis*, under the name of ceruchus; but he does not seem to be aware that it had been noticed by any other writer; and indeed he may have been, as he remarks, the first who gave a precise description of it.

But the remarkable form of this fish in connection with its still more remarkable manners, had attracted the attention of observers of Nature from the earliest times; and, strange to say, at a time when imagination, superstition, and imposture were united in ascribing to the inhabitants of the ocean mysterious properties—so that the circumstance of his inquiring into their nature and structure was believed to be a sufficient proof to show that Apuleius, the Roman writer of the famous romance the *Golden Ass*, could be no other than a magician—and, when in numerous particulars of form this fish differs much from all others that were known to the ancients, there was, still, considerably less of the wildness of imagination applied to it than to a large proportion of the others. The general appearance of this fish, which is represented as at least unsightly, has caused it to be compared to a tadpole, but a tadpole of enormous size; and when the rough protuberances of its head, and its projecting teeth and ample mouth were taken into the account, its supposed hideous aspect was judged sufficient to entitle it to the designation of sea-devil. Yet, in the form and arrangement of these parts, we can discern a noble example of exquisite contrivance.

The teeth of this fish are set round the mouth like the prongs of a rat-trap; and are long, strong, pointed, and those of the lower jaw are directed obliquely inward; so that as this jaw is withdrawn to close with the upper, these teeth may



The Angler.

become interlocked together, and thus prevent the escape of the prey; while the teeth of the tongue and gullet by the action of muscles which act on the latter, prevent such a struggle as might obstruct the process of swallowing. The teeth appear to be in a state of perpetual renewal, and those of the inner row are, for the most part, the largest. They carry with them, in their growth, a covering of the membrane from which they are produced, and from it, perhaps, they derive nourishment long after their protrusion from the gums, and it may be some amount of sensation. The instinctive force with which the angler retains its prey, when this has come within the grasp of its teeth, may be judged from a fact related by the natural historian Jonston, who tells us that the fish had been left on the beach by the receding tide when a fox came prowling along in search of provender, and chanced to thrust its nose within the compass of the expanded jaws; which then closed upon it and held it fast, until after a considerable time, the captive was discovered by people that were passing by. Mr. Thompson of Belfast records an instance where a gentleman discovered an angler near the shore, and presented the butt-end of his whip to it, when it seized and held by it until it was thus drawn on shore. An angler of large size was also discovered in shallow water, by a couple of boys who were in a boat, where they happened to be without oars. But with the intention, perhaps, of annoying the fish, they loosened a board that lay along the bottom of the boat and thrust it within the creature's expanded jaws, which immediately closed upon it. A struggle then commenced; but so firmly did the fish retain its grasp, that it suffered itself to be dragged out of the water and secured.

It is by this, as in the corresponding instance of the apparently sluggish lumpfish, that what seems at first sight a defect is fully balanced by a skilful adaptation of instinct and inward organization, so as to answer to that definite end which comprises the comfort and safety of the creature itself. It was further the instinctive habits displayed by the angler, that especially drew the attentions of ancient philosophic observers; and, accordingly, we find them particularly described in the poet Oppian's verses; although, indeed, they are there accompanied with the addition of some particulars which tend to raise a doubt whether this usually accurate writer had closely studied the fish itself. He represents that—

> "Within her jaws the fleshy fibre lies,
> Whose whiteness, grateful scent, and worm-like size,
> Attract the shoals and charm their longing eyes.
> But as they near approach with subtle art,
> The wily toad contracts the inviting part."

A more accurate description of the organ and its use is given by Ælian, b. 9, c. 24, where he says the fishing frog derives its name from the manner in which it employs itself. In front of its eyes there are placed some long processes, to the end of which are affixed enticing baits for the purpose of enabling it to ensnare little fishes. This toadfish is aware of the use it may make of these organs to obtain food, and for concealment hides itself in some muddy place, where it keeps its body unmoved while it lifts up and stretches out its line and bait. Little fishes that are wandering about are soon attracted, and begin to nibble, which the angler is quick to perceive, and then it proceeds to move its line in a cautious manner, so as to lead the prey, without alarming them, in the gulf of its jaws, which then close upon them beyond the power of escape.

The generally abrupt depth of water in our seas is a hindrance to the observation of such actions as these, but there does not appear to be any reason for doubting the accuracy of this account; and on the contrary, an examination of other portions of the structure of this fish will tend to point out an extension of these powers in other directions. Thus, from the jaws round the border of the body to the tail there is found a row of membranous or cutaneous lobes, which in most instances, at their extremities, are divided into club-shaped partitions. These are not merely insensible doublings of the skin, but, although in a less degree, they perform the office commonly assigned to the fictitious bait suspended from the fishing-rod, on the top of the head. They offer themselves enticingly to be nibbled by fishes which wander in that direction, and then is brought into exercise an organization which distinguishes the structure of the pectoral and ventral fins. The species of this and the neighbouring family of blennies, possess the power to change their place as they lie on the ground without an effort of the tail or dorsal fins; which latter organs are the instruments of motion in the generality of fishes, but which if put into action by the angler would excite alarm, and so drive away the prey. The pectoral fin of this fish possesses such a frame-work of bones as is equivalent to the wrist-joint of a higher class of animals, and the ventral fin also is fitted with joints resting on a firm series of bones, to which also the pectoral is attached; and the whole is so well supplied with nerves of sensation that, with slow but sure and consciously directed motion, the fish is enabled to creep in advance or retreat, or to turn itself round, and so lay hold of such incautious rovers as have crowded round it without a suspicion of the danger proceeding from the gaping but quiescent cavern of a mouth. And formidable indeed is that gulf, which, as we have seen, lies open to receive the prey—as hungry is the stomach which is prepared to receive it.

But sometimes stratagem will fail to supply the cravings of a hungry stomach; and then, in spite of its inaptitude for effort, the angler will mount into the higher regions of the sea, and there, without discrimination, endeavour to glut itself with any object that may attract its attention. It has been known to grasp within its jaws the floating barrel which is usually fastened to the head of a sean, and it has swallowed the large white-washed ball of cork which formed the buoy of a crab-pot, by which it became choked. When an individual was seen by a fisherman to be swimming near the surface, he threw his boat's iron grapnel at the fish, but not terrified with the blow the fish turned and seized the object as it sunk. Again, a struggle was observed at the surface, and on the approach of a boat it was found to proceed from an angler in its efforts to swallow a gull which it seems to have laid hold of as it was floating on the surface. The fish measured three feet in length, and had so far swallowed the bird, which was found to be the *Larus argentatus,* and which measured almost four feet six inches from wing to wing, as that its stomach and gullet were filled, while the feet, tail, and ends of the wings projected from the mouth. The fish had become choked with struggles of its prey, and they together form a portion of a local museum. An angler was seen to have seized a bird called the northern diver—*Colymbus Glacialis*—but after a long and earnest struggle both the combatants were secured by a fisherman. And, however difficult it may be to imagine how it can happen that such an apparently unwieldy fish has been able to lay hold of the active birds and fishes we have mentioned, some portion of the difficulty will disappear when we know, that in addition to the width of the gape and stealthiness of approach, by a particular construction of the uppermost portion of the chain of vertebræ, by which a distance is preserved between the upper processes of these bones close to the head, and the head itself, the head may be lifted without any motion of the body, which is contrary to what takes place in the generality of fishes.

As another proof that the angler sometimes seeks its prey at midwater, a fisherman had hooked a codfish, and while drawing it up he felt a heavier weight attach itself to his line; this proved to be an angler of large size, which he compelled to quit its hold as it grasped its prey across the mouth, by a heavy blow on the head, and the codfish still remained attached to the hook. In another instance, an angler seized a conger that had taken the hook, but after the last named fish had been engulfed within the cavern of the mouth, and perhaps the stomach, it struggled through the aperture of the gills, and in that situation both the fishes were drawn up together. This fish is all one vast extended mouth, says Oppian, to which we may add by adaptation from our English poet Spenser:—

> "The open mouth that seemed to contain
> A full good peck within the utmost brain;
> All set with dreadful teeth in ranges twain,
> That terrified his foes and armed him,
> Appearing like the mouth of orcus ghastly grim."

The extent of the mouth is indeed formidable, for in an example which measured four feet and a half in length, and weighed seventy-two pounds, this organ measured fourteen inches across; and this in action is capable of being greatly extended by means of several joints with which these parts are supplied to a larger degree than in most other fishes. In opening the mouth the lower jaw is rather protruded than lowered. The upper jaw also is capable of some degree of protrusion, and in its symphysis a sidelong motion is also put in action, by which it appears possible that the angler may be able to swallow a prey equal or nearly so to its own bulk; to which also a wide gullet can afford a passage, and the stomach a welcome, while the skin of the body is so loose as to allow of any degree of distension without inconvenience, and there are no ribs on the sides that might offer a mechanical resistance. Nor can the food pass easily out of the stomach into the intestines without being entirely digested, for the lower or pyloric orifice of that organ is small, and there is reason for supposing that the process of digestion is itself slow. On one occasion there were found in the stomach of an angler nearly three-quarters of a hundred herrings; and so little had they suffered change that they were sold by the fisherman in the market without any suspicion in the buyer of the manner in which they had been obtained. In another instance there were taken from the stomach twenty-one flounders and a dory, all of them of sufficient size and sufficiently uninjured to make a good appearance in the market where they were sold.

And how indiscriminately fishes feed on each other appears from the fact, that in the stomach of an angler which measured two feet and a half, was found a codfish that measured two feet; and in the latter were the skeletons of two whitings; within which, again, were other small fishes.

As this fish has on some occasions displayed a considerable degree of apparently stupid indifference to fear, with remarkable want of caution in avoiding danger, it has been concluded that its powers of perception are in a low degree; and this opinion is strengthened by noticing the small size of the brain in comparison with the bulk of the body. It scarcely fills half the chamber of the skull in which it lies; the remainder of the space being occupied with water, as in other fishes; and it is even said that this brain is in bulk but little above that of a sparrow. The whole head also is regarded as being in a condition of restricted, or arrested development; for, as in most animals in their embryotic state, the head is proportionally larger in reference to the body than it continues to be in the condition of perfect development, it has been judged that its existence in the magnitude we find it in the angler is a proof of the small development also of its other powers. But the abstract truth cannot be reached by such an analogy, and it is to be questioned whether a comparison of the brain of this fish with that of the sparrow be in any respect a just one. There are in all creatures nerves and portions of the brain which are endued with special sensibility—as that of seeing, hearing, and tasting—but in which the anatomist, with his microscope, has not yet learnt to discern a different structure from that which is possessed by other nerves that are altogether insensible to such, or any other conscious sensations.

And again, there exist creatures which, to all appearance, are guided by strong powers of reason in their animal actions, whose brains are vastly smaller in absolute size than that of the angler. The weight of the brain of the bulky fish and of the bird may therefore be the same; but we know that their form, extent of surface, and arrangement of parts, are different; and it is probable that the internal structure of the lobes is still more so—as we know further is the expansion and arrangement of the nerves of the external development of the organs of sensation—in which last particular, indeed, this fish excels a large number of the other inhabitants of the sea. The eyes are directed towards the sides, so that they cannot, as in the case of the skulpins and other flat-headed stargazing fishes, be brought to bear together on a single object; and such is the size of the crystalline lens that, with its strictly globular form, and its position on the posterior part of the chamber of the eye, close to the retina, or nerve of sight, objects at a moderate distance can scarcely be discerned; but it is here that the special function is displayed of a particular muscle of the interior of the eye, first described by Mr. Dalrymple, and known to exist in some other fishes. Its influence is to draw back, as that of the external director muscles is to press forward, the crystalline lens, that by modifying the angle at which the rays of light cross each other, and so enable the fish to discern more clearly at varying distances. There is reason to believe also, that the iris of the eye is furnished with muscular fibres, by which the quantity of light which passes inward to the nerve of sight may be regulated; and how necessary this must be to the varying habits of the fish will presently be seen. In common with some other kindred fishes, the angler is able to move its eyes in various directions, and it is probable that this is effected by each one independent of the other, as is certainly the case with the blennies. From the appearance of lines or stripes on the iris of the eye, there seems reason to suppose also that the organ is capable of contraction and expansion; by which means the eye may be fitted to the varying degrees of light as it exists near the bottom or at the surface of the sea. This fish is retentive of life, so that when the skin has been kept moist, it has been known to live out of its proper element several days.

It is known that the race of this fish is continued by means of spawn, as in other bony fishes; but much obscurity has existed in regard to the early stages of its growth; and from the observations of Dr. Günther, in the *Annals and Magazine of Natural History* for 1861, there appears to be a foundation for the supposition that in its young condition it possesses a different shape from what it subsequently assumes; and that in this state it has been regarded even as a distinct species, under the name of lophius eurypterus; but a remarkable portion of the history of this species is the scarceness of this young condition as compared with the commonness of full-grown examples, and its prolific character. Mr. Thompson weighed the roe in an angler which measured four feet and a half in length, and found the bulk enclosed in the membrane to amount to one pound and thirteen ounces; from which, with due allowance for the superfluous materials, he concluded the number of grains to amount to almost a million and a half.

This fish is not thought of for table with us; but Jonston quotes an unknown author, Alexandrides, for the fact that it was produced at a feast given by Cotys, King of Thrace; and, according to Antiphonis, the belly was particularly esteemed. Willoughby says that when boiled the flesh is white, and in taste like a frog; to which we may add that, according to Risso, a fish which he calls genelli, and which he considers as a variety of the angler, is a delicious dish, as has also been reported by a private individual of our own angler.

A large example of this species may measure in length between five and six feet, but the specimen described measured three feet, and its breadth across the widest expansion of the pectoral fins, about twenty-two inches. The head broad and rounded, forming a large proportion of the bulk; the body tapering behind the pectoral fins, and more compressed towards the tail. Head studded with bony tubercles, six in number, with a depression from the symphysis of the upper jaw upward between the rows, in which the processes of the maxillary bone are received. The lower jaw projects, and is capable of great protrusion; breadth of the mouth in this example ten inches, with two or three rows of long, sharp teeth, the innermost row generally the stoutest and longest, especially in the lower jaw, and each tooth through much of its length encased in its own membranous covering; in front of the palate also are rows of strong teeth, and the same in the floor of the mouth in the place of tongue. Eyes high on the head separate, with a depression between them; vision towards the sides. Round the body from head to tail a series of membranous processes, flat and lobulated, but of some variety in shape; the longest round the head. Skin smooth, loose, and slimy. Strong tubercles behind the eyes; the head covered with numerous irregular lines, from which proceeds a tenacious slime. Two short soft processes, already referred to, above the upper jaw; between them a slender upright filament, its interior structure bony, and which is joined to the bony substance of the head in some cases by a ring joint; in others, a portion of the ring is formed of soft substance. This forms the fishing-rod and line; its termination expanded, soft, hanging down like a bait, and in this example the whole was nine inches long. Behind this are five slender processes, obscurely united by a membrane, which may be regarded as the first dorsal fin; these processes or rays becoming gradually shorter, second dorsal and anal opposite each other, the former having twelve rays, the latter ten; pectoral fins horizontal, with twenty-four rays, joined to the body by a lengthened wrist which is hid under the skin; and the longitudinal direction of the bones of the wrist causes this fin to be placed far behind, yet not so far as the gill opening, which is situated behind it, and is so open in consequence of the loose nature of its membrane and the length of the six slender branchial bony rays, that by fishermen the pair are termed pockets. The ventral fins resemble slender paws, with six rays. Tail slightly rounded, with eight rays; all the fins thick and fleshy, with lobes or crenations at the border. The colour above is of various shades of dark or ashy-grey, mottled, and in a younger condition, prettily and regularly striped, white below: extremities of the fins often red. The olfactory portion of the brain exists as a separate globe of nervous matter, distinct from the united ganglions forming the true brain, although it is united to it by a bar or string of nerve; and from this anterior globe proceed some fine fibres which we should have described as passing foward to the perforated elevations above the upper jaw, which we suppose to form the nostrils; but we hesitate to say that these fibres are actually united to or expanded on these membranous processes, since Professor Owen, whose accuracy in observation no one will question, has not been able to trace them thither. These processes are also furnished, at their root at least, with nerves of considerable size, but which are only organs of feeling, as is the nervous trunk from which these branches spring, and which conveys its powers of sensation over the face and to the corners of the mouth with the neighbouring parts. As this nerve is the largest in the body, except the nerve of sight, we may believe it to bestow the function of exquisite touch in a degree proportionate to its superior size. There exists in this fish also what perhaps we should least expect to find in it, an organ of hearing, which it possesses in a higher degree of development than in many other species. It is true there is no external orifice by which undulations causing sound can obtain access; but there is no reason to suppose that any modulations of sound are felt by any true fish. It is only a few variations of noise or tone that are perceived by them, and in this particular the angler is at least equal with the generality of the inhabitants of the ocean. But to the eye of this fish we would direct particular attention, as it is in its structure we discern it to be better prepared for variety of vision than is the case with the larger part of bony fishes. The crystalline lens is large, by which means it is able to take in a wide range of vision, while its situation far back in the chamber, and very near the retina or expanded fibres of the nerve of sight, from which, by bringing the rays of light to a short focus, the distance at which objects would be seen must be small, is changed, and a larger extent of perception secured by the compressing operation of the external muscles of the eye-ball, the lens itself being thus driven forward towards the front.

THE PRINCIPLES OF SPECTRUM ANALYSIS.

BY THOMAS ROWNEY.

Sixty years or more ago Dr. Wollaston detected in the spectrum obtained from solar light a series of dark bands crossing it throughout its entire length. These lines may be easily seen through a prismatic telescope, of which Mr. Crookes has contrived a simple form. The discoverer does not appear to have thought much of the fact, and seems to have discontinued his experiments, as we have no further account of his researches in that direction. It was not until Fraunhofer of Munich announced his independent discovery of the same lines, and showed that they were constant both in number and position, and mapped them out to the extent of more than 600, with the most sedulous care, that they came to be regarded as features worth notice. He showed that these lines, which now bear his name, might be found in all spectra, by viewing them through a telescope, whether the source of light were the sun, moon, fixed stars, or planets. He also found them in the electric spark, and in flames coloured by the combustion of metals. These two philosophers might justly lay claim to the honour of having laid the foundation of what is now termed spectrum chemistry. In the words of Dr. Miller,*

"The inquiry thus launched by Fraunhofer has been followed in four principal branches of research, which may be described as relating to,—

"1. *Cosmical lines*, or the black lines produced in the light of the sun, the planetary bodies, and the fixed stars.

"2. *Black lines produced by absorption*, a class of phenomena discovered by Sir D. Brewster, in his observations upon the red vapours of nitrous acid.

"3. *Bright lines produced by the electric spark*, when taken between different conductors.

* Lecture reported in *Chemical News*, No. 123.

"4. *Bright lines produced by coloured flames*, or by the introduction of different substances into flame.

"The following chronological table contains the names of those who have made the principal steps in these different subjects:—

"Newton 1701
Wollaston 1802
Fraunhofer 1815

Cosmical.	*Absorption Bands.*
Brewster, 1832.	Brewster, 1832.
E. Becquerel, 1842.	W. H. Miller and Daniell, } 1833.
Draper, 1842.	W. A. Miller, 1845.
Stokes, 1852.	
Brewster and Gladstone, } 1860.	

Electric Light.	*Coloured Flames.*
Wheatstone, 1835.	Brewster, 1822.
Foucault, 1849.	Herschel, 1822.
Masson, 1851—55.	Fox Talbot, 1826, 1833, 1834.
Angstrom, 1853.	W. A. Miller, 1845.
Alter, 1854—55.	Swan, 1857.
Secchi, 1855.	
Plücker, 1858—59.	
V. Willigen, 1859.	

Kirchoff ....1859.
Kirchhoff and Bunsen ....1860."

In order to a right understanding of the results which have been reached by the recent labours of Kirchhoff and Bunsen, it is necessary to be acquainted with the nature of the dark lines, which are so many touchstones or tests by which they have worked them out. Let us suppose a prism of blue glass to be used for effecting the decomposition of a ray of solar light. We have an elongated image, not, however, containing seven colours, as when a white prism is used. The yellow, blue, and green are all absorbed, and we have only the two extreme colours, violet and red, the latter also diminished in breadth, A comparison with the normal spectrum will make the difference at once clear. In passing through our atmosphere, or the atmosphere of the sun, similar changes may take place, and thus materially assist in producing these dark lines. Moreover, there are a class of rays in the solar spectrum which our eyes cannot see, and of which we can only judge by their effects. Of such are the chemical rays which manifest their action in the beautiful results of the photographic art. We may instance also another set found beyond the violet rays, whose presence has been demonstrated by Professor Stokes, by transmitting them through a solution of sulphate of quinine. They have a light bluish-lavender colour. Thus, it will seem that certain rays have such a refrangibility that our eyes cannot take cognizance of them; and so also certain rays exist in solar light which are incapable of transmission through certain media. Applying this to the solar spectrum, we have a clue to the production of the dark lines, by supposing, with Kirchhoff and Bunsen, that the sun has the property of inducing or giving out rays of a certain refrangibility, but yet cannot produce others capable of filling the interspaces. Another interpretation has been given, by supposing an interference in the undulations of certain rays, which produce darkness; but this theory will not meet the circumstances of the case, and we can show by experiment that by making an artificial atmosphere the same or parallel results can be produced.

The natural variations in the composition of the atmosphere produce similar effects, and Brewster was the first to notice bands in the red and green spaces, whose appearance was not constant. These appearances are usually observed when the sun is not far from our horizon; and Dr. Miller mentions an instance in which he saw a group of lines during a thunder shower. They came suddenly, and faded as the rain passed away.

The readiness with which the spectrum responds to changes in the atmosphere, or in the nature of the source of light, is shown in the following experiment of Kirchhoff and Bunsen:—

They threw up into the air of the apartment a small quantity of chloride of sodium in very fine powder. Motion was imparted to the atmosphere, to ensure an equable diffusion of the salt. The spectrum in an instant demonstrated its presence, by showing a golden-yellow band in the yellow space. This effect is uniform whenever sodium is present in a state of incandescence, and is therefore called the sodium spectrum. This result might have been expected, knowing that sodium in any form always tinges flame an intense yellow; but when we come to the combustion of other metals, the bands produced by them are such as could never have been anticipated. When silver is burnt we have other coloured bands brought out equally characteristic, and so with every other metallic substance. To show the relation between these coloured bands and the dark lines, we will suppose the light of a pure white flame to be passed through a yellow sodium flame, and then through the prism. Now, mark the change. The spectrum is no longer continuous, and having its bright yellow band in the yellow space; but where it flashed out so conspicuously is now to be seen a dark line, known as "D." The rationale is obvious. The yellow atmosphere has interfered with the yellow of our normal spectrum, and by that interference darkness has resulted.

Keeping these results in view, we have a key to the whole subject of spectrum chemistry. It can be shown that each metal in a state of vapour has the power to arrest particular rays with a constancy that can be relied on. The arrangement best suited for these experiments is either Dubosq's electric lamp, or the Drummond light, but many of the spectra may be conveniently studied by using Crookes's spectroscope, as made by Spencer Browning and Co., and now too well known to need detailed description. This instrument is well adapted for ordinary purposes, but to appreciate the full beauty and delicacy of the various spectra, we should need an apparatus as perfect as that constructed for Kirchhoff by Steinheil of Munich.

When artificial light is employed—as that of gas or lamp—the dark lines may be brought out by interposing a glass trough or bottle containing nitrous acid gas between the light and the instrument. This gas may be obtained by the action of a small quantity of nitric acid on a piece of copper; and, as we have before mentioned, it acts as an absorptive medium. If a piece of sulphur be introduced into the flame of a spirit-lamp, a good view of its dark bands may be obtained. If the subject for examination be an alkaline metal, the spirit-lamp may be used, or better still, a flame of hydrogen mixed with air and burnt on the top of a tube covered with wire gauze. We thus obtain a flame of high temperature with little light, except what is derived from the substance employed. The metal in a state of chloride is the most convenient form—it being more easily volatilized. It may be introduced into the cotton wick; or if the gas-burner be used, then a loop of platina wire sliding on an upright support is the easiest to manage. The copper spectrum may be readily obtained by dipping a coil of fine wire into pure hydrocloric acid, and immediately inserting it into the gas-flame. When iron, silver, etc., are operated upon, wires of these metals should form the electrodes of a powerful voltaic battery, and be brought by its agency to an incandescent state, when a portion of their substance is volatilized, and exhibits its characteristic action through the prism.

Kirchhoff and Bunsen, while pursuing their researches on the composition of some mineral water, obtained from the combustion of the solid matter a series of bands in two spectra, which did not correspond with those produced by any of the known metals. This led them to infer the presence of some new elements which the eye of man had never yet seen. After evaporating several tons of the fluid, their labours were rewarded by obtaining two new metals, which they named Cœsium—(greyish blue) that being the colour of the bands—and Rubidium (dark red). No sooner had they done this than they were off into the depths of speculation, conceiving that they had in their power a means of analysis capable of much higher application.

These ingenious and indefatigable workers found that the bright lines in the metallic spectra corresponded closely with the dark lines of the solar spectrum. Why was this? and how could it be explained? They found, by experiments before cited, that each colour was opaque to rays of its own colour.

To illustrate the point more clearly, we may suppose two pendulums of equal length to be placed side by side. If the one be made to vibrate, it will, after a time, cause its companion to do the same in consequence of its equal length or isochronous condition; and so it is supposed that the rays of one colour will be taken up by another whose vibrations are of equal length, and so be arrested in their voyage. Now look at the application of this result. If, in the rays of light from an artificial source, this principle be correct, it may also be correct with the rays of solar light. Hence they have inferred that the dark bands of the solar spectra are produced by their passage through an atmosphere containing certain metals in a state of high combustion or vapour.

Upon these grounds they have concluded that in the outermost solar envelope exist all those metals in a state of vapour, whose colour-bands coincide with dark lines of the solar spectrum, as sodium, potassium, iron and nickel; and that it is by the more powerful light of the photosphere shining through this only feebly-luminous layer that the dark bands of Fraunhofer are produced by the process before described. They have also inferred the source from which these metals are derived to be the mass of the sun. A bold assertion, perhaps a correct one; but we are certainly not at present justified in accepting it as if it were proved; and we may advantageously reflect upon the words of Dr. Miller:—

"Fascinating as this theory is, it must be remembered that it is yet upon its trial, and that it does not explain the facts at present known respecting the vapours of hydrogen, mercury, chlorine, bromine, iodine, and nitrogen. M. Morren even questions the accuracy of some of Kirchhoff's observations. Thus, he states that in a measurement which he made of the red band of potassium, conjointly with Plücker, they found that it did not correspond with the solar line A, but that it is considerably more refrangible."

There are many other important facts which will have to be considered before we can arrive at a complete theory of the spectral phenomenon. For example, chloride of lithium produces a single crimson line in the flame of a Bunsen burner; the greater heat of a hydrogen flame enables it to emit an orange ray, and the voltaic arc adds a brilliant stripe of blue. In like manner, iron and other metals furnish spectra which advance in complication as the temperature of their vapour is increased.

Professor Roscoe says that "the general rule is that *lumi-*

nous solids give off a different *quality of light* when they are differently heated, and luminous gases give off the same kind of light at all temperatures."* The spectra of gases are quite as interesting as those of the metals; hydrogen, for example, giving a red and a blue band, and nitrogen beautiful violet stripes.

THE FEATHERED REPTILE OF SOLENHOFEN.†

Last summer M. Witte of Hanover, called the attention of M. A. Wagner to a slab of the well known Solenhofen lithographic slate, about one and a quarter square feet in size, containing fossil remains of an extraordinary and bewildering character. The skull, neck, and both hands were wanting, but the greater part of the dorsal vertebræ and all belonging to the tail were well preserved. The humerus and fore arm, consisting of radius and ulna were present on both sides. "At the anterior extremity of each fore arm there is a broad short bone which is injured." The pelvis, more like that of a Pterodactyl than a bird, is imperfect, the right side only remaining. The hinder extremity is complete on the left side; on the right only the thigh and shank remain. The thigh bone is strong but not long, and the shank not perceptibly divided into tibia and fibula. The tarsus consists of a single powerful bone shorter than the shank, and having its lower extremity widened, and bearing three articular processes to which as many toes are attached. The latter are of moderate length, and armed with strong hooked claws. Except to the comparative anatomist, these singular remains might present nothing striking, but the description proceeds to tell us that the anterior limbs and tail were covered with feathers, which have left their impressions in well marked lines. "From the short broad bone which lies close to the extremity of each fore arm there issues a radiating fan of feathers, by which two feathered wings are produced, having their external outline curved like a bow." The tail is also feathered, but the feathers are shorter than those of the wings, and instead of radiating from the end of the tail they spring from both sides throughout its length, starting at a small angle, and forming a "leaf like or oval group." Before the discovery of this fossil, Von Meyer described a feather from the same quarries, which he conjectured to have belonged to a bird, as it was not to be distinguished by any special peculiarity. On receiving the account of M. Witte's investigation, he however came to the conclusion that the feather he had seen must

* Lecture at Royal Institution reprinted in *Chemical News.*
† See *Annals of Natural History*, April and May 1862.

have belonged to a "similar animal," which he designated *Archæopteryx lithographica.* For various reasons drawn from comparative anatomy, M. Wagner rejects the idea of the creature having been a variety or new kind of bird. He says "a reptile with the simple tarsal bone of a bird, and with epidermic structures presenting a deceptive appearance to bird's feathers, is far more comprehensible to me than a bird with the pelvis and vertebral column (especially the long slender series of caudal vertebræ) of a long tailed Pterodactyl, and with a perfectly different mode of attachment and of feathers." The idea of a "deceptive appearance" in the feather is negatived by Von Meyer, who states that in his specimen the fibres of the vane can be distinctly traced, and even the small barbules with which they are beset. M. Wagner named the fossil which he examined *Griphosaurus* (Enigma-lizard), and it does not seem that Von Meyer has any reason for supposing the creature to which his feather belonged was of a different nature, although he has given it a different appellation. M. Wagner thinks the discovery of the new fossil may explain the foot prints in the Trias, which have been ascribed to birds, and Von Meyer remarks that in 1824 he pointed out the danger of too closely following Cuvier's theory that a similarity of particular parts indicated a similarity of other parts, or of the whole.

SECCHI ON MAGNETIC AND ATMOSPHERIC PERTURBATIONS.

In a letter to the French Academy, the distinguished Roman observer Secchi, gives a summary of the conclusions he has arrived at respecting the connection between magnetic perturbations and atmospheric movements. This he considers established, first, by the great variations of magnetic elements, and especially in the intensity of the horizontal force, on the occurrence of storms; secondly, by the irregularities which accompany periods of squalls; thirdly, by the great depression of the bifilaire,* and the variations of other instruments which precede, or follow immediately, great changes in the weather; fourthly, by variations of intensity corresponding with variations of the winds; fifthly, by the *aurora borealis,* which, considered as a signal of variation in wind and weather, belongs to the class of phenomena under discussion.

* The "Bifilaire," or Bifilar, is a Horizontal Force Magnetometer, so called from the magnetic bar being suspended by a double thread of silk or wire. Its object is to measure variations in the intensity of the horizontal component of the earth's magnetic force.

The immediate cause of the connection thus traced, M. Secchi ascribes to atmospheric electricity, which, when discharged from the air to the earth, must generate strong currents by which the needle is affected. Such currents, he observes, exist not only during auroral manifestations, but also during storms, and are exhibited by each instrument according to its nature, the galvanometer showing changes in tension, and the compass-needle making known alterations in the total force of the current which passes beneath it. With reference to the questions of whence comes the electricity circulating in the soil, and what is its immediate vehicle, he replies by pointing to the precipitations from the atmosphere. The rain especially, he says, discharges an immense quantity of electricity into the earth, and, in general, it may be said that strong actions upon the instruments only occur after a rainfall has taken place at some point more or less remote, even beyond the limits of the visible horizon. This circumstance may, perhaps, explain the fact that magnetic perturbations indicate approaching squalls. Rain usually produces negative electricity over a considerable extent of atmosphere, and it is itself generally negative, which accounts for the notable diminution of horizontal intensity which precedes squalls. The precipitation of vapour without rain, which often happens between eight and nine on clear nights, and which is accompanied by very strong electricity, may explain the magnetic perturbations which occur at that time, and the diurnal electric period which corresponds with the movements of the horizontal needle may belong to the same class of meteorological facts. Even the *aurora borealis* may be included in this category, as there is a continual fall of ice-needles, almost invisible, but whose existence is clearly shown in the narratives of Polar voyages. Atmospheric electricity on these occasions may, perhaps, be exalted by accessory causes, such as the change which takes place when vapour passes to the state of ice, or by the friction of wind against the little icicles in a dry and very insulating atmosphere, and also by the inductive action of superior regions on the falling and floating particles of ice. These various subjects, M. Secchi tells us, are illustrated in his *Mémoires,* but he does not pretend that magnetic disturbances have no other causes than those indicated in the preceding remarks. Further observations will be made at Rome, and notices afforded in the *Bulletin Météorologique,* published in that city.

It is interesting to know that the instruments used by Mr. Secchi were supplied from the Observatory at Kew.

ON THE GEOLOGICAL VALUE OF RECENT OCCURRENCES.

BY GEORGE E. ROBERTS.

Not unfrequently in the passing, and by many scarce-heeded, news of the day, facts in the physical condition of the earth's surface are chronicled, which, rightly studied, are of high geological importance. As "Intellectual Observers," we may aid very greatly our comprehension of bygone physical events by seeking out these apparently valueless phenomena of modern times, and comparing their results with those operations of past ages which our acceptation of Lyellian philosophy teaches us were the accomplishments of like ordinary, and, in our day, unregarded means. If these principles rule our daily observations, much that has heretofore been unseen and uncared for will be perceived, and found replete with instruction. Risings and sinkings of the surface will be noted as going on simultaneously in many parts of the British Isles, and the rate of growth—so to speak—of land above the sea, of sandbanks from wind action, of morasses by the extension of Sphagni and other bog-plants, and of tide-covered estuaries into areas of permanent land will become ascertained facts. Observations of this kind are peculiarly easy of record just now in the neighbourhood of London, by reason of the trench-diging into the alluvium of the Thames for the main drainage works, and I notice with much pleasure that one gentleman; officially connected with these works, Mr. Cresy, is taking accurate sections of the depth and variety of character displayed in that alluvial deposit, in the formation of which, during the last 2000 years, man and the river seem to have been co-workers. In the study of these modern physical conditions, a re-action resembling that of the new school of German Bibliopoles, who are collecting and laying up in store the ephemeral publications of the day—the street ballad, the tradesman's bill, and the thousand-and one circulars of social and unionist character which flutter our library tables, seems to have set in among geologists; with this difference—that he who studies human life collects for the learning of the future, for the delight of antiquaries in centuries to come; while the philosopher of Nature collects the new-born rarities of the day that they may aid his comprehension of kindred workings in the ages which are past.

A very notable example of a modern occurrence thus throwing light backwards upon ancient physical story I see in the *Times* newspaper of the 5th April. It is worthy of preservation in a remarkable degree, for it illustrates in a clear and decided manner phenomena of ancient deltas and estuarine brackish water deposits in Permian, Carboniferous, and Triassic times, whose commingle of marine, fresh water, and terrestrial organisms have puzzled the geologist. This is the occurrence in question.

"THE FLOODS IN CALIFORNIA.—*San Francisco, February* 11*th*.—I have just received your letter, which has been double its usual time getting here, owing to our fearful visitation of tempest and flood. We have been shut out from the world ever since the 15th of December last. It began to rain on the 1st of December, and we did not regard it much, for we looked for the annual rains. But the rain—which, as usual, was snow in the mountains—continued the whole of the month of December, and about the middle the mountain snows began to melt, as the rain had actually got warmer. The consequence was that the Sierra Nevadas poured down rivers upon rivers of water, until the whole of that great basin of California which the mountains bound was entirely submerged. The only outlet to this water is the Golden-gate, the entrance to the bay at San Francisco from the Pacific Ocean. Take the map of California, and see where, on the south, the mountains come to a point below Tularo Lake, and then go up north to where they again join at Shasta, and then picture the whole of the immense tract of land they enclose under water, and the bay of San Francisco a vast river, pouring its volumes into the Pacific Ocean by the before-named Golden-gate. Fancy, also, the tides of that ocean having no effect in our bay, and welling up at its entrance, and you will have a feeble idea of the magnitude of the volume of water that has for two months ravaged California. Not a ship could enter our harbour, and only the most powerful steamers could stem the torrent. Sacramento, Marysville, and Stockton, our three principal interior cities, all under water, and all communication cut off with them excepting by boats. Business completely at a stand-still, no goods going up and no money coming down. It was very strange to see the sea for about ten miles around the mouth of our bay. In the interior, about sixty miles from San Francisco, and at the embouchure of the northern rivers, are vast tracts of land covered with rushes and semi-aquatic plants, that go by the name of tulé lands, something like the paddy-fields of India. Well, as the waters rose, these immense morasses rose also, and in process of time, becoming detached, floated away with the current in masses of from 100 yards to half a mile in size, and they all floated out to sea, travelling, some of them, more than 100 miles before their arriving. Once arrived in their grander sphere of action, it was the most extraordinary thing to see the myriads of water-snakes, faithful to their home, twisting and twirling in the salt sea, and to see the water-fowl that screamed over their nests as though warning the islands of their danger, and to see our coast when any of the islands were thrown up on it, and the thousands and thousands of snakes wriggling their way over the shrubless sands that bound it for miles in search of anything to hide them from the wholesale slaughter that sticks and stones, and knives and even guns made among their host. We wanted St. Patrick to come. You know the innate dread we have of a snake, and you can fancy our disgust, amounting to horror, at this invasion of slimy things crawling upon us. All the salt water fish have left the bay, and all the oysters have, like good men, died in their beds."

Another remarkable modern illustration of ancient work I have lately met with a slight note of in a paper of the day. In a comparatively recent eruption of one of the Icelandic volcanoes, a stream of lava making its way to the sea, caught up and embedded in its flow the recent shells and pebbles of the beach. Some specimens of this lava, lately shown to me by Captain Campbell, contained this beach-debris, and reminded me forcibly of the layers of volcanic ash, contemporaries in time of far gone Silurian ages, which lie inter-stratified with the sea beds they intruded on through Northern Wales.

Another exceptional modern event—may it be the last of its kind! which has been made to do good service in the geological cause was the bursting of the Holmfirth reservoir; by observing the effects of which, in moving huge stones and re-laying the transported material along the course of the flood, Mr. Prestwich was enabled to throw light upon the power and effects of water-action similarly confined in geological times.*

These cases I have noted, however, may truly be regarded as exceptional ones, though by their prominent character their power of teaching is the greater; but, as they illustrate the kind of phenomenon which it will be instructive to study whenever opportunity presents, I have quoted them in illustration of the work. In an excellent paper upon "Trails, Worm-markings, and Tracks," contributed by my friend Professor Rupert Jones to the *Geologist* of last month, much valuable material for study is pointed out, and he shows most clearly, by direct teaching and by inference, that by the use of a modern key we read the Nature-printed hieroglyphs of the past.

Geological Society of London, May 1862.

* *Journal of the Geological Society*, vol. viii. p. 225.

WORK FOR THE TELESCOPE.—PLANETS OF THE MONTH.—DOUBLE STARS.

BY THE REV. T. WEBB, F.R.A.S.

PLANETS OF THE MONTH.

THERE may be a fair chance of getting a sight of Mercury in the evening twilight at the beginning of the month, as he attains his greatest elongation from the Sun, and his dichotomy, or half-moon phasis, on the 6th. A position, however, near the horizon is seldom favourable for the employment of those high powers which are requisite to make out details in an object at that time scarcely 8″ in diameter. Those who possess good instruments equatorially mounted may, of course, always find him (except when too near the Sun) at a more suitable altitude, as his brightness renders him visible throughout the day; and it is in their power to supply one of the desiderata of planetary astronomy, the confirmation of the phenomena discovered by Schröter and Harding at the beginning of this century. These consisted chiefly in a difference in the shape of the two cusps, and in the occasional presence of dusky spots and belts, whence Bessel deduced a rotation in 24h. 0m. 53s. Schröter also perceived slight irregularities of form not only in the terminator or boundary of day and night, but in the circular limb, and a difference between the breadth of the observed and calculated phasis, which last has been confirmed by Beer and Mädler.

Venus is still conspicuous in the mornings, but is becoming gibbous and comparatively uninteresting.

Jupiter is passing away towards the west. The following transits may be looked for, though the planet is getting more distant and smaller, his diameter at the end of the month being reduced to 32″·6.

2nd. Shadow of I. goes off at 9h. 41m. 9th, I. and its shadow, and III., are all on the disc together. I. emerges at 10h. 21m., III. at 11m. 20m., the shadow at 11m. 36m. 12th, Shadow of II. departs at 10h. 25m. 15th, Shadow of IV. enters 9h. 44m. 16th, I. is on the disc from 9h. 59m. to 12h. 16m. III. will be in transit at the same time, emerging at 10h. 19m.; the shadow of I. enters at 11h. 15m. 19th, Shadow of II. enters at 10h. 16m., the satellite 15m. later. 25th, Shadow of I. goes off, 9h. 55m. 26th, II. enters, 10h. 20m. Some of these, it will be seen, are interesting configurations.

Saturn continues to turn to us the dark side of his ring.

DOUBLE STARS.

The rapid advance of summer twilight has somewhat overtaken our work, and we are compelled to defer some remarkable pairs to a future opportunity; many other beautiful objects are succeeding them, but the nights are so short that the telescope is not likely to be much in requisition: and we shall therefore postpone for the present the description of such as may be equally well seen later in the year, and confine ourselves to a small number, which, from their nearness to the horizon, are passing speedily away, or cannot be observed, during ordinary hours, at any other than the present season.

8. γ *Virginis.* 1″·6. 77°·9. (1831·38). *round,* (1836·06). 1″·9. 191°·6. (1843·33). 3″·8. 169°·9. (1858·39). Both 4. Silvery-white and pale yellow, the latter the less brilliant. Struve pronounced them alternately variable; this seems confirmed by some observations of Smyth, Dawes, and Fletcher; and, as Humboldt remarks, probably indicates a very slow rotation of both suns upon their axes. In every respect a most remarkable pair. No stars are more unquestionably binary, and none have run so interesting a course, combining such varied distances and velocities. Cassini II. perceived that this was a double star at Paris in 1720, with a distance of about 7″·5, fully half that of Mizar. Since that time the components have been approaching with a gradually accelerated speed, and after a most rapid perihelion, or rather *periastron,* passage in 1836, have been widening out again, and are now a comparatively easy object, at least 4″ apart. At the nearest appulse, Sir J. Herschel's great reflector at the Cape failed to exhibit any other than a circular disc; and the splendid achromatic at Poulkowa, near St. Petersburg, with an object-glass of about 14¾ inches in diameter, and a power of 1000, was only able just to indicate, what was proved by the undiminished light to the naked eye, that there was no actual eclipse. The orbit has given a great deal of trouble to computers, from the inaccuracy of some of the observations. Admiral Smyth has laboured most diligently in clearing up the difficulties which beset his favourite object; and on the whole Sir J. Herschel considers that the period must lie between 140 and 190 years: about 180 seems the more probable duration.

There is little difficulty in finding γ, from α, Spica Virginis, the principal star in the constellation. Spica is on the meridian about 8h. 30m. in the early part of June, and is the most conspicuous star in the southern sky: γ is the nearest bright star to the right of it, and a little above it. γ, as well as η Virginis a little W. of it, and ζ further off to the E., are all near enough to the equator to measure the diameter of the field ofview.

9. δ *Corvi. Algorab.* 23″·5. 210°·9. 3 and 8½. Pale yellow and purple. Sestini calls the small star white. This pleasing pair is easily found, being that nearest to Spica of the four principal stars in Corvus, and forming an equilateral

triangle with Spica and γ Virginis. As it is now declining rapidly, the search for it should not be postponed.

10. α^2 and α^1 *Libræ.* 3′ 49″. 314°·3. 3 and 6. Pale yellow and light grey. A little after 10h. at the commencement of June, when Spica is beginning to decline towards the S.W., two considerable stars will be seen near the meridian E. of it; the lowest, which lies most to the right, is the star in question; the upper one being β. α is a wide but grand object, owning merely an optical connection. The Sun passes very close to this pair, a little beneath them, during the night of Nov. 5. β Libræ is well worth looking at, on account of its beautiful pale green hue, a very uncommon colour in large stars, though often existing, or induced by contrast, in smaller companions.

EXHIBITION TACTICS.

THE opening of the first great International Exhibition created a phrenzy of egotism and self-glorification, and the success of England in so novel an undertaking stimulated other countries to follow in her wake.

The idea was a happy one, and although there may be only two cities in the world in which it could be advantageously carried out on a grand scale, every country which has entered into the industrial stage of development has an interest in securing a periodical repetition of the friendly strife. Stripped of rhetorical exaggerations, the process is a stock-taking of the skill and power which various nations employ in the production of exchangeable goods. Every department is a page of the ledger or balance-sheet, and the objects are so many entries in the complicated account. The whole concern is thus a matter of bookkeeping with things instead of figures, and must be primarily tested by the facility, or difficulty, of arriving at results. In the first Exhibition, making allowance for that want of experience under which all parties suffered, there was a marvellous adaptation of means to the desired end. The building was not only beautiful of its kind, but its details were so arranged as to secure individual convenience while presenting the prospect of a magnificent whole. Moreover, the structure enabled the largest quantity of goods to be examined with an approximation to the smallest quantity of walking about. From such a beginning we ought to have made decided progress in what may be called "Exhibition Tactics," or the art of managing so varied and extensive a display. That we have not done so will be apparent to everybody who remembers the structure in Hyde Park, and pays a visit to the great higgledypiggledy at the Brompton end of the town. We will not stop to discuss the inconvenience of selecting a locality accessible with great difficulty to nine-tenths of the inhabitants of the metropolis, and remote from the mass of inns and lodging-houses which visitors frequent. The land was vacant, and must become a profitable speculation for influential jobbers if a large stream of public money could be turned that way. This, in brief, appears to be the history of the foundation of the far-famed "Boilers," which were the precursors of the present scheme. The story may some day be told in full; but our present purpose is less with the site than with the arrangements of the newly-opened enterprise.

As an international undertaking the value of such an Exhibition must depend, first, upon the collections being a tolerably fair and complete representation of industrial skill; and, secondly, upon the facilities afforded by their collocation for the purposes of investigation and comparison. Could exhibitors be persuaded to co-operate in such a manner, objects of the same kind should be placed in series; the porcelain or textile fabrics of England, for example, occupying one side of a gallery, and similar productions of foreign nations occupying the other. In the Picture Gallery at Brompton, "Foreign Schools" fill one portion of the fine suite of noble and suitable rooms, while "British Schools" are exhibited in the other. Here we have an approximate illustration of a good method, although there are certain drawbacks, as the pictures which are first seen on entering the British, from the foreign department, seem to have been selected for their position on account of their not possessing those properties of colour which enable them to be viewed with advantage, while the impression of the continental paintings is still fresh and vivid upon the eye. English art has, moreover, suffered from the snobbishness engendered by the Royal Academy, whose agents have been permitted to thrust their water-colour brethren into an inferior set of apartments, and hang their productions in defiance of everything but that *malice prepense* which the oleaginous practitioners are accustomed to manifest towards their aqueous rivals amongst the wielders of the brush. But notwithstanding these defects, if we were to assume British and foreign art as fairly represented in the two collections, the arrangement offers considerable facilities for the comparison of the two. Very different is the result if we try to ascertain how we stand with reference to other countries in the industrial race. The nave, with its conglomerations of incongruous and oddly huddled together objects and edifices, shows at once that the genius of muddle and confusion animated the Commissioners when they disposed of their space. The building itself is badly adapted to the purpose, because it offers no convenient natural divisions for a technological display; but its original defects have been aggravated by corresponding imperfections in the Commissioners' minds. As a fashionable lounge, in which promenaders are sure to find something of interest, and do not care whether it be a bronze gate, an equatorial telescope, a case of mixed pickles, or a diamond necklace, the new show may win considerable praise; but it is almost as much trouble to go from Regent Street to the *Boulevard des Italiens* as to discover and follow any given branch of trade in the English and French portions of the large Babel which Captain Fowkes and the Commissioners have made.

Not only is the arrangement bad and abominable in its logical conception, but it is, in the main, ill adapted to do justice to specific portions of the contents. Generally speaking, the eye is greeted on all hands with a confusion worse confounded of incongruous objects, and it is quite a relief to turn out of the clumsy bustle to such a tranquil nook as the little court in which the Mintons exhibit their unrivalled porcelain. "General Jumble" appears to have been the chief manager of the concern, and when we have had proof of the disorderly brains which have presided over the *mêlée*, we shall not be surprised to find minor defects, in full harmony with the confusion which has been so thoroughly attained. Foremost among these lesser grievances is the want of directions where anything is to be found, and the want of labels to explain it when it turns up. At conspicuous and convenient spots, plans of the building should be shown, with references to its contents; a few sign-posts should add their guiding remarks, and in each leading division the public ought to find tables of its contents. In some cases a sufficient description is appended to each article, but as a rule the information is very meagre, and often confined to Russian, Spanish, or some other little known tongue. It is also important to give prices—which is seldom done—as the appearance or quality of an article is only one condition of industrial merit, and an international exhibition ought to afford an easy mode of ascertaining who will supply our wants at the cheapest rate. The meanness of the Commissioners in refusing season tickets to exhibitors has sadly curtailed the number of attendants necessary to display their wares, and give the explanations which visitors require, and in this we may see a warning not to permit private greediness to stand, on another occasion, in the way of the public good.

The intelligence of the Commissioners is illustrated by their treatment of the scientific collections, which have experienced little respect. Dalmeyer, Cooke of York, and one or two others, have managed to obtain a limited allowance of ground floor, for a portion of their exhibition of optical instruments; but on the whole the makers of philosophical apparatus have a right to doubt the judgment of gentlemen who seem to consider a superb telescope inferior to a pound of candles, or a first-class microscope below an arm-chair. With reference to this important class of productions neither commissioners nor exhibitors—excepting a few of the latter, such as Smith, Beck, and Beck, with their microscopes—have made any provision by which the quality or use of the objects can be seen. It would, for example, have been very interesting and instructive to compare the performances of undoubtedly first-rate instruments, by expensive makers, with cheaper forms by Parkes of Birmingham and other meritorious manufacturers, who have a benevolent, and we trust to themselves profitable, regard for the poorer student's purse. This want will be felt with regard to articles whose use is well known, but when we come to such novelties as the chronographs in the French dapartment, special arrangements should have been made to illustrate their action. It is interesting to be told that a mysterious-looking combination of brass and steel, locked up in a glass box, can measure the flight of a musket ball to the thirty-thousandth part of a second, and the visitor may consider himself lucky that the label tells him thus much, but far more ought to have been done to make such objects understood.

On the whole the Exhibition looks well for British skill and taste—the chief exception being the management of the concern itself, and we would suggest that the guilty parties should be piled up in a "trophy," so as to show the inhabitants of all countries the sort of people to whom such work ought *not* to be confided when another opportunity comes round.

ACARI IN PHOTOGRAPHIC BATHS AND CHEMICAL SOLUTIONS

In our report of the proceedings of the Microscopical Society, the reader will see an account of the appearance of some acari in a nitrate of silver bath employed for photographic purposes by Dr. Maddox. The occurrence of such a form of life under these singular, and, as might have been thought, fatal conditions, calls to mind the experiments made many years ago by Mr. Crosse, and which were ridiculously misrepresented in many statements current then and since. The simple facts are recorded by Dr. Noad in the first volume of his *Manual of Electricity*, from which we extract a few of the most important particulars. In the course of his numerous experiments on electro-crystallization, the philosopher of Broomfield operated upon a solution of silicate of potash, which he supersaturated by hydrochloric acid, and allowed to fall in drops upon a piece of porous red oxide of iron from Vesuvius, connected by platinum wires with a voltaic battery. On the fourteenth day he noticed a few whitish excrescences, or nipples, which proceeded to develope filaments, and on the twenty-second day assumed the forms of perfect acari. Mr. Crosse observed, when these facts were commented on: "I never ventured an opinion as to the cause of their birth, and for a very good reason—I was unable to form one." He succeeded in obtaining similar acari in solutions of nitrate, and sulphate of copper, sulphate of iron, and sulphate of zinc; likewise in solutions of silicate of potash, and fluosilicic acid. The latter experiment occupied eight months, when the creatures appeared at the negative pole. Mr. Weekes of Sandwich repeated these experiments with silicate of potash "inverted over mercury, the greatest possible care being taken to shut out extraneous matter, and in some cases filling the receivers with oxygen gas." In these instances the acari appeared after the lapse of more than a year. Dr. Noad made similar trials, and after more than sixteen months found the acari on and about the terminal cells of the battery, but not within the bell-jars. Mr. Crosse repeated his experiments, with greater precaution to exclude extraneous matter, and with the same results; but he discovered that it was necessary, as mentioned by Mr. Slack in the discussion at the Microscopical Society, to furnish the little animals with the means of emerging from the fluid. He noticed that "if he let an acarus fall into the fluid under which he was born, he was immediately drowned," and Mr. Weekes observed the same fact. In another case the acari were developed in an atmosphere of chlorine, but they were motionless, and Mr. Crosse remarked, "whether the chlorine prevented their complete animation, I cannot say."

The nutrition of creatures formed under such circumstances is as difficult to account for as their origin; but the paper in a former number of the INTELLECTUAL OBSERVER on the *Conditions of Infusorial Life*, will suggest many considerations that may be advantageously borne in mind. In remarking upon Dr. Maddox's experiments, Dr. Lankester suggested that the paper with which his vessel was covered may have furnished some nutritious matter for the singular visitants; and he also pointed out the great importance of studying manifestations of life under unusual circumstances.

No mention of the objects discovered by Crosse and Weekes appears under the head *Acarus* in the *Micrographic Dictionary*. A certain portion of the scientific world found their prejudices interfered with; so some misrepresented, and others suppressed what had actually occurred. Dr. Maddox is fortunate in having made his observations when better treatment may be anticipated.

THE GREAT FOUCAULT TELESCOPE.

M. Léon Foucault has laid before the French Academy an account of the great telescope constructed upon his principle for the Observatory at Paris. He observes that his efforts to obtain large instruments with reflectors of silvered glass could not be deemed completely successful until he had reached dimensions exceeding those of the largest achromatic objectives, and that it was only by way of establishing a claim to the recognition of his plans that he announced the formation of mirrors of 10, 20, and 40 centimetres in diameter. Now, he is able to speak of one nearly 80 centimetres in diameter, having a focal length of 4½ metres,* which has been completed in the establishment of M. Secrétan. This mirror, mounted in a Newtonian telescope, has been at work for three months at the Observatory, performing to the entire satisfaction of the director, M. Chacornac.

The thick glass disc was cast in a curved form (*bombé*), at the factory of St. Gobain, in a mould prepared by M. Sautter, the director of the works for the lenticular lighthouse apparatus, and although possessing sufficient homogeneity for its intended purpose, showed before it was silvered that a flaw had occurred during the process of cooling. On its arrival at M. Sautter's workshops, it was reduced in dimensions by bringing it nearer to the required shape, and by cutting a groove to fix the mechanism necessary for its manipulation. It then passed into the hands of M. Secrétan's skilful operatives, who ground it with a counter piece of glass, 50 centimetres in diameter, assisted by emery and water. This process, which was frequently tested by the spherometer, occupied a week, at the end of which time a fine grained and exactly spherical surface was obtained. Having been thus prepared, it was polished by hand, the polisher employed being 22 centimetres in diameter, and covered with rouge. This polishing was completed by one able workman in another week, and the mirror was changed from the spherical to the paraboloid form. From this moment its success appeared certain, and it was removed, with the necessary tools, to the Observatory, to be optically tested, and to receive the finishing touches.

The frame and stand were made by M. Eichens, the director of M. Secrétan's works. The telescope is suspended from its centre of gravity by two trunnions, resting on two solid vertical columns. It possesses vertical and azimuthal movements, so that it only requires to have its inclination adjusted to the latitude of the place in which it may finally rest, to constitute a veritable equatorial. In consequence of the complaints made

* The metre is 39·3779 inches; the centimetre 0·3937 of an inch.

by the French astronomers of the unfavourable atmosphere of Paris, the new telescope will be placed in an observatory to be erected in the south, and specially devoted to original investigations.

On the 28th ult., M. Le Verrier exhibited to the Academy a drawing representing the double nebula in Canes Venatici—the wonderful spiral formation of which was made known through the magnificent instrument at Parsonstown—as seen by the Foucault mirror. The Abbé Moigno tells us that the drawing exhibits "incomparably more details than those given by Herschel and Lord Rosse." If this be correct, the Foucault telescope must possess an enormous advantage over the old form of reflectors, as the diameter of the new instrument is less than half that at Parsonstown.

We understand that four-inch instruments of this description, in a square mahogany frame, elevated or depressed by a rack movement like that of a reading-desk, may be had in Paris for ten pounds. They are, however, liable to become tarnished, when they need an inexpensive process of repair.

DIALYSIS.

BY W. B. TEGETMEIER.

The application of the researches of Mr. Graham respecting the diffusion of liquids to the purposes of practical chemistry and the arts of civilization, offers one of the most interesting examples of the eventual tendency of even the most abstract scientific investigations to become practical, and so to aid in promoting the comfort and welfare of mankind. It is almost impossible to imagine a subject offering apparently less practical advantages than does the admixture of two liquids with each other, and yet from the rigorous and scientific investigation of the phenomena of their mutual diffusion, and the laws which regulate its operation, has sprung the new method of dialysis, which promises to revolutionize a very large number of chemical operations, and to introduce new methods of maunfacture into the arts that will entirely subvert many existing processes.

The subject is so interesting and so novel in its practical bearings, that it will be desirable to trace its gradual development from an abstract scientific truth to its present useful applications. Mr. T. Graham, the Master of the Mint, has long held a very high position among the most eminent scientific chemists that this country has produced; among other subjects that were diligently investigated by him some years since were the laws which regulate the mutual diffusion of gases. The inquiry as to the rapidity with which liquids of different densities diffused themselves followed almost as a natural sequel to that respecting the gases. Mr. Graham's first experiments on the diffusion of liquids were made by means of what he terms *phial diffusion,* and they were performed as follows:—Solutions of different salts, whose diffusive powers were to be examined, were prepared of equal strength, and phials of exactly the same size and shape were filled with these solutions, and then placed separately under the surface of water contained in much larger vessels, the mouths of the phials being left open. Under these circumstances it was found that a certain proportion of the heavy solution contained in the phial rose in opposition to the attraction of gravitation, and mingled with the water by which the phial was surrounded. In the case of coloured solutions, this diffusion was visible to the eye, and in others it was capable of being proved by analysis. It was found, however, that the solutions of different bodies diffused themselves with very different degrees of velocity. Thus common salt diffused with twice the rapidity of Epsom salts or sugar. These, again, are double as difusive as a solution of gum; and albumen, or white of egg, in its turn, does not possess one-fourth of the diffusive power of gum, nor scarcely more than one-twentieth of that of common salt.

These experiments were varied in different modes, by allowing the diffusion to take place under slightly varying conditions, but the same general results were obtained. The laws deduced from these phenomena are, that crystalline bodies—such as salt, sugar, nitre, etc.—are much more readily diffusible than those that are amorphous, such as gum, gelatine, albumen, solution of starch, or any substances that enter into combination with water in the same manner that they do.

Hence, with reference to this subject, Mr. Graham arranges substances into two groups: those crystalline in character and readily diffusible in water he terms *crystalloids;* the solution of these is always free from gumminess or viscocity, is sapid, possessing, in a higher or lower degree, the power of affecting the nerves of taste. The other class, whose diffusive power is low, he distinguishes as *colloids,* because gelatine or glue (*colle*) may be taken as their type. The solutions of these substances have no disposition to crystallize, and in the solid form they do not possess flat surfaces, such as characterize crystals, but exhibit an irregular roundness of outline. Their solutions are always gummy when concentrated, and what is strikingly remarkable, they are all insipid or wholly tasteless. In the moist condition they are liable to undergo great changes, and solutions of them in a state of purity cannot be preserved unaltered for any length of time.

A solution of a colloid body such as gelatine is found to offer scarcely any impediment to the diffusion of a crystalloid throughout its entire mass. This diffusion will also take place through any soft solid with almost equal rapidity; a very familiar example of this fact is shown in the process of salting meat, in which case the rapidly diffusible crystallizable sea-salt penetrates to the interior of the flesh, which is a combination of different colloid bodies, such as fibrin, albumen, gelatine, etc.

Upon the fact that crystalloid bodies possess the power of diffusing themselves through soft solids depends the operation known as *dialysis*, and the construction of the instrument called the *dialyser*. This consists simply of a tambourine-shaped frame of gutta-percha, over which is tightly stretched a piece of parchment paper, which completes the resemblance to that musical instrument. This parchment paper is quite impervious to water, so that no passage of fluid similar to filtration can take place through it. If the dialyser be floated on the surface of pure water, and a mixed solution of a crystalloid and a colloid body be poured into it, the process termed dialysis immediately commences; all the crystalloid matter passes through the parchment paper into the water, and the colloid matter remains behind in the dialyser. As an instance of its action, let us suppose a mixed solution of sugar and gum to be poured into the dialyser, when the sugar passes through into the water below, and the gum remains behind in a pure form. If a mixture of the beautiful aniline dye known as magenta and some burnt sugar or caramel be employed, the passage of the magenta into the pure water is readily observed, the dark-brown uncrystallizable colloid caramel remaining in the dialyser.

Other facts of great interest have been discovered as the results of these investigations. Thus it is found that by means of dialysis, we may obtain pure in solution many substances hitherto regarded as being perfectly insoluble. Amongst these may be mentioned silica, alumina, Prussian blue, peroxide of iron, stannic acid, and numerous other bodies of a similar character.

For example, if a solution of soluble glass, which is formed by fusing silica with an excess of soda, be taken and acidified with hydrochloric acid, the acid unites with the soda, forming common salt, or chloride of sodium, the silica remaining for some time dissolved in a gelatinous or colloid form, mixed with the solution of the chloride of sodium. If, however, this mixture of gelatinous silica and common salt be placed in the dialyser, the salt rapidly diffuses itself into the water in the outer vessel, and the solution of pure silica in water remains in the dialyser. This solution is found to have a feebly acid reaction on test paper, but not to the taste, as, being a colloid, it cannot pass through the membrane of the tongue so as to affect the nerves of taste. The solution of silica remains for some time perfectly limpid, but eventually sets into a firm jelly. This alteration may be brought about immediately by the presence of several substances, particularly by any earthy carbonate such as chalk. This solution of pure silica possesses remarkable properties; it is absorbed by gelatinous tissues such as the skin of animals, in the same manner as tannin; and like it converts them into a kind of leather, which possesses the remarkable property of not putrefying when kept moist. In the same manner a solution of pure peroxide of iron may be obtained, by first dissolving excess of the hydrated oxide in hydrochloric acid, and then dialysing, when a colloid solution of oxide of iron remains, that is capable of being gelatinized like the silica.

Prussian blue, which is insoluble in pure water, is capable, when recently precipitated, of being dissolved by the aid of gentle heat in a solution of one-sixth of its weight of oxalic acid, when it forms the well-known permanent blue ink. If such a solution be dialysed, the Prussian blue, is in the course of a few days, obtained in a solution in pure water, and may be rendered gelatinous by the addition of sulphate of zinc and several other metallic salts, as the solution of silica is gelatinized by the addition of carbonate of lime.

Such are a few of the many examples of these remarkable phenomena. They are as yet of too recent discovery to have been applied to many practical purposes, but a vast number of applications at once suggest themselves. In cases of the suspected poisoning of articles of food, the poison, if a crystalloid substance like arsenic, can be readily dialysed and obtained in a pure form, however heterogenous may be the mixture in which it is contained.

Dyeing will be greatly facilitated by steeping a fabric in a pure solution of some colloid dye, which will unite with the animal or vegetable fibre as it gelatinizes.

The purification of many drugs, and the separation of different substances in the chemical arts will be rendered much easier than heretofore. In fact there appears scarcely a limit to the application of this principle. Already, as may be seen by the report of Mr. Church's paper, read before the Chemical Society, and reported in our second number, page 156, dialysis has thrown light upon obscure points in geology, such as the formation of flints and other silicious fossils, and it promises equally to benefit physiological research. In fact, humble and inconspicuous as its phenomena may appear at first sight, it is probable that in its influence on science and art, it will greatly surpass any discovery of late years.

PROFESSOR GAMGEE ON UNWHOLESOME FOOD.

Animal poisons still constitute one of the most obscure problems with which chemistry and physiology have to deal. When the Tsetze fly, mentioned by Dr. Livingstone, kills his victim the horse by a wasting disease, how small in quantity must be the morbific matter, which, working we know not how, deranges the vital processes of nutrition and assimilation, and modifies the condition of all the fluids in the great body of the unhappy brute. When a German village suffers from the influence of the peculiar virus developed in badly prepared sausages, or when a dish of mussels torments the admirers of that questionable variety of mulluscous food, our analysts fail in their efforts to separate the peccant matter from the general mass, and our physicians are not more successful in the endeavour to explain the precise mode in which disease or death may supervene. We look to the general law that "a molecule in motion tends to communicate similar motions to other molecules within its influence," as expressing what probably takes place in the class of facts with which we have to deal; and although we may in some cases be able to discriminate between the varying amount of danger attending different stages of putrefaction, we cannot define the precise conditions in which a decaying substance exists, when it is invested with the highest amount of deleterious power. Offensiveness to the sense of smell is no criterion, because sulphuretted hydrogen, and other gases, which make a violently unpleasant appeal to our olfactory nerves, are capable of existing quite independent of any organic poison, or miasma, which may or may not accompany them according to the circumstances of the case.

When we have to deal with a preparation of arsenic, tobacco, opium, or any substance employed in medicine or the arts, we are able to extract a definite material which has little or no tendency to undergo further change, unless it is brought into contact with other bodies under certain conditions. Thus arsenious acid may be preserved unaltered for an indefinite period; the oil of tobacco, or the alkaloids of opium will remain unchanged in our bottles; but when putrefaction assails an organized structure, the morbific power that is evolved, lies in the peculiar motions and changes which influence the ultimate arrangement of particles, and in the operation which they exert upon other substances susceptible of similar alterations in their condition. There is also another consideration that we must bear in mind, and which results from the complex arrangement of atoms in the organic world, or in products which may be derived therefrom. As an illustration of this complexity, let us look at the amylaceous and saccharine group of bodies, starting with cane-sugar, in which we find twelve equivalents of carbon, eleven of hydrogen, and eleven of oxygen. Professor Miller gives a list of eighteen substances of this group, exhibiting various elaborate combinations of a multiplicity of atoms of the three elements. In other groups belonging to the animal series, still greater complexity prevails, and as such substances are built up in a great variety of ways, so there is an equal variety in the modes in which they may be taken to pieces, and a change of properties—sometimes a very striking one—is found at every stage, whether of the ascending or descending scale. Thus we can understand how putrefactions—which are regulated modes of resolving complex bodies into simpler forms—may, under different circumstances, afford very different results.

These reflexions will assist in explaining the great dangers which result from animal food in an unsound condition. If disease has changed the normal state of the particles, we may be sure that the food is made mischievous, although we may not, without experiment, be able to say to what extent any particular individual may suffer from eating it.

Professor Gamgee, in an important article on "Unwholesome Meat and Milk,"* classifies the evils of bad animal food under five heads, as produced by (1) Cadaveric venom and animal poisons of undetermined nature, developed spontaneously in health or disease. (2) Animal poisons well known from their effects in creating specific contagious diseases. (3) Organic poisons, the result of decomposition. (4) Mineral and vegetable poisons absorbed into the systems of animals, and which contaminate their flesh and milk. (5) Parasitic animals and vegetables, inducing disease in men. The learned professor is inclined to "regard as one and the same deleterious principle developed in an infuriated and over-driven ox, a passionate woman, the cadaveric venom of the human subject, or that of human beings or animals suffering many hours in labour, or from parturient fever." We may presume that the juices of an enraged philosopher would be quite as dangerous as those of a passionate woman; and in all these cases there is a connexion between a certain mental or nervous condition, and the poisonous character which the solids or fluids assume. Mr. Gamgee says that he has frequently spoken to butchers on the subject, and received from them an account of how they have suffered from cuts received in dressing over-driven animals. In man, he tell us, the meat of such creatures produces violent dysentery, with febrile excitement.

Where specific malignant disease exists in animals, the

* *Edinburgh Veterinary Review*, May 1862.

danger of using their flesh for food is exceedingly great, and very numerous cases of severe disorder and death are on record, both here and on the Continent. With reference to pleuro-pneumonia, which brings so many beasts prematurely to the shambles, it is satisfactory to learn that although the flesh is deteriorated, it "cannot be called poisonous;" and strange as it may seem, the occurrence of this disorder has furnished the milkmen with a profitable mode of carrying on their trade. Professor Gamgee says, "In the city of Edinburgh there are dairymen who never knew what it was to make money until pleuropneumonia appeared. They originally paid £10 or £15 for a rich-milking Ayrshire, which they kept a twelvemonth or more. They now pay £25 or £30 for a fat crossbred short-horn cow, which they calculate on selling diseased within three months from entering their dairy, and they find the latter system most profitable. . . . They have gone so far as to say, 'We do not want disease out of the country; it is keeping everything high.'"

We need not pursue the subject further, especially as the valuable papers of Dr. Cobbold have exposed the dangers of introducing parasites in company with food. We will, however, observe, on the authority of Professor Gamgee, that *many* persons suffer from tape-worm through indulging in a nasty propensity for eating raw pork. Our benevolence does not prevent our saying, "served them right;" but while such savage feeding may have its appropriate reward, we must enter a strong protest in favour of those who are poisoned against their will.

THE WAYS OF THE ORCHIDS.*

Orchids are universal favourites: the children love to pick them in the meadows, and they occupy the place of honour in the costly conservatory. They combine beauty with grotesqueness, strangeness with elegance, to an extent not paralleled by any other tribe of plants; and now that they have secured an eloquent and erudite interpreter in the person of Mr. Charles Darwin, they make their appearance as Floral Professors, delivering to us the profoundest lectures on methods of adaptation, theories of evolution, and other wondrous mysteries of organization and life. Mr. Darwin is one of the few writers so possessed with his subject as to be incapable of circumlocution. He speaks out of the fulness of his heart and brain, and

* *On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the Good Effects of Intercrossing*, by Charles Darwin, M.A., F.R.S., etc. London: John Murray. 1862.

crowds his pages with rich stores of clearly elucidated, carefully arranged, and for the most part recondite facts. The Origin of Species is always present to his mind: but whatever may be our opinion of the great theory which will hereafter be associated with his name, we cannot lay down his volume without acknowledging that he helps us to know, and teaches us to think. Philosophers have often invented hypotheses, and promulgated doctrines, which tended to darken counsel and limit enquiry, which acted as a poisonous narcotic upon the intellect, and placed a pretended explanation, like a barrier, across the path of truth. In Mr. Darwin's speculations we discover none of this evil tendency. They form no opiate to lull us into repose, but suggest endless fields of investigation, and spur us on to a vigorous collection and examination of facts. In this way they are good. They may be refuted; they may be swallowed up in an ampler exposition of ultimate laws; but whatever their fate, they will have assisted to train fresh bands of keen observers, and they will have scattered far and wide the seeds of scientific thought.

The stories of the orchids belong to the "fairy tales of science." In the structure of these eccentric plants we meet with startling contrivances elaborately combined to produce unexpected results. In the Bee Ophrys alone has Mr. Darwin discovered "perfectly efficient contrivances for self-fertilization," and even then combined with "manifest adaptations" for the occasional transport of pollen from one flower to another. As a rule, these curious plants are dependent for their perpetuation upon humble members of the animal world, and their structure exhibits a combination of peculiar difficulties with still more peculiar facilities, for the accomplishment of the final act of vegetable existence, the production of a fertile seed. For a detailed exposition of these arrangements we must refer to Mr. Darwin's book, but we will endeavour to explain the leading facts of orchid history, and just glance at their value in a scientific point of view. In ordinary flowers, the stamens, supporting the pollen-bearing anthers, surround one or more organs of a different shape, called the pistils. When the right time comes the pollen grains fall upon the pistils, and send forth slender tubes, which reach the ovaries and fertilize the germs which they contain. In "all common orchids there is only one stamen, and this is confluent with the pistil, forming the column." The anther is divided into two cells, which often gives the appearance of their being two anthers instead of one. In common plants the pollen, when ripe, is detached with great facility as a fine powder; in orchids the grains are coherent, tied together in masses by peculiar threads, and "often supported by a very curious appendage called the caudicle" or little tail.

The pollen masses with their appendages are collectively called *Pollinia,* a word which we shall have occasion to use. The orchids are botanically considered to have "three united pistils or female organs." The two lower stigmas* are often confluent, so as to appear as one. The upper pistil exists in a very modified and curious condition, having its stigma converted into the *Rostellum,* of which it is very difficult to give an intelligible description without the aid of a drawing, which time will not allow us to prepare. Mr. Darwin observes: "the rostellum is a nearly spherical, somewhat pointed projection, overhanging the two almost confluent stigmas." It either includes, or is formed of viscid matter, and has two discs to which the pollen masses are attached by means of their caudicles. These organs, as we shall see, have a most important work to perform, and they may be discovered in any common orchid, by removing the sepals, or leaves of the calyx, and the petals or flower leaves, except the lowest, which has the most singular shape, and is called the *labellum,* or lower lip. This lip forms a convenient landing-place for insects, "*it secretes nectar,* in order to attract them, and is often produced into a long spur-like nectary." If an insect alights on the lip, and tries to reach the nectary with his proboscis, it finds the rostellum in the way, and in pushing by it detaches one or more of the viscid discs to which the pollen masses are attached. Mr. Darwin succeeded in imitating this action by introducing a pointed pencil, and on drawing it back the disc was firmly attached. While these discs are in their place a liquid keeps their cement moist, but when they are removed it sets in a few minutes, and causes the pollen masses to be firmly fixed to the intruding body. This is essential to the process of fertilization, for if it slipped on one side or the other it would not come into contact with the right portion of the pistil of the flower to which the insect paid its next visit. Nor would it succeed if it preserved the upright attitude in which the adhesion took place. Let the reader hold a finger upright, and suppose the pollen mass attached to its tip, let him then curve the finger horizontally—that is the position which the anther must attain. This change is effected in about half a minute, by the contraction of the adhesive disc. Thus, while an insect flies from one flower to another, this highly curious apparatus arranges itself exactly in the right direction for its work. Now comes another interesting adaptation, noticed long ago by Robert Brown. The stigma or pistil head is very sticky, but not so tenacious as to pull off all the pollen after a single contact. Its resistance to an insect's return snaps some of the threads by which the

* The *stigma* is the fleshy extremity of the pistil, and may be seated upon the ovary, or elevated upon a stalk—the *style.*

pollen grains are fastened, but it leaves others for another flower to catch in turn. This description applies, especially to *O. maculata,* and similar flowers, but it affords the key to the process which takes place throughout the tribe. In *O. pyramidalis* the viscid disc is single and saddle-shaped, and the labellum, or lip leaf, is furnished with two ridges "expanding outwards like the mouth of a decoy," and which will guide any fine flexible body to the trap which the plant contains. The proboscis of a moth, or a bristle, in an artificial experiment, finds itself saddled with the adhesive disc, and Mr. Darwin gives a drawing of the head of an *Acantia luctuosa,* to whose proboscis seven pairs of pollinia are attached.

There is a highly interesting question of orchid manners not quite solved, although an explanation suggested by Darwin appears likely to prove true. In many orchids no secreted nectar has been discovered, and it was supposed that they were the Jeremy Diddlers of the vegetable world, existing by an "organized system of deception." Mr. Darwin chivalrously endeavours to rescue their morality from so odious a charge, which likewise impugns the sagacity of countless generations of moths, and, after sundry experiments, he arrived at the conclusion that the insects have to bore through a delicate membrane to arrive at the treasured sweets, and that this delay gives the adhesive matter of the discs time to set. In five species he found the honied bait within the nectaries, and in them the cement solidified so quickly that the plant had no need to detain its useful guest.

In the genus *Ophrys,* important varieties of structure are met with, and the motive of the insects for visiting the flowers is not clear, but, nevertheless, their curious intervention is proved to take place. In another great tribe of British orchids, the *Neotteæ,* a new set of difficulties, and special arrangements to overcome them, appear. Thus, in the Marsh Epispactis an insect could enter without touching the rostellum, but when once inside the labellum would spring up, and he would have to back out, and place himself in the right positon for the rostellum to fit him with a membranous cap, bearing the pollen grains. In the Ladies' Tresses, *spiranthes autumnalis,* the rostellum is "a long, thin, flat projection," bearing in its middle what Mr. Darwin terms the "boat-formed disc." The touch of an insect's proboscis, the vapour of chloroform, or a natural change in the condition of the plant, splits a fine membrane, and sets the apparatus free.

In three genera of British orchids, the *Malaxis, Listera,* and *Neottea,* "no portion of the exterior membranous surface of the rostellum is permanently attached to the pollinia." The first we shall pass over, but the second introduces us to new wonders. The *Listera ovata*, or "Tway-blade," derives its English and most expressive name, from the singular cleft form of the labellum. In this tribe "the pollen grains are attached together in the usual manner by a few elastic threads; but the threads are weak, and large masses of pollen can be easily broken off." The rostellum, according to Dr. Hooker, is internally divided into a series of little chambers (*loculi*) which contain and shoot out drops of viscid matter. It is, in fact, a vegetable spring-gun, and the moment it is touched, off goes the sticky shot, carrying with it the pollen it catches in its way. "As the pointed tips of the loose pollinia," says Dr. Darwin, "lie on the crest of the rostellum, they are always caught by the exploded drop. I have never once seen this fail. So rapid is the explosion, and so viscid the fluid, that it is difficult to touch the rostellum with a needle quickly enough not to catch the pollinia already attached to the partially hardened drop." In two or three seconds the cement hardens, and the pollen mass is securely fixed to the object which this vegetable artillery has assailed.

We have thus given a very faint idea of the ways of the British orchids. Of their splendid foreign relatives we must not now speak, nor anticipate the delight which the student will experience in reading Mr. Darwin's book. Such themes remind us of the beautiful picture given by Longfellow, in his *Fiftieth Birthday of Agassiz*, where, reverting to the infancy of the great philosopher, he makes "Nature, the old nurse," take the child upon her knee—

Saying: "Here is a story-book
  Thy Father hath written for thee.

"Come wander with me, she said,
  Into regions yet untrod,
And read what is still unread
  In the manuscript of God.

"And he wandered away and away,
  With Nature, the dear old nurse,
Who sang to him night and day
  The rhymes of the Universe.

"And whenever the way seemed long,
  Or his heart began to fail,
She would sing a more wonderful song,
  Or tell a more wonderful tale."

These "wondrous tales" become more wonderful when science endeavours to explain the enigmas which they present. Most botanists would agree with Darwin in tracing the relation which the various parts of the orchids bear to those of ordinary plants. The science of homology, as he tells us, "clears away all mist from such terms as the scheme of nature, ideal types, archetypal patterns, or ideas, etc. The naturalist, thus guided, sees that all homologous parts or organs, however much diversified, are modifications of one and the same ancestral organ: in tracing existing gradations he gains a clue in tracing, as far as that is possible, the probable course of a modification during a long line of generations. He may feel assured that, whether he follows embryological development, or searches for the merest rudiments, or traces gradations between the most different beings, he is pursuing the same object by different routes, and is tending towards the knowledge of the actual progenitor of the group as it once grew and lived." Following Robert Brown, Mr. Darwin resolves the orchid into five simple parts, three sepals and two petals, and two compounded parts, the column and the labellum. The latter he considers as "formed of one petal and two petaloid stamens of the outer whorl, likewise completely confluent." Those who deny the modification for which Darwin contends would explain the agreements and correspondences which he traces, by a theory of "types;" but he asks "Can we, in truth, feel satisfied by saying that each orchid was created exactly as we now see it, on a certain ideal type; that the omnipotent Creator, having fixed on one plan for the whole order, did not please to depart from his plan; that He, therefore, made the same organ to perform divers functions—often of trifling importance compared with their proper functions—converted other organs into mere purposeless rudiments, and arranged all as if they had to stand separate, and then made them cohere? It is not a more simple and intelligible view that all orchids owe what they have in common to descent from some monocotyledonous plant, which, like so many other plants of the same division, possessed fifteen organs arranged alternately, three within three in five whorls, and that the now wonderfully changed structure of the flower is due to a long course of slow modifications—each modification having preserved that which was useful to each plant during the incessant changes to which the organic and inorganic world has been exposed."

Thus speaks Mr. Darwin in defence of his ingenious scheme, upon which we feel no call to pronounce sentence, because the means of final decision do not as yet exist. To prove inductively what really was the order of the universe in any great group of facts, requires that we should have a complete series of the facts before us, which in this case we have not. To prove deductively the correctness of any hypothesis, demands the previous establishment of the general laws from which the particular phenomena spring, and this has not yet been done. We are entitled to say to Mr. Darwin: we suspend decision with more or less doubt against you, because, as you know, your proof is incomplete; but we are not justified in demanding the production of a particular kind of evidence, unless we can show that it exists and might be obtained. We may, for example, logically say, "If your theory be true, connecting links and transition forms must have existed during the lapse of time, and until you can prove that they did exist, we are not convinced." But if we ask for so many connecting links within certain limits of time or space, we are bound to show the probability of their having existed within those limits if ever they existed at all.

Fortunately, it is not necessary that we should make positive affirmations concerning things of which we know little, or nothing at all; and if, speaking physically, science enlarges the sphere of action assigned to secondary causes, our conception of the First Cause becomes grander in proportion to the precision and complexity of the work which we see performed. If the orchids be only modified descendants of a more ordinary kind of plant, what a wonderful picture of powers, forces, and relations is presented to our view. How inconceivable the Wisdom which established and guides the whole, and which secured the occurrence of the most skilful and amazing changes of parts and organs, precisely at the right time. If a little flower moved a great poet to "thoughts too deep for tears," surely the "Ways of the Orchids," may excite a reverential contemplation of Nature, far removed from the arrogant dogmatism which prejudice and ignorance so readily beget.

THE HAIRLESS MEN OF AUSTRALIA.

The following curious account of the Bald men of the Balonne is taken from the *Sydney Empire*, Feb. 19th, 1862, and as it suggests very curious inquiries, both ethnological and physiological, it is to be hoped that further information may be obtained.

"It is now some few years since a report first obtained currency, that, far in the Western interior, beyond the Balonne River, a tribe of aboriginal natives existed who exhibited remarkable physical distinctions from those with whom explorers and other colonists have so long been familiar. It was said that the natives in question were entirely destitute of hair, even on the head, which was as bald as a billiard ball. Other remarkable peculiarities were also mentioned, but the absence of ocular proof led most people to doubt them, and it was pretty generally believed that either the blacks alluded to were merely suffering from some cutaneous disorder, or the tale was one of those bush 'yarns' which outlying settlers think it no harm to hoax the townsman withal. Yesterday, however, we had an opportunity of ascertaining that all the statements were perfectly true. Mr. M'Kay, a gentleman just arrived from the Balonne River by way of Rockampton, called at our office with one of these natives. He is a young man, according to Mr. M'Kay's belief, only about sixteen or seventeen years of age, but certainly looking much older. His head is entirely destitute of hair, nor is there any trace of hirsute honours on his body. There was a black, ingrained appearance on the scalp as if the roots of hair remained, but Mr. M'Kay states that this is merely the traces of a dirty cloth which he was in the habit of wearing on his head. There needed not, however, this remarkable destitution of hair to show that the individual before us was the type of a race utterly differing in physical peculiarities from the ordinary aboriginals of Australia. The whole contour of the face, form of the head, expression, colour of skin, and listless, almost sullen attitude, at once suggested the Mongolian. His physical development is far inferior to that of the healthy aboriginal found in other parts of Australia. The large, rapid eye, thick lips, broadly-spread nose, and deep brown skin were all absent. The peculiarity of the face was most evidently Chinese, and the eye confirmed this impression. The skin of this interesting stranger is precisely of that deep yellow-brown shade which might be expected in a descendant from Chinese and aboriginal Australian parents. The party to whom he belonged, for there is no clear reason for calling it a tribe, appeared to inhabit the country to the north-westward of the Upper Warrego. Mr. M'Kay had not seen more than six or seven of them at various times, one, at least, of whom was a woman, and one man was much taller and more strongly proportioned than the specimen brought to our office. The whole circumstances of the case render it extremely probable that these remarkable people are the descendants of Chinese fisherman, who having, years ago, landed or been cast away in the Gulf of Carpentaria, or on the Australian coast of the Arafura Sea, have remained with the Australian aborigines, and transmitted the physical peculiarities of their race to their descendants."

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ROYAL GEOGRAPHICAL SOCIETY.

Ascent of the Yang-tse-kiang.—Dr. Barton's paper gave an account of a journey made up this river. It was intended that the exploration should continue as far as possible up the Yang-tse, and should then traverse Thibet, cross the Himalaya range, and descend into the plains of Hindostan. The disturbed state of the country, however, rendered the journey impossible beyond the town of Ping-Shan. This town is situated on the Yang-tse-kiang, in the province of Sze-chuen (hitherto known to Europeans only by the reports of the Jesuit missionaries), and is 1800 miles above Shanghai. Up to this expedition, only 900 miles of the river have been known.

The paper gave a most interesting account of the river valley, and described the mountainous country through which the river flows in its upper and middle course to 360 miles above Han-kow. It was shown how, by means of the tributaries of this river, water communication is kept up between the ports at the mouth, and the north-west provinces, Canton and Pekin. With the last mentioned place, intercourse is carried on by means of the imperial canal, which crosses the river at Ching-kiang-foo.

The alluvial soil of the river-valley above the Tong-ting lake, produces wheat, beans, and millet in abundance. In its higher course the river passes through deep gorges, where the bed is narrow and the water very deep. In one of these, the E-chang gorge, the cliffs rise abruptly above the river to a height of 500 feet. The mountains are covered with oak, fir, and cedar trees. The hill sides are subject to terrace cultivation, and for a long distance, about 200 miles, the principal objects of culture appeared to be the poppy and tobacco. The sands of the river are washed for gold, and coal and iron are worked to a considerable extent.

The lower part of the Yang-tse-kiang was in the hands of the Taepings, and everywhere evidences were seen of the desolation and utter ruin that they had brought along with them. The city of Nankin, which had a population of 600,000, was reduced to about 2000 inhabitants. The town was in ruins, the far-famed Porcelain Tower a heap of fragments, and the gardens and fields overgrown with weeds.

Farther up the river, where the people were undisturbed, there was a dense population, and all the evidences of Chinese industry. But on reaching the province of Sze-chuen, the travellers found another insurrection—totally unconnected with that of the Tae-pings—which rendered it impossible for them to proceed. Almost at the farthest point reached, the party were met by some native Christians, who welcomed them, and took them to their service in a little chapel, meanly furnished. For this the excuse was made that the rebels of Sze-chuen were unfavourable to the Christians.

The results of the journey may be summed up as follows: 1800 miles of the river had been ascended, that is, 900 miles farther than any European, except the Jesuit missionaries, had been; coal in very large quantity had been found, enough to supply all steamers that should be engaged in the navigation of the river; the river had been found to be navigable for small steamers up to the point reached by the exploring party; the whole of the valley had been found fertile, producing corn, tea, silk, and opium; and lastly, it had been found that the province of Yunnan forms the right bank of the river, and is not, as it has been represented on older maps, about 100 miles to the south of it.

The imperial rule is by no means general in China. In the east there is the rebellion of the Taepings; in the south there are insurrections of the Mussulman population; there is the rebellion in Sze-chuen, and there are others in other provinces.

Consul Parkes said that the Taeping rebellion broke out in 1849 in the province of Kwang-si. Its effect had been to desolate all the flourishing and populous provinces which had been overrun. The rebels have no flotilla, and cannot hinder the navigation of the Yang-tse-kiang. As a proof of the probable value of the future commerce of that river, it was stated that from April to December of last year, 152 foreign vessels passed up from Shanghai to Hankow, and 170 junks in foreign employ; and it was estimated that trade to the extent of £10,000,000 sterling would be done there during the present year. The probable causes of such wide-spread insurrections are the pressure of population on production, the absence of poor laws, and the inefficiency of the police. The government tried to rule by moral suasion, but the people were not obedient. The Chinese government is a stationary despotism, with no vigour, and has been for 1200 years in entire isolation from the rest of the world. Had it not been for the Tartar invasion 220 years ago, matters would have been worse. Now, the hope is that intercourse with western nations will give life.

The Chinese were acquainted with the use of opium long before the British took it to them, and they only prefer what is imported, because it is better than what is home-grown.

The Jesuit missionaries have been very successful; but when they were first established in China, in the sixteenth century, they were high in court favour, which they did not lose till they concerned themselves in political intrigues in 1720. At present it is reckoned that there are 400,000 Roman catholics, 12 bishops, 80 missionaries, and 90 native priests. The missions cost 59,000 dollars a-year.

Up to the present time Protestant missionaries have laboured under the disadvantage of being confined to districts within thirty or forty miles of the ports. Now, however, they will be able to do more; and Dr. Lockhart's medical mission at Pekin has been already most successful.

The Fiji Islands.—These islands are at present peculiarly interesting from the fact that the chiefs wish to cede them to the British, and that the question of their acceptance is now under consideration. Dr. Bensusan's paper gave an account of the group. There are two large and many small islands, 180 in all. They are of volcanic, or of coral formation. The larger islands are hilly, the heights rising from 2000 to 4000 feet. The chief exports are cocoa-nut oil, tripang, sent in large quantities to China, tortoise, and pearl shell. The islands are well adapted to the growth of cotton, and the produce of this plant has been as much as 800 lbs. to the acre, which is more than the average of South Carolina and Georgia. The harbours are extensive and numerous, and afford good anchorage. The Fiji (or Viti Islands as they are more correctly called) would afford return cargoes for ships coming home from Australia.

Vancouver's Island and British Columbia.—Captain Mayne, R.N., read a paper on a journey across Vancouver island, from the New Saw Mill settlement, established at the head of the Alberni Canal to Nanaimo, the coal depôt of the island. During this journey many difficulties were encountered. At one place snow-covered mountains obstructed the passage, but on the whole the country was found good; and a road between these settlements would be highly advantageous to the colony. It was also stated that along the courses of several rivers of the island there are large extents of land fit for ploughing without needing previous clearing. A paper on British Columbia, by Mr. Kelly, was read. It gave a detailed account of the mineral wealth, the extensive gold-fields, splendid forests, and fertile land of this colony. The Fraser River is open to vessels drawing from eighteen to twenty feet at all time of tides; and after the channels are buoyed and lighthouses erected, it will be navigable as far up as Yale. The great obstacle at present to the development of the wealth of British Columbia is the difficulty of getting emigrants to it from England. Mr. Kelly proposed to make the trade of this colony flow through British territory, *viâ* the Vermilion Pass, Pembina, and the Grand Trunk Canadian Railway. The Vermilion Pass will present little difficulty in road-making, the grade being only 1 in 135. New Westminster might be reached from Portland (Maine) in twenty-five days. Captain Mayne and Dr. Ray both said that, at present, the route by the Rocky Mountains was almost impracticable. The passes through the mountains are much encumbered with wood; and in crossing the prairie ground between the Red River settlement and the Rocky Mountains, game and buffalo are not abundant, and, indeed, not always to be found. In speaking of the richness of the Cariboo diggings, Captain Mayne said that he had been told of three men, who, after one day's work, took out nearly 195 ounces of gold in nuggets of large size.

ZOOLOGICAL SOCIETY.—*May* 13.

Gigantic Pair of Antlers.—Mr. Louis Fraser exhibited a pair of enormous antlers, the property of Lord Powerscourt, who forwarded the following note respecting them:—"This pair of horns was bought for me by the Hon. Julian Fane, at Vienna, about six weeks ago. The history he got with them was that they belonged to a person who lived near Kronstsdt, in Transylvania, and they were sold out of his Schloss (Palace) at his death, and bought by a travelling merchant, who again sold them to a burgher of Vienna, from whom Julian Fane bought them for me.—"Powerscourt." The weight of this pair of antlers is 74lbs. The height in a direct line four feet three inches, but following the curve of the antler, five feet eight inches, the greatest width being five feet five inches, and the number of points on which a cap can be hung, the usual test as to what constitutes a point, is forty-five. These appear to be the largest horns on record. The antlers shed by the Wapite deer in the Zoological Society's garden rarely reach half the weight above stated.

MICROSCOPICAL SOCIETY, *May* 14*th.*

Messrs. Smith, Beck, and Beck, exhibited an instrument called the "Museum Microscope." It consists of a large cylinder of brass, resting on a cast-iron frame, and surmounted by a microscope body. The great cylinder contains a series of small cylinders, each carrying numerous slides, exceeding five hundred in all. One slide cylinder after another is brought under the microscope; and by turning a milled head the objects are presented in succession—the name of each being conspicuously shown. The microscope is furnished with three powers, any one of which may be brought into action by a simple mechanism. The instrument, which is only adapted for transparent objects, presents great advantages for public exhibitions, as its movements are easily understood, and there is little chance of unskilful observers doing any harm to the objects or the machinery.

Mr. Webb presented to the Society a slide containing the first chapter of the Gospel of St. John, written by himself with a machine of his own invention, in the 500th of an inch. Mr. Ross presented a fine bust of his late father.

Dr. Leary read a paper on some new flukes. Mr. Smith described his method of taking micro-stereographic drawings; and a paper was communicated by Dr. Maddox on some living organisms found in a nitrate of silver bath used for photographic purposes. They appeared to be mites, bearing a strong resemblance to the *Acarus Crossii.* From the circumstances detailed their appearance could not be accounted for, nor was it at all clear what they could find to live upon. The nitrate of silver was in the proportion of forty grains to the ounce; a sheet of paper was usually laid over the vessel and the cover pressed down.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

The duties of the writer of the following short paragraphs necessitates his careful examination of almost every article in the raw material and scientific classes at the International Exhibition. He proposes to utilize the advantages he possesses by bringing before the readers of the Intellectual Observer a series of notes on those objects of scientific interest that may be most worthy of notice, or that from the magnitude of the collection might be liable to escape observation.

The present series is confined to the first four classes, those including what are termed raw materials. All the objects alluded to are contained in the eastern annexe or its approaches.

Aluminium Bronze.—The applications of aluminium and aluminium bronze to the purposes of ornamental art as well as to the manufacture of objects of utility is strikingly exemplified in the magnificent series of articles exhibited by Bell Brothers (18). One of the strangest properties of this singular alloy of copper and aluminium is that after being forged it is annealed by precisely the reverse treatment to which iron is subjected, as it is heated to dull redness and then plunged into cold water.

British Gold and Silver.—The value of the precious metals that may be obtained from British sources is but beginning to be appreciated. Cox of Derby (71), shows a mass of silver weighing nearly 2000 ounces, obtained from lead ores, and the Vigra and Clogau Mining Company (383), exhibit ingots of gold of 123 ounces, showing the weekly yield obtained from these mines.

Tensile Strength of Iron.—At the end of the case of iron manufactures from the Round Oak Iron Works of Lord Dudley (332), is a piece of cold rolled plate, having a sectional area of one square inch, that was tested at the government dockyards, and was found to support the enormous strain of upwards of fifty tons before it broke. This inch bar of iron would have supported a greater weight than that of 700 persons.

Sheet of Metal One Mile in Length.—A sheet, or shaving of cut lead, one mile in length, and having an area of nearly 800 square feet, is exhibited by Wilmhurst's Patent Foil Company (410). This is, perhaps, the longest sheet of metal ever manufactured.

Rail One Hundred and Seventeen Feet in Length.—In the open court adjoining the eastern annexe, may be seen a rail 117 feet long, rolled by the Butterley Iron Company in one length.

Gigantic Masses of Rolled and Forged Iron.—Among the stupendous masses of iron exhibited may be mentioned the forged double crank shaft, weighing twenty-five tons, and designed for the engines of one of the new armour-plated vessels now building. Forged armour-plates are also shown more than six feet in width, that can be manufactured of any thickness and almost of any length required, and a rolled boiler plate 112 square feet is exhibited.

Amorphous Phosphorus and its Practical Applications.—The discovery that phosphorus is capable of existing in a condition in which it is no longer spontaneously inflammable but capable of being exposed to the air without change, or danger of ignition, is turned to account by Bryant and May (488), who exhibit matches which cannot be ignited by friction anywhere except on the prepared surface of the box. The secret of the contrivance being that the chlorate of potash compound, tipping the match, is destitute of phosphorus, which in the amorphous form, is placed on the sand paper, hence these matches are perfectly safe from accidental ignition, and moreover are not poisonous.

Pseudomorphous Crystals.—Mineralogists are acquainted with many substances which crystallize in forms that do not belong to them, or are pseudomorphous ; the formation of these crystals is well illustrated by the soda manufactures shown in the building. Gigantic and beautiful crystals of bicarbonate of soda are exhibited having the exact form of the common carbonate when crystallized with ten equivalents of water. They are produced by exposing the latter to the action of carbonic acid, which is absorbed, and changes the chemical constitution of the substance without affecting its physical form, hence results one salt having the form proper to another.

Thallium, the last New Element.—The last new element which has been recently discovered, in extremely minute quantity, in some ores of sulphur, by the aid of the spectroscope and process of spectrum analysis, is shown by its discoverer, Mr. Crookes; several of its compounds are also exhibited. Thallium gives a single, bright green line in the prismatic spectrum, hence its name from Thallus, a green branch.

Utilization of Mixed Cotton and Woollen Rags.—A very ingenious method of utilizing a waste product has been devised by Mr. Ward, and is illustrated by his specimens in case 618. The rags of mixed cotton and wool such as the ordinary *Orleans* and *barège* and many fancy Norwich goods, are submitted to the action of superheated steam, which is of such a temperature as completely to char and destroy the animal fibres without effecting the destruction of the vegetable tissue, which can consequently be employed in paper-making, the charred remains of the wool being useful as manure.

Aniline and Coal Tar Dyes.—The production of the valuable dyes derived from coal tar is illustrated by a beautiful series of specimens showing the various stages of the manufacture, and a block of solid aniline purple, or mauve, about one thousand pounds in value, containing sufficient amount of colouring material to dye hundreds of miles of silks (581). These beautiful specimens are exhibited by Mr. Perkins, the discoverer of the colours. Splendid specimens of crystallized rose aniline or magenta are shown by Messrs. Simpson and Nicholson (600). This colour, which in the solid form is of a lustrous metallic green, resembling the wing-cases of tropical beetles, is crystallized around wires, arranged into large crowns.

New Process for Preserving Uncooked Meat.—Specimens illustrative of Jones's process of preserving of raw meat, as joints of beef, fowls, salmon, etc., are exhibited (795). The plan adopted is to extract the atmospheric air by means of a vacuum, and then to admit nitrogen or azote. This permeates the substance of the flesh, and prevents the putrefactive changes which would otherwise ensue.

Multiple Telegraph Cable.—The Gutta Percha Company exhibit a specimen showing the perfection of their mechanism and workmanship. It consists of a cable half an inch in diameter, which contains forty-nine telegraphic wires, each perfectly and separately insulated, and capable of conveying its own electric current without influencing, or being influenced by, the currents passing along the other wires.

Adhesive Strength of Glue.—The tensile strength of the iron exhibited has been already noticed; one of the makers of glue shows a wooden bar having the same sectional area of one square inch; when sawn across and united by glue, the joint resisted a tensile strain of 504 lbs. before breaking, a remarkable contrast to the 50 tons supported by the iron.

NOTES AND MEMORANDA.

The Companion of Sirius.—It appears that Dr. Peters has reconsidered this subject, and written to *Cosmos* to the effect that the newly-discovered star may be that body whose existence was first conjectured by Bessel. Mr. Bond has published in *Silliman's Journal* some additional particulars, and he states that Mr. Safford having concluded his calculations, agrees with Dr. Peters in assigning fifty years as the period of the revolution of Sirius. M. Chacornac estimates the light of the companion star at one ten thousandth of that emitted by Sirius, and M. Le Verrier calculates its bulk at a third or a fourth of that of the larger orb.

New Polariscope Object.—Mr. Marston of Ludlow recommends a double oxalate of chromium and potash. He dissolves in hot water one part bichromate of potash, two binoxalate of potash, and two oxalic acid. A specimen he has been kind enough to forward to us exhibits splendid effects, which are improved by the selenite stage. He recommends viewing the crystals with a half-inch. We succeeded well with a two-thirds.

Mr. Hind's Nebula Found.—Messrs. Winnecke and Otto Struve saw this curious variable body through the great instrument at Pultowa on the 22nd of March. Its brilliancy is now little inferior to that of the comet of 1861, which remains visible. On the 29th of last December the nebula was likewise seen at Pultowa.

Insect Destroyer.—A weak solution of chloride of lime is said to preserve plants from insects if sprinkled over them. Flies are also got rid of in stables and other places by scattering chloride of lime on a plank. If the same substance is mixed with half its weight of some fatty matter, and a narrow band of the composition smeared round a tree, insects will not pass it.

The Silkworm Disease.—The *Archives des Sciences* gives an account of an important discovery of the nature of this obscure and mischievous complaint, which, without changing the external appearance of the silkworms, destroys their value by attacking their internal organization, and especially causing an atrophy of the apparatus which secretes the silk. The microscope disclosed the supposed morbid element in the shape of small bodies which M. Cornalia designated oscillating corpuscles, and to which M. Guérin gave the inappropriate name of "hematozoids." M. Lebert considered them unicellular plants, and Professor Chavannes called them "crystals." M. Cornalia announced, in confirmation of his view, that when worms which died of the disease were exposed to moisture their bodies were covered with a mould whose spores had a remarkable resemblance to the "oscillating corpuscules." But whatever be the real nature of these bodies, their presence is a certain sign of the existence of the disease, and M. Vittadini has made the curious discovery of their appearance in the egg. He tells us that, as soon as the development of the embryo commences, its tissues in diseased specimens are filled with the oscillating corpuscules. He has also ascertained that the diseased eggs are developed more slowly than healthy ones, their complete evolution requiring four or five days, and even more, instead of two or three. He, therefore, recommends the destruction of all the backward progeny; and, confirming the observations of Marshal Vaillant, M. Quatrefages, and others, he advises the culture of the worms in the open air. M. Chavannes states that if the eggs are developed in the open air upon trees furnished with a metallic trellis, upon which the process may take place, a complete regeneration of the race can be readily effected.

Photographic Hints.—M. Civiale has obtained fine impressions by employing a mixture of one part of wax and four of paraffine. Major Webster Gordon employs equal parts of the iodide and bromide of cadmium in the preparation of collodion for instantaneous photographs, which he developes by means of pyrogallic acid. M. Reynaud remarks, that when great sensitiveness is required, the collodion should contain but a very small quantity of free iodine. He also states that bromide of silver is, in comparison with the iodide, more sensitive to the least refrangible colours, red, yellow, etc. Bromides of ammonium and cadmium possess this property in a still higher degree. Bromide of potassium communicates to collodion a delicacy similar to that produced by its iodide. For moist collodion he employs three or four grammes of the bromide to twelve grammes of the iodide, and one *litre* of normal collodion.

New Chronograph.—*Cosmos* gives a brief account of an instrument invented by Captain Schultz which is able to measure the duration of phenomena which only last the five hundred thousandth of a second. It consists, first, of a drum, about a metre in circumference, having its surface silvered and covered with lampblack before the experiment begins. A double motion gives this drum three turns in a second. Its next portion is a "diapason" giving five hundred vibrations in a second; its third portion is a point fixed on the "diapason," which traces a sinuous curve on the drum; and lastly, it has a small electrical apparatus which marks by an induction spark, the beginning and the end of the phenomenon, which is investigated. "That which characterizes this instrument is the great length of the mark on the cylinder which represents an infinitesimal duration;" and it is affirmed that it recently measured the time occupied by a projectile fired from a rifle in traversing a few centimetres. Each centimetre is equal to 0·3937 of an inch.

Diatom Cysts.—Madame Lüders states the cysts enveloping certain specimens of *Coconema cistula*, *Gomphonema*, etc., are not, as has been supposed, vesicles formed by the diatoms, but Amœbæ by whom they were assailed. She found that an Amœba occupied one or two hours in surrounding a group of Synedra. This lady is also of opinion that observers have taken for spores of diatoms small infusoria which are often developed in their interior.—*Mohl Botanische Zeitung*, *Bibliothèque Universel*, Feb. 1862.

Leeches.—Dr. Ebrard observes that an adult leech gorged with blood requires nearly eighteen months in a state of captivity for the process of digestion. Young and free specimens accomplish the same task in six weeks or two months.

Peculiar Greens.—In a recent paper on dyeing, read by Dr. Crace Calvert, at the Society of Arts, he called attention to the curious fact that the greens produced by dyeing silks first with Prussian blue and then in an acidulated bath of carboazotic or picric acid, appeared green in artificial light, while the greens obtained with indigo and picric acid turned blue under the same conditions. He also stated that the Chinese vegetable green Lokao, which M. Charwin has succeeded in obtaining from the European seed *Rhamnus Catharticus,* is the only substance he was acquainted with capable with suitable reagents of producing the seven colours of the spectrum.

Improvement in Kelp Manufactures.—Mr. Stanford dries the seaweed he operates upon, and presses it into cakes, which he carbonizes at a low red heat in iron retorts, collecting the volatile products, among which he finds ammonia, wood spirit, and paraffine oil. By this process a considerable loss of iodine is prevented, and a larger quantity of useful products obtained. He hopes that the masses of weed thrown up on the south coast of England will in future be utilized, especially as the deep water weeds from the Atlantic are found to be the most valuable.

Development of Coral.—In No. II. *Intellectual Observer*, p. 167, we gave a short account of the investigations of M. de Lacaze Duthiers on the growth of coral; we extract the following additional particulars from *Comptes Rendus*, 3rd March, 1862. The embryos, which are vermiform, swim with their tails foremost and mouths backwards, and after continually bumping against various objects, they fix themselves, and give up a locomotive life. They are most disposed to come into contact with other bodies when their elongation ceases, and they begin to lose the worm-like form. In their process of growth they become shorter and broader, and then the slender extremity which carries the mouth recedes in the centre of a circular disk or pad, from which the rudiments of eight tentacles speedily grow. In addition to multiplication by ova, the coral polyps increase by budding, and thus build up their well-known reefs. The living coral is composed of an axis, or central solid portion, and the external soft polypiferous layer, which M. Duthiers tells us owes its colour to the multitude of spicules which it contains. In tracing their growth it appears that, after exchanging the elongated worm shape for the disk form, the young coral animals pass quickly from white to rose colour, and then to a lively red, as the calcareous corpuscules are formed. They have as yet no axis, and the solid portion is represented entirely by the corpuscules. The little creatures are elegant objects with their expanded tentacles, although exceedingly minute—a quarter or half a millimetre in diameter. They are at first single, but bud freely, and as each bud repeats the same process, a large compound family is soon produced. At first the solid particles are uniformly distributed through the tissues, but after the budding they multiply in particular directions, and are surrounded and united by a calcareous cement, and thus the axis is produced. This mode of producing a polypary is not restricted to the individuals who commence a colony, but takes place at the extremities of old branches, where juvenile members always exist, and it always happens that towards the base of adult branches the cement is deposited faster than the corpuscules (spicules), and in regular concentric layers.

A Modern Cyclops.—Doctor Depaul lately exhibited to the Academy of Medicine at Paris the body of an infant, which lived a short time. It had only one eye in the centre of its forehead. The nose was wanting, and the mouth, reduced to a small orifice. The mother of this monstrosity was twenty-three years old, and had previously given birth to a properly-formed child.

Vegetable Amœboid Bodies.—Dr. Hicks states he has verfied his observations on the Amœboid state assumed by zoospores of Volvox Globator. He also finds that when mosses are kept in water, the endoplast of the elongated cells in their radicles is apt to become detached, and collect in ovoid masses, which comport themselves like Amœbæ. Watching some for several hours, he found the whole exterior to become covered with minute cilia.—*Quarterly Journal of Microscopic Science.*

Dr. Beale on the Tissues.—In summarizing his conclusions, Dr. Beale regards every living structure as composed of matter *formed* and matter *forming.* The latter he denotes as "germinal;" a cell he describes as matter in these two states. The "germinal matter" sometimes corresponds with the "nucleus," in others with the "nucleus and cell contents," in others to the matter lying between the "cell wall, and the cell contents," in others to "intercellular substance," or to the fluid or viscid material which separates cells, nuclei, or corpscules from each other. Thus the nucleus of the frog's blood corpuscle is "germinal matter," the external red portion being "formed material."—*Quarterly Journal of Microscopic Science.*

A Portable Styptic.—The *Moniteur des Sciences Médicales* recommends country surgeons and others to soak amadou or German tinder in a solution of perchloride of iron of a density about 1·250. It should then be dried in the sun and be rubbed between the hands to restore its suppleness and porosity. Small pieces applied to leech bites soon stop their bleeding. They may be held in their place by strips of plaister.

New Alloys.—The cannons recently cast for the Austrian navy are composed of copper 600 parts, zinc 382 parts, iron 18 parts. This alloy is reported to be excessively tenacious, and easy to forge and drill. It is called after its inventor, Aich metal. We also notice in *Cosmos* a description of an alloy of block tin 375 parts, nickel 55, regulus of antimony 50, and bismuth 20 parts, which M. Trabuc of Nismes proposes as a substitute for silver, as it resists the action of vegetable acids. It is prepared by placing in a crucible one third of the tin, together with the nickel, antimony, and bismuth; over this is laid another third of the tin, and above that a layer of charcoal. The crucible is then closed and brought to a reddish-white heat, and its contents examined with a red-hot rod of iron to ascertain if the nickel is melted and the antimony reduced. The last portion of tin is then made to pass through the charcoal, and the mixture well agitated.

The New Rotifer.—Professor Williamson, in calling the attention of the Manchester Literary and Philosophical Society to the *Cephalosiphon Limnias*, described in the *Intellectual Observer* for February, noticed its possessing only one calcar, whereas the floscularia, when furnished with them, have two, and he suggested the importance of ascertaining whether two existed in the primary condition, and one was suppressed in the process of development.

Crystallizations for Polariscope.—Mr. Davies read a paper to the above Society, showing how beautiful arborescent forms could be obtained by taking a salt like the double sulphate of copper and magnesia, drying a portion on a glass slide, fusing it in its water of crystallization, then allowing it to cool slowly. Starting points for groups of crystals could be obtained by touching the film with a fine needle.

The Brighton Well.—After digging to the great depth of 1285 feet, water was obtained on the 16th of March. It burst up suddenly with great violence, and a loud report, through the lower green sand, which had been reached in the excavation, and rose more than 800 feet in thirty-six hours.

Sir John Herschel on Meteorology.—In a letter to the Manchester Literary and Philosophical Society, Sir J. Herschel denies that he has abandoned the Hadleian theory of winds. He is disposed to attribute the extraordinary climatic features of the last two years to the great outbreak of solar spots in September 1859, which was associated with unprecedented magnetic disturbances. This occurred as the sun was passing southwards across the equator, and Australia experienced a summer of unusual heat. The quantity of vapour then thrown into the atmosphere from the southern ocean does not appear to have been yet got rid of.

Homœopathic Medicines and the Spectroscope.—Dr. Ch. Ozanam states in the *British Journal of Homœopathy* that a spectroscope by Steinheil enabled him to recognize lithium in the fifth dilution of its chloruret, a drop containing 5 billionths of a milligramme. The milligramme is one thousandth of one gramme, which is a minute fraction less than 15½ grains. He detected sodium in a drop of the 6th dilution of its chloruret, which weighed 3 centigrammes, and contained three hundred billionths of a milligramme.

Markings on Diatoms.—Professor O. N. Road, U. S., has published in *Silliman's Journal* (Jan. 1862) some fresh investigations on the much-disputed question of diatom markings. He brings the microscope to a horizontal position, removes the mirror, and places a lamp or candle in the axis of the instrument, and not more than three inches from the stage. If a small sphere of glass is then placed in the focus of the objective the inverted image of the lamp or candle which it forms is seen in an erect position, and if a rod one-tenth of an inch in diameter is moved up and down between the sphere of glass and the light, its image is distinctly seen. "Upon replacing the sphere by a minute concave lens, as an air-bubble in water, the reverse takes place; to gain distinct vision of the flame, it becomes necessary to move the compound body within the focus: the image of the flame appears inverted, and the motion of the rod seems reversed." Having thus noticed the different action of concave and convex lenses, he experimented with the markings on *Coscinodiscus*, *Triceratium*, etc. When these objects were mounted in water, which possesses a much smaller index of refraction than the silica of which they are composed, and viewed with a power of 600 or 800 diameters, "each hexagon was found to contain a minute distinct image of the flame, the motion of the rod showed that the images were inverted, and consequently formed by *concave* lenses. When mounted in Canada balsam, which has a higher index of refraction than silica, the influence of the balsam predominates, and the action of the lens is reversed, so that the markings behave like convex glasses. Balsam of Tolu, with a still higher index of refraction, gives the same results.

The celebrated
Simon Petition Crown.

EDGE INSCRIPTION.

THOMAS SIMON MOST HVMBLY PRAYS YOVR MAJESTY TO COMPARE THIS HIS TRYALL PIECE WITH THE DVTCH AND IF MORE TRVLY DRAWN & EMBOSS'D MORE GRACEFULLY ORDER'D AND MORE ACCVRATELY INGRAVEN TO RELIEVE HIM.

THE INTELLECTUAL OBSERVER.

JULY, 1862.

MONEY AND MONEYERS.

BY JOSEPH NEWTON, OF H. M. MINT.

There are many conflicting accounts of the origin of money; but all agree in giving to its introduction a very ancient date. It is certain, however, that at the period of the Trojan war it was not known to the Greeks. Neither Homer nor Hesiod speaks of gold or silver. They, on the contrary, invariably express the value of things by stating that they are worth so many sheep, or oxen; and they estimate a man's wealth by the extent of his flocks and herds. The wealth of a country they judged of by the abundance of its pastures. Homer values, for example, the golden armour of Glaucus at one hundred oxen, and the brazen armour of Diomedes at nine oxen. Laertes purchased the beautiful slave, Euryclea, for one hundred oxen. In the seventh book of the *Iliad* we read, that—

> "Each in exchange proportioned treasures gave,
> Some, brass or iron, some, an ox or slave."

It is pretty certain too that no gold coins existed in Egypt till the time of the Ptolemies. Lucan attributes the invention of money to Itonus, King of Thessaly, and son of Deucalion, the hero of the mythological deluge, and who was said to have re-peopled the earth. Several other theories, all probably as baseless, have been current as to the invention of money. According to Herodotus, the first people who coined gold and silver were the Lydians. It is tolerably clear that so far as Persia is concerned, Darius, the son of Hystapses, was the first monarch who coined gold in that country. The pieces of money produced by him were named after him—"Darics"—in the same manner as the gold coins of Philip of Macedon, father of Alexander the Great, were called "Philips." The Persian coins had so little alloy in their composition, that they may almost be said to be pure gold. One of them, in Lord Pembroke's collection, weighed 129 grains, which, singularly enough, was the standard weight of an English guinea. While Persia maintained her independence, the Darics were in extensive circulation; but after the Grecian conquest of the country it is believed that they were almost entirely melted down, re-coined, and re-issued with "the image and superscription" of Alexander.

The silver coins of Aryandes, who was appointed a prefect in Egypt by Cambyses, were of Persian mintage, and they, like the Daric, had an indent on one side, and the effigy of an archer on the other. The specimens of these silver coins in England vary in weight from seventy-nine to eighty-one grains. This discrepancy, no doubt, arose from the imperfect mode of manufacture then pursued; and, indeed, as we shall probably have occasion to show, it is next to impossible, even now, to produce coins, in large quantities, of uniform weight. With regard to the scriptural word "talent," in reference to money, it may be stated that Homer used it to signify a balance; and, in general, in his days, it was applied either to a weight or a sum of money—such sum differing in value with the country or period in which it was used. Every talent consisted of sixty minæ, and every mina of one hundred drachmæ; but of course the talent varied in weight with the minæ or drachmæ of which they were composed. When Darius became sovereign of Persia he divided the kingdom into satrapies or provinces, each of which was assessed at a fixed amount of tribute money. Those provinces that paid in silver were compelled to adopt the talent of Babylon for their standard, whilst those which paid in gold adopted the Euboic standard. The Babylonian talent, according to the showing of Herodotus, was equal to seventy Euboic minæ. The Euboic talent was so called from the island of Eubœa. It is generally supposed to be identical with the Attic talent, because Athens and Eubœa used the same standard of weight. The mina Euboica and the mina Attica consisted each of one hundred drachmæ. As represented by English money of the present day, the talent of Babylon was worth £226, and that of Eubœa, or the Attic talent, £193 15*s.*

It is well ascertained, however, that among the ancients the relative proportionate value of gold and silver was subject to considerable fluctuations. In the reign of Darius, for example, gold was thirteen times as valuable, weight for weight, as silver. In the time of Plato it was twelve times as valuable; in that of Meander, the Ionic poet, it was only ten times the value; and in the days of Julius Cæsar gold was only nine times more valuable than silver. The last named reduction was due, undoubtedly, to the enormous quantities of gold which Cæsar had "appropriated" from the temples and public buildings in the various cities he conquered.

The word "Money" is derived from *Moneta*, which, again, came from the verb *Monere*, to advise. The Anglo-Saxon word *Monige,* the German *Muntz,* the French *Monnoie,* the Italian *Moneta,* and the Spanish *Moneda,* are palpably all traceable to the same Latin root from which comes the English word money. When Britain became subject to the Romans, no coined money was lawful unless it bore the effigies of Cæsar: it was called tribute-money. This tribute-money was not only impressed with the effigy of the emperor, but with certain inscriptions indicating rent money, represented by symbolic coins. Thus, for large cattle, the tribute-money was stamped with the figure of a horse; for less, with that of a hog; for corn-fields, with an ear of corn; and for a poll-tax, with the head of a man. The coins of the British prince Cunobeline were not only impressed with the figures of animals, but with the word *tascio,* which signified task, tax, or tribute. Without venturing further into the history of money, generally, we may at once come to its history, so far as England is concerned, and give some account of those who have been entrusted from time to time with its literal production. It is established, then, on the most conclusive bases, that in the earliest periods at which coins, or records of coining, exist in this country, mints were established in every large town. From about the close of the ninth to the middle of the sixteenth century, the practice prevailed of stamping on coins the name of the town or city at which it was minted. Thus, therefore, we possess evidence of the existence of numerous mints. In early periods, moreover, several persons as the king, certain archbishops, bishops, abbots, and others, exercised by royal prerogative, by usurpation, or by grant, the privilege of minting in the same place at the same time. Previous to the union of the seven or eight Saxon kingdoms, each of the petty kings, and several archbishops and bishops, appear to have exercised the right of coining independently, and to have put their own effigies and devices on the coin produced. After the transformation, however, of the heptarchy into one monarchy, Athelstan, who reigned A.D. 920-940, at a grand council or parliament, ordained that there should in future be but "one money" throughout the kingdom. This expression undoubtedly meant that there should be but one authority, effigy, and device—namely, those of the monarch himself—attached to, or ornamenting the coinage of the realm. At the same time that Athelstan and subsequent monarchs denied to their subjects the right of minting independently, they conceded to some of them the privilege of minting vicariously, as grantees of the crown. Accordingly, we find that royal, episcopal, and abbatical mints were in being, and in full operation long after Athelstan's "order in council."

For instance, it is on authentic record, that that monarch, the Archbishop of Canterbury, and the Abbot of St. Augustine's were all engaged in coining in the City of Canterbury at the same time, and under royal ordinances. At the time, of the compilation of *Domesday Book*, and long subsequently, the king and the respective bishops of Norwich, Hereford, etc., minted at the same time in those cities, and this practice of coining, by prelates and other favourite subjects did not cease and determine until the middle of the sixteenth century. It further appears probable that in the same early times the king, archbishop, or abbot had several distinct mints in the same city at the same time. In Athelstan's *Mint Ordinance*, in the *Anglo-Saxon Records*, and in *Domesday Book* it is particularly notified, in almost every instance, how many minters, or monetarii there shall be in each place, or under each person privileged to mint. For instance, Athelstan's chief ordinance runs that at Canterbury there shall be seven minters, four for the king, two for the archbishop, and one for the abbot, and so on for other places. Now, that each minter had his own die, which, with a hammer, a pair of shears, and a balance, constituted the apparatus of a mint, is very nearly demonstrated by a variety of writs and records in which the monetarii and cuneii, or dies, agree in number. The connection between monetarius and cuneus is rendered still more obvious by noticing that, soon after the date of *Domesday Book*, the custom of specifying the number of monetarii in any place was superseded by specifying only the number of cuneii.

That the privilege of having one die did not involve the right of having another, is also tolerably certain. Those who were permitted to coin pence were not justified in coining halfpence, and *vice versâ*. Enough has been said, probably, to prove the fact that mints existed at the periods of which we speak in various towns, and that frequently there were two or three mints in the same town. In all these the monetarii were held responsible for the character of the coin produced at their particular mints, and heavy and peculiar punishments were awarded to those who ventured to abuse their trust, and debase the coinage.

Coming to a much later period, that of King Edward VI., we find in one of his letters-patent, that he and his father had "erected, as well within our Tower of London as within divers other places of our realmes of England and Ireland, sundry myntes to be employed, and ordered in such sorte and forme as is contained in certain several indentures." On the 10th of October, 1550, the same king in his journal, now extant in the British Museum, speaks of "York, Master of one of the myntes in the Tower;" and on the 21st of September, 1551, speaks not only of "York's mint," but also of "Throgmorton's mynte in the Tower." Again, in the year 1553, we find that a commission was issued by Philip and Mary to Sir Edmond Pakham, High Treasurer of oure Myntes within oure Tower of London." During the reigns of Henry VIII. and Edward VI., while there were certainly two or three mints in the Tower there were two others without that fortress. One of these was "in the Manor of Suffolk House, in the Borough of Southwark," and another "in Duresme Place in the suburbs of London." The site of the first has since attained, and, to a certain extent, maintains an unenviable character, while that of the second is occupied by Durham Street, Strand.

Each of these distinct mints appears to have been presided over, and worked, by a single officer with workmen under him, and these were the monetarii before alluded to. From the seventh to the thirteenth century, as the coins of the intervening time abundantly testify, the practice prevailed of stamping on each coin the name of the minter, above the name, or emblem, of the place of mintage. Little, however, is actually known of the minters, or monetarii, except that in the Anglo-Saxon and Anglo-Norman laws and ordinances they were the only persons from whom penalties were exacted for debasement of the coinage. The position of these money makers in society has been much discussed, but it is pretty plain that they were servants or attendants of the king or prelate, who accompanied their master, and struck money for his use when required so to do. They were certainly in close dependance on the king, had houses or apartments rent free while at work for him, and were obliged to get their dies from the Crown Die Office.

A.D. 1132-1135 seems to have been the epoch of a systematic identification of the Mint with the Exchange, in the persons of their respective officers, the minter and the exchanger—the latter being the person appointed to exercise the prerogative monopoly of "exchanging," that is, of bullion, and coin dealing, and broking. The writ of the same date is further worthy of remark, from the fact that it implied that the whole country had been mapped out into comitatus—counties or districts—to each of which its own minter, or mint and exchange had been assigned.

This was the epoch also of the first step towards a consolidation of the exchanges and mints, namely, of the consolidation of their accounts, so far as the profits of the Royal Seignorage were concerned, by the appointment of a single accounting officer, known as the keeper or warden. It appears to have been the earliest date of the triple organization of the Mint—two other departments now being named as checks upon the master. One of them was represented by the warden, and the custos cuneorum, or keeper of the dies, and the other by the king's assayer and the "trial of the pyx," on behalf of the king and the public. With reference to the original institution of the trial of the pyx, which ceremony is still occasionally performed, and is too well understood to need explanation here; it is only necessary to say that Ruding, a very good authority, dates it in the reign of Henry II., A.D. 1154-1189. In the year 1208, we find in a royal writ the name of operatores, or operarii monete, or workers in the Mint, introduced for the first time. From this time forward, indeed, the Mint which had previously consisted of but one operative department consisted of two, superintended respectively by the operarii, and the monetarii. Most probably the introduction of mechanical improvements in the art of coining, and possibly the increasing demand for coin, led to those changes, and gave rise to the term operarii, which might consistently be supposed to include all the labourers in the establishment.

The year 1279 is a remarkable one in the annals of British minting, for in that year the mints throughout England were consolidated in their operative departments, and placed under one mint-master. This officer, singular to say, was a Frenchman, and his name was William de Turnemire. He was sent for from Marseilles, and constituted Magister Moneto Regis in Anglia, or Royal Mint-master throughout England. It is somewhat remarkable that from this period the practice of stamping the name of the minter on the coin ceased, and it was never again resorted to. The mint agreement between the king and Turnemire refers almost exclusively to operative matters. It is preserved in the Red Book of the Exchequer, and we give some of its rather quaint and curious enactments. It appears that Turnemire was to cause the money to be made in four places "for the present," viz. London, Canterbury, Bristol, and York. In each of the three latter places he was to have under him a magister, to have the custody of the mint and money there. He was to bear all burdens and expenses in the said four places, and to provide for the wages of the monetarii, for the loss of silver by fire, sizing of the coins, as also for the wages and expenses of himself, of the deputy masters under him, and to provide his other servants with meat, drink, and dress. He was to pay for charcoal, repair of dies, and other expenses about the money. The king, however, was to provide convenient houses, to satisfy the cuneator or hereditary die-engraver, for his fees, and Turnemire was then bound to deliver the coin to the king of right standard, blanched and perfect in all respects, and he was to receive from his majesty in return, sevenpence on every pound weight of sterlings—namely, $3\frac{1}{4}d.$ for the wages of the "Monetariorum percutientium et fabricantium monetam," $1\frac{1}{4}d.$ for adjusting and sizing the coins, and 1*d.* for wages, expenses, diet, etc. For the striking of farthings, which from their small size involved more labour in their manufacture, Turnemire was to receive 10½*d.* per pound weight. The mints under Turnemire's management were worked satisfactorily, and his system prevailed for many years. In 1281 the check upon various offices of the mints was increased, and a comptroller appointed.

Henry VII., it may be stated, was the monarch who originated our present coinage or currency. In the year 1489 he ordered the striking of a new money, of double the value of a royal noble, to be called a sovereign, and to pass current for twenty shillings. In 1504 he also first authorised the striking of shillings and half shillings, in addition to groats and half groats. By the statute of the same year he appears to have given the present form to our coins, by ordaining that every piece of his new money should have "a circle about the 'utter' part thereof; and also that all manner of gold coins thereafter to be coined, should have the whole scripture about every piece of the same gold, without lacking of any part thereof; to the intent that his subjects might have perfect knowledge by that circle and scripture when the said coins might be clipped and impaired."

He also appears to have revised the custom of placing numerals on the coins after the name of the monarch, to distinguish those struck by different monarchs of the same name—a custom which had been disused from the time of Henry III. (A.D. 1272), until his own (A.D. 1485), which now renders it extremely difficult to appropriate with accuracy the coins of the intermediate kings.

Unquestionably, however, the most important change made in connection with the Mint, between the years 1344 and 1509, consisted in the gradual rise of the joint authority of the warden, master, and comptroller, or virtual Mint Board, and in the gradual transference into their hands jointly of great part of the several supervising responsibilities of the warden, and comptroller, and of some part of the active management of the master. Into the causes and motives of these changes it is not necessary here to go. It will be sufficient for our purposes merely to record them.

The Mint indenture of the year 1350 is remarkable as being the first on record which specifies that the mint-master shall be master and worker "in the Tower." It obviously, however, contemplates his minting in several places, as the king engages to appoint wardens in each place where he shall mint. In the indenture of 1356 the wider title occurs of master and worker in the Tower of London "*et aillours parmie Engleterre;*" in that of 1395, in the Tower and at Calais, in that of 1422, in the

Tower, at York, Bristol, and Calais; in that of 1464, in the Tower, in the realm of England, in the territory of Ireland, and in the town of Calais; while in that of 1483 the mint-master becomes "master and worker in London, and elsewhere within the realm of England," and this has continued to be the usual style of the mint-master down to this hour. Other alterations in the system of government took place during the 165 years in question, but they were of minor importance, and need not be specified more exactly.

Between the years 1509 and 1544, some remarkable innovations on the purity of the coinage took place, and they are by no means creditable to the memory of Henry VIII. That monarch indeed departed from the wise mint policy of Henry VII., and debased the silver currency until it contained only one-third, or even one-fourth of precious metal, to two-thirds, or three-fourths alloy. The evils, confusion, and counterfeiting to which such a degradation of the coinage gave rise may be imagined, and indeed it took twenty-six or twenty-seven years to remedy the mischief done in this direction by Henry VIII.

An instance of the attempts made to rectify the then disordered state of the Mint may be found in the letters-patent of the year 1551 (temp. Edward VI.), reciting "Forasmuch as it it has come to our knowledge and to the knowledge of our Counsail, that there be divers and many things practysed and used within our Myntes, and by our officers and ministers in our said Myntes, necessarye for our honour and profit of our realms and dominions, to be reformed, altered, and changed." To effect these reforms the Earl of Warwick, High Admiral of England, and Sir William Herbert, Master of the Horses are by the same letters-patent nominated "Chief Commissioners, Surveyors, Controllers, and Overseers of all officers and ministers within our said Myntes, and of all rules, statutes, and ordinances heretofore had or made con-concerning the same." These newly appointed officers set themselves to work in earnest, and much good came of their labours. Another and similar commission was appointed in 1559, to inquire into the state of the Mint, and devise what standards, officers and ministers, ordinances, profits, etc., might advantageously be continued, or abolished, or adopted.

One material feature of change resulting from these commissions of inquiry, was the defining more accurately the constitution of the Mint. This was done in an instrument called the "Establishment of the Mint," and specifying the officers of the Mint, their duties, responsibilities, and salaries. Several of these documents were subsequently issued, with various modifications—one, for instance, in the reign of Queen Mary, and another in that of Queen Elizabeth. The "Establishment" of the last-named monarch is the only one now known to be in existence, and it is of an elaborate, minute, and curious character; it is entitled "The Establishment of the Courte and Office of the Quenes Highnes Mynte within the Towre of London, made the 6th day of December, in the thirde yere of our Soveraigne Lady Quene Elizabeth," and did space allow we should certainly quote from it at some length. As a specimen of its phraseology and orthography, we give the following:— "Item, the Quenes Highnes is pleased that the under-treasurer, comptroller, and assay-master, for the more perfecte and sure doinge of all her Highnes affayers in the sayde Mynte, shall appointe these inferior offycers hereafter specifyed, so that they be skylfull: that is to saye, one clerke, to make the dayly indentures and other wrytyngs betwyxt the sayde under-treasorer, comptroller, assay-master, and moneyers, and he to have for his wages £10: Item, one syncker, to syncke the irons (dies), and to have for his yerlye fee £20." In this quaint fashion the whole document is couched, and it defines very closely the duties and emoluments of all employed in "ye sayde Mynte."

Before passing forward from the period included between the years 1544-71, it would be unjust to omit mentioning the following convenient Mint arrangements of Queen Mary's. Queen Mary, in reforming the currency, which she commenced doing within two months of her accession, did not restore exactly the old standard from which Henry VIII. had so disgracefully deviated, and which consisted of 11 oz. 2 dwt. of fine silver to 18 dwt. of alloy, but instituted a new standard of 11 oz. fine to 1 oz. of alloy. Had this excellent plan been allowed to continue, we should now have had in Great Britain, as in British India, a uniform alloy in both silver and gold coinages, namely, 11 parts fine to 1 of alloy. Queen Elizabeth unfortunately undid these regulations, and reverted to the old standard, and hence has arisen the difficulty of comparing the relative values of gold and silver.

So much has been said against Queen Mary, that it is a satisfaction to have something to say in her majesty's favour, and this we can conscientiously do in reference to the coinage. Queen Mary ordered that the pound weight of silver should be coined into sixty shillings, whereby every crown weighed precisely an ounce, and every subordinate coin became an aliquot part of a pound, or an ounce. Elizabeth, by debasing the silver currency to sixty-two shillings in the pound, destroyed this convenient arrangement. In restoring the old standard of gold again, Queen Mary cut the pound weight into £36, so that three sovereigns weighed an ounce. In her reign too the complete consolidation of the Royal Mints was first effected, and the whole of her money was consequently struck in the Tower of London.

In the year 1571 many alterations as regarded the working staff were contemplated, and even proposed in the Mint, but as they did not take place it is unnecessary to define them. In respect of the apparatus, mechanical and otherwise, it may be said that up to the year 1561 it was of the most primitive nature. The hammer was the stamping-press, and shears, scales, and files the principal accessories. In the year just named the "mill and screw" system of coining was introduced by a Frenchman, who unfortunately adopted the same plan of money making for his own private behoof, and was, it is said, hanged at Tyburn in consequence. It is pretty clear that "mill and screw" did not supersede "hammer and tongs" coining for many years after the date named by Ruding for the introduction of the former. Mr. Joseph Burnley Hume—to whose indefatigable exertions while secretary of a recent Royal Mint Commission we are indebted for much historical matter contained in this paper—is of opinion that the *Company* of Moneyers was first formed between 1561 and 1578, though he cannot specify the exact date. Prior to that period they were only, he thinks, ordinary workmen; and in support of his view, *i.e.* as to the formation of the "Company," he adduces the fact that the most ancient document extant in reference to that body bears date 1578. Certain it is that from this time forward to 1851, the Company of Moneyers contracted with successive governments for the coining of the monies of the realm, and that they kept up the succession in their own body by the reception of apprentices, for whose admittance among them they received heavy premiums. Thus much in passing. We shall have hereafter to refer to the Company, and so for the present, we leave them in order to trace the annals of coining —the physical history, so to speak, of money in England.

By the year 1583 the Mint had passed into a state of considerable internal disorganization, and its expenses had materially increased. One individual—Sir Richard Martin—had obtained a kind of monopoly in the establishment. He was indeed a "pluralist," and drew the salaries for three or four offices, besides being "Goldsmith and Platesmith to the Queen." Another series of little reforms ensued, and then matters remained *in statu quo* till 1626, when a considerable departure from the constitution of the Mint took place. The power of the moneyers was much increased by the change, and they became practically mint-masters, though nominally subservient to the chief officer. No grounds appear to exist for this alteration, except the desire on the part of Charles I. to appropriate to himself profits which had previously been allowed to the master and worker. Charles, in fact, farmed out—nominally on a sub-contract with the mint-master—the moneying process to the moneyers, thereby creating an *imperium in imperio* which paved the way for the introduction into the Mint system of many anomalies and incongruities. From the year 1626, therefore, may be traced the rise and influence of the Company of Moneyers, which influence culminated, and was overthrown in the reign of Queen Victoria.

Previous to this time almost the only notices respecting them which occur in legal documents have reference to their being impressed or imported from beyond seas, or being in poverty or distress. The power thus placed in their hands by the unfortunate monarch was used in successfully obstructing, for some thirty years subsequently, the introduction of improved machinery into the mint. On the 11th of February, 1629, for example, a royal warrant was issued authorising Nicholas Briot, the eminent mint engraver, to make trial in the Tower, of his new mills and presses for coining, but up to the year 1631, as appears from a petition of Briot, this trial was never permitted. The moneyers, in fact, disapproved the experiment, and prevented its being made. Similarly, in 1649, "The Council of State and the Commons in Parliament, having had it represented to them that the coins of the realm might be more perfectly and beautifully done, it was ordained, that Peter Blondeau should be sent for from Paris to come to London to treat for the price and expense of coining money after his new invention." Blondeau arrived in London in September of that year, but though the committee of the Mint was appointed to examine his new way of coining, and reported favourably upon it, the opposition of the moneyers was so powerful that a considerable time elapsed before he could proceed to realize his plans. He was at last permitted to execute some proof pieces, whereupon the moneyers exhibited against Blondeau a charge of treason, for coining in a private house! Under pressure of this he was driven out of the kingdom. The introduction of improved machinery into the mint was thus vexatiously delayed until 1662, when Blondeau was again sent for—the office of engineer, with a salary of £100, was created for him, and profitable rates were assigned him under a twenty-one years' patent.

Before passing finally from these times, it may be well to state that it was the period when the British coinage attained its greatest beauty and perfection. In 1628, Nicholas Briot, and in 1649, Thomas Simon, his pupil, were respectively appointed engravers to the mint, in which position the latter, indeed, remained till after the Restoration; and it is a striking fact that, notwithstanding the introduction latterly of machinery of the most elaborate and ingenious kind, scarcely an approach has been made to the excellence of the coins then executed. When it is remembered too that the inferiority of the coinage is one of the main inducements to counterfeiting this fact becomes sufficiently eloquent. As a proof of the admirable talent of Thomas Simon as an engraver, we refer to the illustration forming the frontispiece of the present number of the INTELLECTUAL OBSERVER, which is a faithful copy of his celebrated petition crown. The history of this is too well known to require repetition. As it would be an invidious act to depict only the work of an engraver of times long past, it has been considered proper to introduce also a *facsimile* of the scarcely less remarkable work of the late William Wyon—the Victoria crown piece. This arrangement may appear inconsistent with the chronological order of our narrative, but it certainly is not obnoxious to a charge of injustice towards the memory of Wyon.

Once the moneyers were compelled to submit to the introduction of Blondeau's machinery, they set about making the best bargain they could respecting it, and a new contract was arranged between them and the mint-master. They were taught and instructed in their new duties by Blondeau, and undertook to perform all the operations of minting, from the stage of the standard wrought bar downwards; to provide all materials and necessaries; to defray all waste of working, all repairs of machinery, etc. They also agreed to maintain the horses for working the horse mills, to find alum, argol, and sawdust; "to keep in repair the ovens and utensils for nealing and blanching, and to make good the balances, tubs, bowls, and sacks." Thus things went on till the year 1666, when a new Coinage Act was passed which altered completely the financial arrangements of the Mint. It also interfered materially with the constitution of the establishment, and Ruding, no mean authority, says, that the act was "most fatal to the interests of the mint."

Between the years 1695 and 1697, a great re-coinage into milled money, of all the clipped and defaced hammered silver money of the country took place; and on April 6, 1697, a committee of the House of Commons, appointed to inquire into the "Miscarriages of the officers of the Mint," made its report. This report is of a most interesting character, and throws great light upon the internal economy of the money manufactory as it existed at that time. It is, unfortunately, of too great length for transcription here. We may, however, mention that Dr. (afterwards Sir) Isaac Newton, who was then warden of the mint, figures in the report as a witness examined by the committee. A number of stringent resolutions were passed by the committee, who also proposed to bring in a bill for the prevention of

The Wyon Crown-piece.

EDGE INSCRIPTION.

ANNO * REGNI * UNDECIMO * DECUS * ET * TUTAMEN.

sundry malpractices which they had discovered to exist in the Mint. It does not appear, however, that any bill was brought in, or that any material alteration or improvement followed the presentation of the report.

In 1706 the following change took place in reference to the Corporation of Moneyers, as they loved to style themselves. They were allotted certain small salaries when the coinage in one year did not reach a certain amount. Hitherto, they had not been considered to be in the position of "standing officers" of the Mint, but more in that of workmen receiving piece wages when at work. The history of this alteration, which remained in force up to the period of the dissolution of the Company, may be briefly given:—The "Corporation," in 1693, had petitioned the Treasury to the effect, "that by reason of the work falling off so much of late years, they had become poor and so much in debt, that they must be ruined without some consideration were had for them." Again, in the reign of Queen Anne a similar claim was presented; and at length a Treasury order awarded the moneyers £25 each per annum when the coinage in any one year should not reach the value of £500,000. Afterwards, in 1743, this allowance was increased to £40 per annum, under like conditions.

Probably the most important change made during the eighteenth century in the practical management of the Mint, was the total cessation of the mint-master's practical functions, and his gradual transition from a permanent practical head-officer, having personal knowledge of the process of minting, to a salaried officer of rank, having frequently no knowledge whatever of the process of minting, and quitting his office with every change of ministry. This absurd and mischievous system remained in force till 1848, when the Russell ministry abolished it by the appointment, for life, of Sir John Herschel. The re-coinage of the gold currency of the kingdom, in 1774, effected a considerable improvement in the status of the Company of Moneyers. The number of persons comprising it had been reduced at the instance of the Government, when awarding them subsistence-money; and the consequence of the re-coinage of gold was, that large profits were shared by comparatively few persons. They were thus raised to affluence, and the tone of their communications varied accordingly. In 1780 an attempt was made to abolish the Mint altogether, and to place the coinage in the hands of the directors of the Bank. This, in fact, was the avowed intention of Mr. Burke's famous bill for economical reform. It set forth "that the Mint is expensive, and that the coinage ought to be none or little expense to the nation; therefore, it is enacted, that the office of the Mint shall be abolished." There were clauses for paying salaries to the present officers of the Mint who should be removed; it was proposed too that the Treasury should contract with the Bank for coinage, and that the Bank should undertake the remittance of all money for foreign parts. It is needless to say that this bill never became part of the law of the land; and that the Mint, with all its faults and shortcomings, remained unscathed by Mr. Burke's onslaught.

In 1806, and some years after the pressure upon the Royal Mint had necessitated the employment of contractors to supplement its exertions by the production of large quantities of copper coin, the erection of the present noble institution on Tower Hill for the manufacture of coin was commenced. It was fitted with powerful machinery, made principally by Messrs. Rennie, and Messrs. Boulton and Watt; and in 1810 the first coinage—one of copper—took place thereat. The years 1815, 1816, and 1817, witnessed considerable changes in the Mint organization and constitution. One of the principal of these was that the master or his deputy, the king's assayer, the comptroller, the king's clerk, and the superintendent of machinery—a new officer appointed to have charge of the steam-engines and machinery recently erected—were constituted a Mint Board, for the management of the affairs of the Mint. Another was, that the moneyer's rates, which had previously been fixed and mentioned in and by the indenture, were left to form the subject of a separate agreement, terminable at three months' notice, between the mint-master and the moneyers. In 1815 a statute was passed to provide for the new silver coinage then undertaken, and this contained many important enactments, which space unfortunately forbids further reference to. In 1817 the ancient office of warden was abolished, and the duties, powers, and authorities pertaining to it were transferred to the master and worker. In 1837 a Select Committee of the House of Commons was appointed to inquire into the establishment of the Mint, and much important information was elicited by it. The death of King William IV., and the subsequent dissolution of Parliament, prevented any action being taken upon the report of that committee; and until the year 1848 the *imperium in imperio* of the Corporation of Moneyers remained unquestioned, or at least, undisturbed. The end of their long reign, however, was approaching. In the last-named year a Royal Commission was appointed for the purpose of "inquiring into and reporting upon the constitution, management, and expense of our Royal Mint." This commission was composed of Richard Lalor Sheil, master and worker of the Mint, William Cotton, Esq., Sir Edward Pine Coffin, and Colonel William Nairn Forbes; and Mr. Joseph Burnley Hume was appointed their secretary.

On Tuesday, March 28th, 1848, the Royal Mint Commission first met for the "despatch of business," and their sittings continued at intervals up to January, 1849. Almost every principal officer of the establishment was examined, together with several belonging to the Bank of England, and others connected with Goldsmiths' Hall. From these examinations a mass of information was derived, and the indefatigable secretary to the Commissioners engaged himself in adding to this by his researches in the British Museum, the State Paper Office, and other quarters where information could be obtained. The Provost of the Corporation of Moneyers was the champion of that body, and he as diligently sought out evidence in support of their claims. Some of the documents handed in by this gentleman were of a curious character, and but that this paper has already extended itself to so great a length, we should feel disposed to quote from them. All the ingenuity and exertions of the Company proved of little avail, however. They could after all only demonstrate that they had enjoyed the privileges and emoluments arising from their position by "prescriptive," and not legal right. It was shown, on the other hand, that inconvenience and expense arose from the system of "farming" out, as it were, the fabrication of the coinage of the realm, and that really the Crown possessed the power of terminating the contract with the Company at a very short notice.

Accordingly the Commission in 1849 reported to Her Majesty the results of their inquiries and deliberations. Without troubling the readers of the INTELLECTUAL OBSERVER with the whole of the reasons which induced the Commission to come to a conclusion completely adverse to the Company of Moneyers, and fatal to their further existence as a corporate and privileged body, it may be well to extract from their report one of its main clauses:—"We are convinced," say they, "that the Moneyers' claim of exclusive right rests on no more substantial ground than ancient usage, no charter or other written record of its commission having been produced by them, or otherwise discovered to exist; that it cannot be shown that they existed as a distinct united body earlier than the middle of the sixteenth century; that their pretensions to be a separate corporation, with legal rights, are supported neither by proof nor probability; and that if the abolition of their long-exercised privilege of exclusive employment in the work of the coinage should ever give them a title to pecuniary compensation for the loss of its advantages, they have in no way established their right to its perpetual continuance."

It was impossible to misunderstand language so plainly expressed as this, and it is certain that so acute a lawyer as Mr. Sheil would not have appended his signature thereto unless fully justified by the facts and evidence adduced. Many months elapsed, nevertheless, before steps were taken to remove the Company from their posts. There were, during the years 1849 and 1850, great demands made upon the Mint for gold and silver coin, and it was probably considered unwise to dislocate existing arrangements during the existence of the pressure. The Moneyers were not averse to the delay for their percentages upon coin produced were going on, and these were of more value than the retiring allowances which they were likely to obtain when superseded.

Meanwhile Captain (now Colonel) Harness, of the Royal Engineers, was appointed Deputy-master of the Mint, and he at once, and with consummate talent and vigour, applied himself to the task of framing a new system of government for the executive department of the establishment. The work was arduous and difficult. The moneyers had retained in their own hands the exclusive control of the operations of the coinage, and they were not too willing to transfer to others the results of their experience. The new deputy-master was not to be deterred by the reticence of those over whose heads the "sword of Damocles" was suspended, but he carefully and cautiously completed his plans, and prepared himself for his future campaign. Mr. Sheil was succeeded in the Mastership of the Mint by Sir John Herschel, towards the end of the year 1850, and at the beginning of 1851 the moneyers received the "notice to quit" which they had so long been expecting. Again fortune favoured them, the Bank pressed the Mint for gold coin, and they were asked to retain office some time longer. This they did until the autumn of that year, when their connection with the place was finally and irrevocably severed. By way of compensation they however received annuities, varying in amount from £500 to £1000. At the time of their official dissolution the number of moneyers was five. There were also two apprentices to the company, and these received annuities amounting to £150 each, for their loss of prospects.

Thus terminated the reign of the moneyers, whose history has been elucidated as far as the space allotable here for the purpose has permitted, and thus passed away an institution which, in one form or another, had existed from the time of the Heptarchy. It only remains to be said that in the hands of the Government the Royal Mint has lost none of its efficiency, whilst the country has gained considerably, in a pecuniary sense, by the change. Sir John Herschel retired from his office in 1854, and he was succeeded, in April 1855, by Professor Graham, F.R.S., who at this moment is Master of the Mint.

It would be unfair to omit stating that *Duncan's Work on the Currency* has been laid under contribution for some facts in reference to the early history of money. With this acknowledgment the subject of "Money and Moneyers" may be for the present left, although the writer is conscious that much of interest in reference to it remains unsaid.

MACHINERY AT THE EXHIBITION.

BY J. W. M'GAULEY.

Proceeding from the western dome northward, along the transept, we catch such a glimpse of the vast collection of machinery to be found in the western annex, and of the immense building itself, that we must assuredly be devoid of all curiosity, and must feel very little interest in arts and manufactures, if we do not experience the most intense desire to explore its wonders. And that such are the feelings of the great majority of those who visit the Exhibition, is evinced by the fact that the machinery department is at all times one of its most crowded portions. The great advantage of such assemblages consists not only in the opportunity which it affords to every one of becoming acquainted with the various machines which are used for industrial purposes, but also in the means it supplies of making comparisons, and thus marking with accuracy the progress of improvement. At the last Exhibition the specimens of what might be done in the different branches of mechanical art were calculated to awaken the deepest interest; but South Kensington presents to our view at this moment such a collection of machinery as was never before seen in one place; and possibly during the existence of the present generation shall never be seen again. Its superiority over everything of the kind is manifested not only by the number of specimens exhibited, but by the great size of some of them. In this one vast hall are collected almost every contrivance of practical utility, and the mechanical requisites of almost every art and manufacture.

Machinery had made great progress at the time of the last International Exhibition; the skill and ingenuity of modern times had even then devised all the admirable contrivances, by means of which we are at present enabled to perform such wonders in the constructive art, and to work on so large a scale, and yet with such precision. And if we examine the different modes that are used for obtaining motive power, or of applying it to practical purposes, we shall find that we have not, since 1851, either increased their number or, to any considerable extent, augmented their capabilities. There is no species of steam engine now in use that was not at that time well known and skilfully constructed; but the extent to which the various kinds are used has undergone some modification, since the oscillating-engine is less and the trunk-engine more commonly employed. Certain important alterations also have been made in the form and in the arrangement of marine-engines. These are due to the screw-propeller having in a great measure superseded the paddle-wheel. At the period of the last Exhibition, almost every steam vessel was furnished with paddles; but experiments had recently been made, which rendered it probable that the screw would be applied to vessels of war, although no idea was then entertained that it possessed advantages which have caused it since to be almost universally adopted in the navy. The change which has thus taken place has rendered a considerable modification of the marine-engine necessary; it must have a higher velocity, and the crank-axle must occupy a very different position from that which was formerly assigned to it. There is also a great and general endeavour to diminish the space occupied in steam-vessels by the engines; hence a great compactness has been given to them, and a great condensation of their parts has been effected, and this has been accompanied by an augmentation of their strength and solidity. This is effected in various ways; the beam, in every form, has been nearly discarded, and direct-action engines are almost always used in steamers. When the oscillating engine is employed, there is no connecting-rod; when the trunk-engine, there is no piston rod; and the use of a double piston-rod, causes the piston and connecting-rods to occupy only the space usually required by one of them. Moreover, the position and form given to the condenser and pumps, tends more or less to the economization of space. When the screw was first applied, the required velocity was obtained by gearing, or some similar contrivance; but these methods have been abandoned, and the screw-shaft is driven to its full speed by the engines themselves. In 1851, the largest steam-engines exhibited were of but six hundred horse power; those in the present Exhibition include engines of eight hundred horse-power, and portions of others of twelve hundred and fifty, and even of thirteen hundred and fifty. Nothing can exceed these admirable specimens, in the arrangement of their details, and the excellence of their finish. Stationary engines also have been modified to some extent, chiefly by a more general use, and a more simple application of the condenser and of the principle of expansion. The latter was well understood long since, but it is now being generally applied in the best manner, and in most cases with a power of varying its extent at pleasure.

Powerful locomotives were found in the last, and they are very numerous in the present Exhibition; but they have undergone very little change in the arrangement of their details; the chief innovation, perhaps, being the use of injectors instead of feed-pumps. On the present occasion the magnificent line of locomotives found in the western annex presents a most imposing appearance. In connection with this subject, we ought to notice the method adopted by the London and North-Western Railway Company, for supplying the tenders of quick trains with water without stoppage; it is very simple, and is fully illustrated by the model exhibited; there seems to be no reason why it should not be very generally adopted. An excellent opportunity is afforded, on the present occasion, of comparing the various kinds of engines as constructed by ourselves and by foreigners: and in making such a comparison we cannot fail to be struck by certain novelties in two Austrian locomotives. One of them, which has *four* cylinders, is intended for high velocities; it is supposed to secure greater safety, and a more perfect freedom from the jumping which arises from the necessarily imperfect balancing of parts, by a more equal distribution of force on the crank-axle. Whatever may be found to be the result of such an arrangement in practice, the weight, complication, and expense of construction and repair are seriously increased. The other locomotive, which has *ten* coupled wheels, is intended for steep inclines and sharp curves; its weight is distributed more uniformly, on account of the number of wheels, and adhesion to the rails is rendered more effective by all of them being coupled. To prevent strains, a certain amount of motion is allowed to the axles at the boxes, and the coupling, from its form, accommodates itself to the curvature of the line, being lengthened at the outer and contracted at the inner side. Whether this capability of self-adjustment is compatible with firmness and strength, is a matter which may fairly be questioned.

Machine-tools rank next in importance to the steam-engine. All those we employ at present were in general use in 1851, though some of them have undergone modifications and improvement; and it may be affirmed that, during the past eleven years, we have neither increased their number nor much extended their usefulness; nevertheless, practical mechanics and the constructive art have progressed during that period. We cannot, it is true, point out any novelties in the strict sense of the word. Our chance of producing these becomes every day diminished; the constant exertions of men of the highest genius and most extensive experience must have brought forth so much fruit, that comparatively little in the way of machinery must remain to be discovered. But there is, and there always will be, abundant opportunities for making valuable improvements in practical science, and the time that has elapsed since 1851 has been by no means barren in such indications of progress. This will be sufficiently evident to those who compare the past with the present Exhibition. Eleven years constitute a very considerable portion of the duration of human life; those who eleven years ago were young are now of mature age; and those who were then of mature age are now old; but we and numbers of our readers can make the comparison. In doing this, it is impossible not to advert to the very important part which is played by those contrivances which are included under the general name of *machine-tools.* In reality they are the means by which all improvements are effected in the construction of the various kinds of machinery; and thus, indirectly, they are the sources of every advance in arts and manufactures. The imperfections of these appliances, or, as we ought rather say, the want of them, caused the greatest difficulties and embarrassments to Watt in his endeavours to improve the steam-engine. But time removed these obstacles to the carrying out of his admirable conceptions. This, however, was merely in accordance with a general law, by force of which the creation of a demand is always followed by a means of supply. Thus the necessity of forging an unusually large bar led Nasmyth to the invention of his steam-hammer. The impossibility of guiding a turning-tool with accuracy, or indeed at all, without almost intolerable labour, in the case of very heavy work, led to the invention of the slide-rest. The nearly incontrollable vibration of a long bar, in a single lathe, led Whitworth to the invention of his duplex: and such instances might be multiplied almost without limit.

Comparing the machine-tools exhibited in 1851 and 1862, we find that the lathe, planing, slotting, and drilling-machines, exhibited on the last, might very well take their places on the present occasion, so little have they been altered. The lathe is by far the oldest contrivance, and it is still the most generally used in the construction of machinery. In its best form, it may be considered as a kind of universal appliance, that to a great extent may be made to supply the place of every other; for besides turning, it will bore, and drill, and even plane, etc. As might be expected from its importance, it was not only well represented at the last Exhibition, but on a very large scale also; since, among the specimens of it were some for turning railway-wheels seven feet in diameter, and shafting thirty-six feet in length, and we have scarcely advanced farther since that time. The enormous weight of those lathes which are used for boring large cylinders, both then and now, prevented their being exhibited.

The planing-machine, though in some respects improved, has undergone no very serious modification since 1851. The ponderous nature of the larger machines, must always present great obstacles to their being transported from place to place, and must render the proprietors unwilling to move them without very urgent necessity. The difficulty experienced in such circumstances has however been greatly lessened, by the use of the steam-crane; masses of eighteen or twenty tons weight, and even more, are now handled without any difficulty: and hence the larger machines are better represented on the present than on any former occasion. Shaping, drilling, and other machines of an equally important character, are found in great numbers in the present exhibition, as was true also of the last.

There are certain contrivances of great importance to the machine-maker, which have advanced more perceptibly. Thus the steam-hammer, which, in 1851, was comparatively a clumsy and complicated machine, has become compact and simple, while its efficiency has been greatly augmented. In its most imperfect form, it was still a welcome substitute for the old forge-hammer. The latter weighed at most a few hundred weight, the steam-hammer often weighs fifteen or twenty, and sometimes fifty tons, and yet can be controlled with the utmost exactness. It has greatly the advantage of the radial hammer, on account of its whole weight being effective, and its face being in all circumstances parallel to the face of the anvil. It enables us to manufacture immense masses of iron and steel with great ease; and to weld them, if necessary, with but little danger of leaving flaws: its capabilities are well illustrated by the very large crank shafts, both in the rough and finished states, which are seen in the eastern and western annexes. In 1851 it was not exhibited in action; at present many specimens of it are in operation daily.

The steam-crane, to which we have already alluded, is another contrivance that greatly facilitates the construction of machinery. It was barely invented at the time of the last Exhibition, and the steam was supplied to it by a separate stationary boiler; at present the boiler is attached to it and without its bulk being inconveniently increased. Steam-cranes did good service during the erection of the exhibition buildings; two of them raised all the ironwork to its position, and a few more brought the heavy goods and machinery to their allotted places. One of those used on such occasions is exhibited.

While we direct attention to the present favourable state of constructive science, we must not pass over unnoticed those proofs, afforded by the present Exhibition, that for some the teachings of experience are of little avail, and that time, ingenuity, and money are often wasted on contrivances which have been sufficiently tried before and found wanting. The principle of expansion is now universally received as of unquestionable utility, but the way in which it is carried out is not always in accordance with the progress which has been made: and hence we find engines exhibited, in which it is applied by the methods of Hornblower and Woolff, that have been long since exploded. It has been clearly established that no practical advantage is gained by expanding the steam in a separate cylinder. A heavy flywheel is almost always found to produce sufficient uniformity of action, but if the variation of power consequent on carrying the expansions to great lengths is found inconvenient in particular cases, it is a more advantageous and almost as simple a mode of remedying the inconvenience to use the two cylinders in the form of a double engine, whose piston rods, as in the case of marine engines and locomotives, act on the crank axle at right angles to each other.

The caloric engine also is exhibited, although many experiments have shown that it is surrounded with difficulties which in practice cannot be overcome. This would have been an excellent opportunity for repeating the experiments which have been recently made at Paris, and, as it has been triumphantly asserted, with so much reason for hope.

We find electro-magnetic engines also. In 1851 numbers of these were exhibited; and the jury, as they inform us, entertained very sanguine expectations of their ultimate success. Time, however, has shown these expectations to have been without foundation, and they are now indulged in by very few. The electro-magnetic engine, as we have shown, page 22 (I am referring to the first number of the INTELLECTUAL OBSERVER), cannot possibly compete with the steam-engine in economy, were there no other obstacle to its adoption. Electro-magnetism has been recently applied to a purpose the success of which is far more probable—the production of artificial light. The principle on which this is sought to be effected is illustrated, at the Exhibition, by two machines of considerable power; the one English, with commutators, the other French, without them. It is certainly capable of emitting a very intense light: and, after the machine is constructed, at the cost of little more than a small amount of steam power; nevertheless, though its advocates are very confident of success, there does not seem at present much probability of its general application as an illuminating agent, even in lighthouses, for which it is supposed to be specially adapted.

There are many points in which the present Exhibition reminds us of the progress which has been made. Castings are now produced with ease that but a short time since would not have been even attempted; cylinders are now bored and finished which a few years ago would have been considered of unmanageable size; forgings are executed which not long ago would have been out of the question. To prove the accuracy of these assertions, we have only to direct the attention of our readers to the connecting-rod and crosshead exhibited by Maudslay and Field, and to the cylinder and crank-axle exhibited by Penn and Sons.

Another improvement which has been introduced, is the use of steel more generally, and in very much larger quantities. Its advantages have always been admitted; it is far more to be depended on than iron, and, with the same strength, may be much lighter and less bulky; but, until recently, its cost and the difficulty of obtaining it in large masses prohibited its more general application. These obstacles have, however, been removed. The production of steel from pig-iron was proposed by Bessemer in 1856; but the process he used was for some time not very successful, an impure steel being the result. It was, however, subsequently ascertained that, when pure ores, which are very abundant, are employed, the quality of the product is everything that can be desired. The vast quantity manufactured by Bessemer's method in this and other countries is a proof of its excellence. Everything is at present made of steel; tires, rails, axles, bells, cannon, steam boilers, etc.; and it is now produced in enormous masses:—one block of steel in the western annex weighs twenty tons, and there are several others of very great size. Bessemer's process is founded on common sense; he takes just as much carbon from the pig-iron, as will leave any required quality of steel or malleable iron. In the roundabout way that was previously used, all the carbon was removed to form malleable iron, and then some was restored to change the malleable iron into steel. The rational method is now used everywhere, and the quantity of steel exhibited by the various countries is very great.

This is not the only illustration which the present Exhibition affords, of the application of scientific principles to practical purposes. Philosophy had taught us long ago that evaporation causes cold, and established the truth of this by some experiments on a small scale. But our knowledge on this point is now practically applied: and ice is made abundantly at the Exhibition by steam, the required cold being produced by successive evaporations of ether.

But to whatever side we turn, while we survey the wonders which are amassed in this great storehouse of the productions of human skill and human knowledge, we shall observe the utilization of scientific discoveries, and their applications to practical purposes. There is often a very wide space between the discovery of a principle in the laboratory and its application in the workshop or the factory; but the mission of philosophy is fulfilled only when the discoveries it has made have been turned to the benefit of mankind. One of the greatest advantages of such exhibitions as the present is, that all the marvels of art and science, all the fruits of ingenuity and perseverance being gathered together under one mighty roof, everyone may learn what science has achieved, and what principles have been applied to practical purposes. Of the millions who wander through this maze of wonders, many, no doubt, are occupied in considering what may be done in addition to what has been already done, what new material may be utilized, what old process may be improved or what new one suggested, what novel application may be made of the countless principles that are suggested in this vast assemblage of all that man has discovered and all that he has achieved.

HAIL AND SNOW.

BY ALEXANDER S. HERSCHEL, B.A.

All who have examined attentively the feathery down that forms the crystals of a snow-flake, and the compacter pellets of ice that characterize a hail-storm, will have asked themselves the question, What is the origin of so curious a difference in their structure? The answer is by no means long, and may be considered at this time to be pretty firmly established.

The most careful balloon ascents of the last and present centuries have shown that for every mile that ascent is made above the earth, the thermometer sinks 15 Fahrenheit degrees. It is a practice pretty commonly known, to estimate roughly by pulses of the wrist the distance of lightning flashes from the spectator, six pulses being reckoned to the mile until the first peal of the thunder is perceived; and many persons will have noticed as a fact that while near flashes of lightning are followed shortly by drenching rains, falls of hail are more commonly ushered in by distant flashes, which they follow at greater intervals of time. A flash of lightning is generally understood to announce the formation of more or less large drops of rain. The sudden refrigeration of a large highly aqueous tract of the atmosphere, converts the vapour which it embodies to mist, the small particles of which, descending and overtaking each other, presently collect to large drops. It is the property of electricity to reside only upon the exposed surfaces of excited bodies, and hence the electricity, originally imparted to the vapour by evaporation from the earth and sea, acquires rapidly a high state of tension in exact ratio to the diameters of the drops. The latter relieve themselves of their charge by flashes of electricity to the neighbouring bodies of mist, or vapour less advanced in concentration, and lightning and thunder are the results. The drops so formed continue a rapid descent to the earth.

If we take four miles as a usual height for such flashes as precede a storm of hail, we have a cold of 60 degrees below the temperature upon the earth, or 30 degrees below freezing in our ordinary summer temperature, for the condition of the atmosphere where the drops are formed. That they are not frozen upon the spot is partly due to the warmth of the gaseous vehicle that accompanies the vapour to this height, but more especially to the latent heat evolved in the condensation, which maintains the whole at the dew-point of the existing vapour until its last portions are condensed to the fluid form. With our knowledge of the low intervening temperature, we need not however, be surprised that the drops so formed in a moderate temperature should be converted into pellets of ice before their arrival at the earth.

Why should we not then experience the very same processes in winter that are so frequent in summer?

The mean temperature of the former season approximates to the freezing-point of the scale and is more than 30 degrees Fahrenheit below our summer mean. In consequence, the snow line of the atmosphere has descended as it were two miles upon our heads, and the source and fountain-head of our hail-storms is extinguished. These are the very two miles of substratum which in summer despatch vapour of high pressure and dew-point in copious quantities to the colder regions above, and whose most violent upheavals produce the phenomenon of hail.

In winter such an elevated dew-point and pressure are rarely attained, and never in any considerable quantities. The snow that we may watch gradually wasting away upon the ground, in frosts that are long and unbroken, even when severe, bespeaks clearly the low dew-point and pressure of the aqueous vapour at this season of the year. Let us consider what occurs to such a body of vapour elevated suddenly to an unusual height above the earth.

An experiment is easily performed, which is highly instructive in this inquiry. Conceive ordinary alum to be boiled to saturation in a consistent cream of pipeclay and water, and to be set aside to cool. The deposition in crystals is found to have been curiously obstructed. The current which in a clear solution sets constantly upwards from a forming crystal, like the rejected stream from the cilia of a rotifer, bringing to the crystal a steady supply of fresh particles for its aggrandizement, finds here an impediment to motion in the crowded grains of foreign matter; and tree-like, branching skeletons of octahedra are the result of the crystallization, as if feelers had been thrown out from a stem in quest of the saturated solution. The obstructing action of the nitrogen and oxygen gases to the crystallization of snow is of an exactly similar nature.

In the case we have supposed, where vapour of extreme tenuity is elevated, often by its own buoyancy, into regions far colder than its dew-point, a process of direct sublimation takes place. The crystallizing gas in this process bears no larger proportion than two or three parts in a thousand to the obtrusive and far denser gases among which its snow crystals must take their form. In the guarded operations of our laboratories the sublimation of pure vapours is attended with the formation of crystals of considerable solidity and often of great regularity, but in the free play of the elements the hexagonal growth of the ice crystals is developed into an endless variety of forms. Messrs. Lowe and Glaisher have delineated some hundred examples of these figures. In place of the solid prisms peculiar to the system of crystallization, these are flat, patterned, stars of six rays, grotesquely ramified, and having diameters of a twelfth or even a tenth of an inch. They are the skeleton-bases of regular prisms, which, grouped together, form the downy material of a snow-flake.

Thus it is that conditions in the depth of winter are quite unfitted for the formation of hail; but in the microscopic ramifications of the snow crystals we also perceive a plausible reason why lightning and thunder should not in the winter season accompany falls of snow, as they so frequently do in summer those of rain and hail. The large surface and the numerous acute points which these crystals present, are, in all probability, means sufficient for the complete and rapid dissipation of the electricity which they accumulate by their assemblage.

SATURN'S RING.—DOUBLE STARS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, F.R.A.S.

SATURN'S RING.

Our evening skies are losing much of their attraction in the departure of Jupiter and Saturn into the strong twilight, where it will be scarcely worth while to follow them. The globe of the latter is still bisected by the line of the dark side of the ring, the breadth of which* will rapidly diminish during the month, as the earth's annual movement carries us nearer to its plane, till, on July 28th, it will amount only to 0″.085, preparatory to its entire disappearance edgeways on August 12th, after which time the N. side comes permanently into view for 15 years. We intend, shortly, to give some account of the very interesting transits of the shadow of the 6th satellite which have been recently observed: unfortunately its approach to the sun will now put this phenomenon beyond the reach of any but the most powerful instruments. Mr. Dawes has detected with his 8¼-inch object-glass a "very faint gleam of coppery light" in the place of the ansæ, as in 1848; but he has been surprised at the non-appearance of the shadow of the ring, an additional proof of its "almost inconceivable thinness," or of its possessing an atmosphere sufficient to convert its shadow into a mere penumbra. As the sun is, however, now rising higher above its N. side, he says (May 22) that in a few weeks it will probably become distinctly visible as a black line S. of the projected ring, and he calls upon the possessors of powerful instruments to watch the time of its first appearance.

DOUBLE STARS.

We proceed with our list of such of these objects as will not bear delay, unless we can resolve to rise long before the dawn in the early spring. Our first is a very remarkable star:—

11. *α Scorpii. Antares:* supposed to be so named as equivalent in colour to *Ares,* the Greek name of Mars. Scorpio will be easily identified as a fine group of tolerably bright stars near the S. horizon, which, on account of its low elevation, should be examined as soon as the twilight will admit of it. The most conspicuous amongst these is Antares, both in respect of its magnitude and its colour, being the reddest of all the larger stars in the heavens. Smyth calls it fiery red. With

* This breadth was given much too large in the Intellectual Observer for May, the *whole minor axis* (= 2″·04) having been inadvertently substituted for the part visible in front of the ball.

my $3\frac{7}{10}$-inch aperture the disc appeared yellow, surrounded by flashes of deep crimson, mixed, or rather alternating, with a smaller quantity of beautiful green rays. My attention was called to this peculiarity by an old observation of Dr. Forster, in which he stated that he had "observed a remarkable changing of colour in Antares: for a second or two of time it appeared of a deep crimson colour, then of a whitish colour; then the crimson was resumed," the red colour being irregular both in its alternations and continuance. He ascribes a similar phenomenon, in a less degree, to Betelgeuze, Aldebaran, and other red stars. The attendant registered by Smyth is very distant, and I have not entered it; but a much more interesting discovery has since been made by Professor Mitchell with a 12-inch Munich refractor at Cincinnati, U. S., of a very near bluish-green companion; thus constituting it the only close double star of the first magnitude hitherto known. Our astronomer royal thought it would be impossible to see it in England, but it was detected by Dawes several times with a $6\frac{1}{3}$-inch object-glass, and found to have a distance of about 3″·5, and an angle of 273°·17; and on March 27, 1856, he saw it with 8-inches under most interesting circumstances, emerging from behind the dark limb of the moon, about 7ˢ before the principal star appeared; it was thus proved that its magnitude was about the 7th, and its colour independent, and not, as might have been supposed, the effect of contrast. The following remark by this great observer is worthy of attention:—"If the angle of position were nearly coincident with the meridian, it would be almost impossible to observe the small star in these latitudes, as the bright star forms a strong prismatic spectrum in that direction. This atmospherical effect may, however, be in a great measure counteracted by using a single lens as an eye-glass, or by the ordinary double micrometer eye-piece. The star being placed towards the southern (upper) side of the field of view, the eye-piece spectrum may be made very nearly to neutralize the atmospheric spectrum, and a very tolerable image obtained under favourable circumstances." Hippisley also has seen the *comes* twice with a $9\frac{1}{4}$-inch Newtonian, and his remark likewise is deserving of being cited, as to "the great value of the half-hour at and after sunset, for the more delicate and difficult observations in all cases where the object has light enough to be well visible telescopically by daylight, such as exists at that period. This may probably arise from the short equilibrium between the heat of day and the chill of evening; during which atmospheric disturbances, arising from the intermixture of beds of air of different temperatures and densities, may be expected to be at a minimum." Secchi, after several failures, which led him to suspect variable light, saw the companion perfectly with the great achromatic at Rome; and I have been informed by a correspondent, that under very favourable atmospheric circumstances he has seen it distinctly with as small an aperture as $2\frac{3}{4}$ inches. It is evidently not difficult from either minuteness or closeness, but merely from its low elevation, and the blaze of its superior: but should we fail to detect it, we shall assuredly not regret a nearer acquaintance with so superb an object as the great star—a fiery sun, the quality of whose light, so totally dissimilar to that of ours, must, to our apprehension, induce an equal disparity in the development of vegetable and animal life in the system subjected to its influence. There are many other instances of stars of an equally deep or even deeper red, but they are for the most part only visible with the telescope, and as Sir J. Herschel observes, are *insulated*. It will be peculiarly interesting to ascertain whether Antares is physically or only optically connected with its companion.

12. *β Scorpii.* 13″·1. 24°·9. 2 and $5\frac{1}{2}$. Yellowish white and pale lilac. I fancied the smaller star greenish with $3\frac{7}{10}$-inches, 1850·46. This is a magnificent pair, though apparently optical only. It is the brightest star *n p α*.

13. *σ Scorpii.* 20″·5. 271°·6. 4 and $9\frac{1}{2}$. Dusky white and plum-colour. Sestini called the companion white, 1846·5. Easily found from Antares, which it precedes about 2°, a little *n*.

14. *ν Scorpii.* 40″. 338°·5. 4 and 7. Pale yellow and dusky hue. This "charming object," as I have entered it, follows *β* at about 2° distance, a little *n*. Smyth records it as above, but Jacob found, in 1847, that the small star has an 8 mag. companion, at a distance of 1″·75, which, though not seen by Sir John Herschel at the Cape, is an easy object with my $5\frac{1}{2}$-inches, and renders the combination still more beautiful.

15. 51 *Libræ* (alias *ξ Scorpii*). 7″·2. 76°·1 (1834·42). 7″. 68°·1 (1846·49). $4\frac{1}{2}$ and $7\frac{1}{2}$. Bright white and grey. This is a highly interesting object, being really triple, a 5 mag. star, pale yellow, lying close to $4\frac{1}{2}$. Smyth gives for it 1″·4, 6°·6 at the earlier, 1″, 24°·9 at the later epoch. Hence it is evident that under the aspect of a single star we have a binary pair before us in rapid motion. It is to be regretted that it is now too close for ordinary telescopes. With $3\frac{7}{10}$-inches of aperture, its elongation was very doubtful as far back as 1851; Secchi found it but 0″·463 in 1855; and if there is sufficient ground for Theile's computations, the distance would be only 0″·018 in 1860, after which it would speedily widen, attaining 1″ in 1870. He gives a period of 44 years, or 49 by including Herschel I.'s observation in 1782. Jacob prefers 52 years. The more dis-

tant companion is also undoubtedly in motion, and is probably connected with the others, forming a wonderful system of self-luminous bodies, whose mutual relations are to us quite unintelligible. There is another smaller pair, 8 mag. *s* a little *f*, followed by an 11 mag. star; the whole making up a very beautiful group. It may be found thus:—When β Scorpii (No. 12) is on the meridian, a remarkable pair of 3 mag. stars, δ and ε Ophiuchi, otherwise *Yed*, the *hand* of the figure, will be seen nearly over it, almost twice as far from it as Antares. 51 Libræ is a little to the right, and rather above the centre, of a line joining β Scorpii and this pair.

16. ρ *Ophiuchi*, 3″·8. 3°·1. 5 and 7½. Pale topaz and blue. This very beautiful object, which may perhaps be in motion, is finely grouped with two 7 mag. stars, 68 and 72 P. XVI., that is to say, the 68th and 72nd in the XVIth hour of Right Ascension in Piazzi's great Palermo Catalogue—pointing out two angles of an equilateral triangle, of which ρ occupies the centre. It lies 3° *n* from Antares, a little *p*. The star maps of the S. D. U. K. include it in the boundary of Scorpio.

17. 36 *Ophiuchi*, 5″·2. 226°·1. 4½ and 6½. Ruddy and pale yellow. This is supposed to be a binary pair, and the larger star has been thought variable: when I observed it (1854·34), it certainly was but little brighter than its companion. A 7½ mag. star forms with it a triple group. It appears certain that it has a motion through space, in the same direction, and to the same amount, with 30 Scorpii, which is more than 13′ distant *n f*. Should this indicate a real connection, how marvellous an instance is before us of influence exerted through distances which human faculties refuse to comprehend, and where we can only wonder and adore! This pair is due E. at a considerable distance from Antares, nothing conspicuous intervening, with a brighter star, θ Ophiuchi, *n f*, about 2° distant.

18. 39 *Ophiuchi*, 12″·1. 356°·2. 5½ and 7½. Pale orange and blue, 1838·52. Sestini called the companion yellow in 1846·5: Smyth's review made it bluish in 1851·4, and I entered it "clear blue" three years later. This beautiful pair, which shows no movement, is 1° *n p* from θ (see last No.) Near it was the wonderful New Star of 1604, discovered Oct. 10th, at Prague, by Kepler's pupil, Bronowski, and seen by Kepler on the 17th. It was white, and more brilliant than the brightest stars or even planets, Venus alone excepted; but when it reappeared as a morning star at the end of the year, it had already begun to diminish; it continued to decay through 1605, and never came round in the morning again, nor has any trace of it been since recovered. Only two phenomena of the kind have recurred since the invention of the telescope, and both were far inferior; one near β Cygni was only 3rd mag., and Mr.

Hind's New Star in 1848, which broke out at no great distance from the place of that in 1604, barely surpassed the 5th mag.; but as an equally, if not more conspicuous star blazed forth in Cassiopea in 1572, and there are obscure relations, especially in the Chinese records, of similar events in earlier ages, we are warranted in not despairing of witnessing such a glorious sight again, and possibly of getting some approximate idea of its distance and magnitude. Thus far only we can see at present that both must be immensely great, as such phenomena undoubtedly lie far beyond the planetary system, and in the true region of the stars. Imagination shrinks from the contemplation of the impenetrable mystery of their nature, not without some appreciation of the astounding magnitude of the change indicated by so sudden an evolution of most vivid light, and probably corresponding heat also. Whether the new star in the 2nd century B.C., which we are told induced Hipparchus to form the first catalogue, was of this character, seems doubtful. It is strange that among all the authorities whom I have consulted, not one, excepting Humboldt, alludes to the curious fact that Pliny, from whom we have the story, expressly ascribes *motion* to the new object;* Humboldt, who was aware of it, has not much confidence in Pliny's "rhetorical style;" but the expressions of the latter seem as explicit as could in reason be expected.

Having now reviewed the principal double stars near the S. horizon, we will proceed to a constellation—*Böotes*—which will be in sight some time, but part of which we had better take at once, since work will crowd upon us as the days decline. And here Arcturus (α *Böotis*) shall be our guide. Every observer will easily recognize him at a considerable height in the S.W. sky, as one of the most conspicuous ornaments of our summer evenings. Wega, further E., and near the zenith, alone rivals, with its lovely sapphire beam, this glowing topaz. Observers have differed as to their precedency. In 1806, Sir W. Herschel gave the preference to Arcturus; and his son has done the same in the proportion of 718 to 510; Seidel, on the contrary, in 1846, with Steinheil's photometer, gives Wega 100, Arcturus 84. Photometry, however, is confessedly in an imperfect state; and it is not only possible, as Smyth remarks, that "colour may interfere with our exact perception of size," but it has been shown by Argelander and Pogson that in the case of red and white stars there is a considerable difference in the estimates of different eyes and telescopes. Fletcher has also found that the light of Arcturus is slightly variable. On the whole, how-

* Novam stellam et aliam in ævo suo genitam deprehendit: ejusque motu, qua die fulsit, ad dubitationem est adductus anne hoc sæpius fieret, moverenturque et eæ, quas putamus affixas.—*Historia Mundi*, ii. 26.

ever, Arcturus will probably be generally owned as the leader of the northern hemisphere: and in accordance with this, it happened to be the first star seen by Morin, in 1635, in broad daylight; as Morin was perhaps the first observer of stars under such circumstances. Schmidt, formerly of Olmütz, but at present director of the observatory at Athens, has asserted that Arcturus has changed its colour; he had for 11 years considered it one of the reddest stars, and had, in 1841, compared it with the planet Mars; but in 1852 he was surprised to find it yellow, without a trace of red, and whiter even than Capella to the naked eye. This alteration seems unconfirmed by his contemporaries, but the subject is a curious one, as such a change appears to be more than probable in the case of Sirius. In another respect Arcturus is peculiarly interesting, as possessing so great an amount of proper motion: its position alters annually 2″·25 towards the S.W., so that supposing its rate to have been invariable, it must have traversed a space equal to about 7 diameters of the moon, since the creation of man. This extraordinary displacement might be taken as an indication of comparative nearness to our system, and might be wholly or in part ascribed to a contrary motion on the part of our sun, did not the extreme minuteness of the parallax of Arcturus (about 0″·169 according to Johnson) demonstrate its astounding distance, requiring 19 years for the transmission of its light to our eyes; and prove at the same time its incalculable velocity and enormous magnitude. This is a golden sun indeed—the centre, probably of a magnificent system of attendant worlds. It is a grand object in the telescope, but though we have deservedly given it some attention, it is but an intruder in our list, and we proceed to

19. ε *Böotis*, 2″·9, 321°·2. 3 and 7. Pale orange and sea-green. A pair well deserving of Struve's epithet "pulcherrima," and long celebrated as a test of the goodness of telescopes. The recent extension of their size and power now demands a more rigorous criterion, but it is still very useful for trying smaller instruments. An aperture of $2\frac{3}{4}$ inches ought to bring it out; I have seen it as a known object, but do not suppose I should have discovered it, with $2\frac{1}{4}$. W. Struve* thinks there is no doubt of this pair being in slow motion, but Smyth does not consider the question decided. This object is closer than any that we have as yet attempted, and may be considered as our first introduction to a more difficult class, requir-

* It has been recently announced that this distinguished observer, who has rendered such eminent services to sidereal astronomy, has resigned the post of President of the Imperial Observatory at Poulkowa, near St. Petersburg, which he has worthily filled for many years. He is succeeded by his son M. Otto Struve.

ing greater instrumental and atmospheric advantages. We may therefore here suitably introduce, for the encouragement of the beginner, Sir W. Herschel's remark, already exemplified in the case of Mizar, No. 1—that when first seen, such objects "will appear nearer together than after a certain time; nor is it so soon as might be expected, that we see them at their greatest distance. I have known it take up 2 or 3 months, before the eye was sufficiently acquainted with the object to judge with the requisite precision."

ε may be easily found from our *pointer*, Arcturus, being the next moderately bright star *n f*, or nearly over it as it is declining in the S.W.

20. ξ *Böotis*, 7″·3. 332°·1. (1831·53). 6″·9. 332°·9 (1842·42). Secchi found it 6″, 1855·419. 3½ and 6½. Orange and purple. This is a very interesting pair, undoubtedly binary, and revolving probably in a highly elongated ellipse, lying very obliquely towards the eye, with a period given by Sir J. Herschel at 117 years. It will be found nearly due E. of Arcturus, forming with it and ε an almost rectangular triangle, the greater angle being at ξ. It is also the uppermost of a crooked row of four stars bearing downwards, whose position must be noticed, as we shall call up two more of them.

21. π *Böotis*, 6″. 99°·3. 3½ and 6. White: a ruddy tinge seems, however, to have been sometimes noticed in the smaller star. A beautiful pair, though stationary. An alternate view of this and the preceding object forms an interesting study of colour. It may appear surprising that with so much general similarity the one pair should be moving, the other fixed, and apparently optical. It is, however, possible that π may be hereafter found to be binary, its motion, much slower than that of ξ, from inferior density, or from greater mutual distance reduced in apparent amount by greater distance from ourselves, being for the present masked by the position of the companion, at the end of an ellipse foreshortened into a straight line. The concurrence of all these conditions is certainly very improbable, but it is well to be aware of their possibility.

π is the 3rd star, counting downwards, of the crooked row beginning with ξ.

22. ζ *Böotis*, 1″·2. 127°·3. 3½ and 4½. Bright white and bluish white. Struve asserted that they were alternately variable; but Smyth could not perceive it. This pair forms our first instance of a really close object, and is in fact far too difficult for the generality of small instruments, though its separation has been accomplished by one of Ross, senior's achromatics, having an object-glass of only 3⅜ inches. My $3\frac{7}{10}$ inches would strongly elongate, but not actually divide it; this, however, was effected by Dawes's celebrated Ormskirk telescope by

Dollond, which had $\frac{1}{10}$ more aperture, and a most exquisite correction. Secchi, in 1855, with the grand Merz achromatic at Rome, gave it but 0″·978 of distance, and it must be owned that its aspect is entirely that of mutual connection, but it is generally considered stationary; and this fact renders it a most useful criterion for instruments of moderate size, as the rapid motion of many test-objects is continually altering their value. ζ is the lowermost, and somewhat the brightest of the "crooked row."

To give the smaller instruments their turn, we will conclude our present section with

23. δ *Böotis*, 1′ 50″. 75°. 3½ and 8½. Yellow and light blue, or lilac. Wide as this object is, it is pleasing from the contrast of colour. To find it, run a line from Arcturus through ε, and carry it nearly as far again.

OCCULTATIONS.

The occultation of a considerable star by the moon, especially its disappearance behind the dark limb, when rendered sufficiently visible by the earth-light, is a striking phenomenon. Though the different positions of the moon in the sky, night after night, sufficiently show the rapidity of its orbital motion, it is much more impressively brought before us, when a fixed mark enables us to trace its steady advance minute by minute; and there is something extremely grand and beautiful in the smooth, swift motion of that ponderous globe, so perfectly balanced in free space, and urged so uninterruptedly onward by the Creator's power. Occultations, especially of telescopic stars, are constantly taking place, but the majority of them are invisible or inconvenient from the hour, or inconspicuous from the star's minuteness or the moon's brightness. The beginner may be reminded that in these cases, if he lives far N. or S. from Greenwich, the specified times, even though corrected as they require to be for difference of longitude, will not be found accurate; for owing to the moon's comparative nearness to us, each county in England refers her at the same moment to a different position in the sky, and brings a different part of her limb in contact with the star, occasionally raising or depressing her apparent path sufficiently to let the star, occulted at Greenwich, escape entirely free. The country observer, therefore, especially in situations far N., must expect discrepancies, and look out in time, as the event may anticipate the tables. Extinction and reappearance are usually instantaneous. I once (May 19, 1858) witnessed the great star Regulus *snuffed out* in a moment, and a grand sight it was, especially as the telescope (an achromatic exhibited by Slater, in Euston Road, Islington), had upwards of 14 inches of aperture. But in some cases gradual diminution has been observed, which may probably be ascribed to the impinging of the star upon the limb where its general direction, or that of some precipitous slope upon it, forms so small an angle with the moon's path, that the star, whose real (not *spurious* or optical) disc, however minute, must have *some* magnitude, is hidden by slow degrees, and thus the existence is manifested of a quantity too small, hitherto, for the finest telescopic vision. The strange phenomenon of *projection* is occasionally witnessed, when a star, instead of passing at once behind the limb, seems to glide in front of it for a short distance before it disappears. Much attention has been paid to this singular appearance by South, Airy, and others, but to little purpose; it seems to depend upon some illusion in the eye or the telescope; and though its recurrence from time to time is unquestionable, it can never be predicted on any occasion. The present month affords no very favourable specimen of occultation, but the following may be looked for:—

July 10th, 10h. 57m. 30 Sagittarii, 6 mag. This, only a near approach at Greenwich, will be an occultation further N. 11th (day of full moon), 57 Sagittarii, 5½ mag. Disapp. 10h. 22m. Reapp. 10h. 41m. 14th, $\varkappa$ Aquarii, 5 mag. Disapp. 10h. 21m. Reapp. 11h. 24m. 15th, 9 Piscium, 6 mag. Disapp. 10h. 29m. Reapp. 11h. 30m. $\varkappa$ Piscium, 4½ mag. Disapp. 10h. 31m. Reapp. 11h. 24m.

THE HURRICANE OF MAY 1862.

BY E. J. LOWE, F.R.A.S., ETC.

There is something very singular and startling in a hurricane. The suddenness of its appearance, the rapidity of its motion, and the devastation, which shows but too plainly where it has been, are points of special interest to the meteorologist. Unfortunately the exact pressure or velocity cannot be satisfactorily established; a rough approximation being the nearest approach to the truth of a violence so great that the anemometer or instrument used to measure a gale cannot withstand its fearful violence. We can register 10, 20, or 30 lb. pressure on the square foot, but a hurricane, which levels all before it, even sound and deeply-rooted oak trees that have withstood the storms of 200 years, requires something as strong as itself to enable us to record its violence. Fortunately these devastating visitants are not frequent in this country, and, more fortunate still, their violence is confined within narrow limits. The one we are about to describe was accompanied by a thunderstorm which was more or less spread over the centre of England, where in numerous places there was great destruction caused by the hailstones, but not by the hurricane except in the neighbourhood of Newark. Near Peterborough, the direction of the storm was from S. to N.E.; here, for one and a half miles in width, the crops were devastated by huge hailstones of three inches long, two inches wide, and half an inch thick, and much glass was broken. At Oundle, the crops were destroyed and the windows broken, which was also the case at Whittlesea, Eye, Thorney, Crowland, Leeds, Newark, and Whittington near Chesterfield. At Whittlesea, the storm began at three o'clock, and lasted till four o'clock, the wind being rough from S. At Crowland it began at 4 p.m. from S.E.; here the hailstones were from four to five inches in circumference. At Whittington, hail commenced falling at 4h. 45m., the wind W., veering to S., then to E., and by 5h. 45m. again W. At Eye, the storm raged from 3 till 4 p.m. At Buxton, the storm commenced between four and five o'clock, and by 5h. 45m. p.m. the darkness was too great to allow of reading or working, and gas was lighted; there was heavy rain but no hail. The lightning was first *blue*, then *peach*, *mauve*, or *rosy blue*. At Whaley Bridge there was a deluge of rain with sudden fierce S.W. gusts. At Walton (five miles from Wisbech) a sudden S.E. gale for a few minutes at 4h. 50m., the sky being very thick in the W. At the Middle Level Sluice, at 5h. 30m., there was a strong S.S.E. wind, with lightning, thunder, and large rain, which moderated at 6 p.m., going to the N.; strong S. wind till 7 p.m. At Wisbech at 6h. 15m. p.m. the darkness so great as to render it almost impossible to see close to a window; wind S.W. At Lea (two miles south of Gainsborough) continuous thunder from 4 till 6 p.m., at first over Lincoln; at 5 p.m. over Newark (where a dark lurid cloud rested), and after 6 p.m. over Worksop. The day was hot till 6 p.m. when a sudden W. breeze sprung up, and it became colder. No rain or hail. At Radborne (five miles N.W. of Derby) the storm came from S. bearing E., commencing at half-past four o'clock, and lasting till 6 p.m. Heavy rain but no hail, and the lightning never overhead. The course of the storm was from Burton. At Whittington (three miles from Chesterfield) hail commenced at a quarter to five o'clock with W. wind; some stones were four inches round and one and a quarter inches in diameter, weighing from a quarter to half an ounce, and breaking much glass. The wind soon veered to S., then to E., and in an hour was again W. At Chesterfield there was no hail. At Leeds the hailstones were seven inches in circumference. At Wath (near Rotherham) thunder commenced at a quarter past five p.m., and became continuous at a quarter to six; at half-past six very dark, a black cloud extending from S.S.E. to W.S.W.; wind S.W.; storm over at a quarter past seven. At Silloth a storm at 10 p.m. At Shiffnel (Salop) there was no thunder but incessant rain, with a N.N.W. wind. At Ventnor also, and at Clayton, Hurst-Pierpoint, and Clifton incessant rain but no storm. At Sandgate (Kent), Tunbridge, Ramsgate, Gloucester, Byfleet, Barnstaple, and Aldershott there was no storm. At Kington (Herefordshire) incessant rain, and unusually dark, but no storm.

On the previous evening, it is worthy of remark that a violent thunderstorm was raging in the Isle of Wight, extending all the way to London. Also at Clitheroe, Tunbridge, Hurst-Pierpoint, Byfleet, Aldershott, Nottingham, Derbyshire, Leicestershire, Yorkshire, and Lincolnshire, accompanied with large hailstones and *rose* coloured lightning. At Highfield House there was continuous thunder all the afternoon in S. and S.E., from storms following each other in rapid succession in a S.W. current; at 4 p.m. the wind, which had been N., veered to W., and at ten minutes to eight a thunderstorm, in a S.S.E. current, commenced passing over, the lightning exceedingly vivid and very blue in colour. At eight o'clock, for two minutes, there was a hailstorm with stones of a conical form, and as large as nuts. Above an inch of rain fell. In half an hour this storm had passed over to N., but there was much lightning and heavy rain all night. The similarity in many respects of this storm with the one next day makes it desirable to mention it briefly.

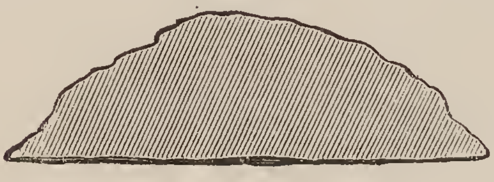
And this leads us to the memorable 7th of May, a day that will long be remembered in Nottinghamshire, memorable for the hurricane near Newark, and for the violence of the thunderstorm in the neighbourhood and elsewhere, particularly striking from the *night-like* darkness, the great size and curious forms of the hailstones, and on account of the magnificence of the colour of the lightning. At Highfield House the morning was fine and sultry, about noon thunder was heard in the S.E., and again continuously in the S. and S.E. at 3 p.m. At half-past two the temperature in the shade had risen to 73·6° with a W. wind, but with clouds whirling round in all directions; a low current carried the broken nimbi rapidly from the W., whilst at the same time the storm-cloud was approaching in a S.S.E. current; at 4h. 30m. the temperature had fallen to 60° (a descent of 13·6° in two hours), whilst the wind had risen to half a gale. At this time in the S.E., low, long-rolling distant thunder gave ominous signs of an approaching storm of great magnitude. The sky gradually became blacker and blacker until, at five o'clock, it was darker than I had ever before seen it in the daytime, with the solitary exception of the total eclipse of the sun in July 1860, within the central path in Spain. A book could be scarcely read at a window, nor away from it could the time be ascertained by a watch. This storm put on very much the appearance of a total eclipse, all near objects had a yellowish glare cast upon them, and the landscape was closed in on all sides at the distance of half a mile by a storm-cloud wall. Rain fell in torrents, being swept along the ground in clouds like smoke. Flashes of lightning followed each other in rapid succession, four or five flashes following close upon each other, then a brief pause, and four or five more. The colour of the lightning was lovely beyond description, an intense tint of *bluish-red*, approaching *rose*, all the flashes being of the same hue. The lightning was too brilliant to look at without pain to the eyes, but when reflected on white paper, the colour was most beautiful, and indeed surpassed all known colours, as much as ultramarine surpasses ordinary blue. The wind now veered to the S. or S.S.E., taking the storm's direction. At 5h. 35m. the temperature had descended to 51° (a fall of 22·6°); the wet bulb being also 51°, the rain was however less heavy. The storm had mostly passed to the N.W., and the sky, more especially in the N.E., was considerably lighter. At 5h. 50m. the wind veered to W.N.W., and the temperature commenced rising. It is worthy of remark that the barometer was almost stationary, being no doubt held up by the great coldness of the storm in comparison with the surrounding air. At six o'clock the temperature had reached 53·3°, the wet bulb being 52·5°, and the wind W., the force having moderated from a pressure of 9 lb. on the square foot (at 5 p.m.) to a pleasant breeze. The storm had passed over us in a S.S.E. current, moving slowly across a violent W. wind. At six o'clock the clouds were in a S.E. current, except in the S.W., where they were in a N.W. current. The nearest flashes were a mile and a half off. At 6h. 15m. the storm was evidently sinking more westerly, the course having become S.E. and then E.S.E. At seven o'clock there was again distant thunder in the E., and at 7h. 15m. flying scud in a W.N.W. current moved with fearful rapidity, passing from overhead a distance of 45° in 42 seconds, a higher speed than I had ever before registered; at the same time a more lofty current carried clouds slowly from the S.E. 7h. 40m. lightning in the N.E., where the sky was again black. From 8h. 40m. till 8h. 55m. a gale, after which the wind moderated. The amount of rain was not excessive, viz. 0·665 of an inch. Several trees were uprooted, and the ground was quite white all over from the bloom torn off the apple-trees.

Severe as this storm was at Highfield House, it dwindles into insignificance when compared with its violence near Newark, where it was accompanied by a hurricane and hailstorm similar to those occasionally witnessed in India. It is scarcely possible to imagine any destruction more complete than that effected by this fearful storm, but fortunately its ravages were confined within narrow limits. It appeared to commence at the village of Barnby, where a small barn was thrown down. After proceeding a mile, its force considerably increased, and just before reaching Coddington its course crossed a farm-house and buildings, which were unroofed. It then passed over several fields, tearing up the hedges. One of the fields was ploughed in ridges for potatoes; these ridges had entirely vanished, and the field was left perfectly level. As it crossed Balderton Lane it unroofed a farm-house and threw down the farm buildings, uprooting two enormous oak trees; a quarter of a mile further it unroofed the house of the head keeper of Mr. James Thorpe, of Beaconfield, breaking nearly all the windows, the hail-stones having in many instances been positively driven through the glass, cutting out a smooth hole without cracking the window-pane. The spout of this house—one too heavy for a man to lift—was carried a hundred yards. A perfectly sound tree, about 60 feet in height and 5 feet 10 inches in circumference (where broken off), was snapped asunder four feet from the ground, and the tree itself carried twenty-nine yards through the air. Although snapped off suddenly, it shows the circular motion of the storm, as the wood is twisted to the very heart of the tree. Near here a man was lifted off the ground, and carried twenty yards, finally being deposited in a hedge. From this point to Mr. Thorpe's house were many fine trees, all of which were torn up by the roots or broken off. About thirty or forty yards from the house the hurricane divided, as the house itself is intact, and also the trees in its immediate neighbourhood from S. round by E. to N. (a lilac tree not having its blossoms damaged); while on the western side outbuildings are unroofed and in some cases destroyed, the large garden wall thrown down, the green-houses smashed, the fencing round the plantations broken off and carried into the fallen timber, and a heavy plank of wood lifted off the ground, snapped in two, one half lodging on the top of a building, and the remainder carried over it into the kitchen garden. A few yards beyond the house the divided gale reunited; its course now passed through a wood, where everything in its path was destroyed; then proceeding onwards a mile and a half reached Winthorpe, doing considerable damage to the grounds of Mr. Hodgkinson, M.P., and some little to those of Mr. Marfleet. A short distance further and its fury became exhausted. The greatest violence was restricted to about three miles in length, and its extreme breadth was from 100 to 150 yards, except near Coddington, where, for a short distance, it was much broader. The course was from S.S.E. to N.N.W., being almost a straight line.

Mr. A. Stevenson, of Tynemouth, who was visiting Mr. Thorpe at the time, was an eye-witness of the storm, and from him I derived the following valuable information. He says that "at 3·30 p.m. there were mutterings of thunder. From 4 p.m. till 4·30 heat oppressive; about 4·45 and till 5 exceedingly large and curious hail fell; they were of four shapes.

1st. Hemispherical, clear like ice, except the central point,

1 A.



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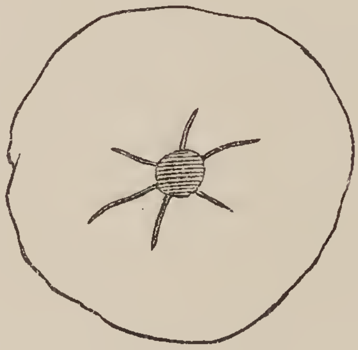
1 B.

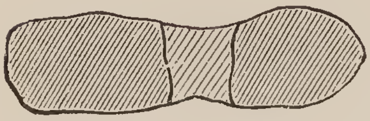


Base.

which was opaque, and from which semi-opaque lines radiated along the base. The diagrams represent the average size; some were a little larger. Of these only a few fell near Beaconfield.

2nd. Flattened spheres, more numerous than the first,

2 A.



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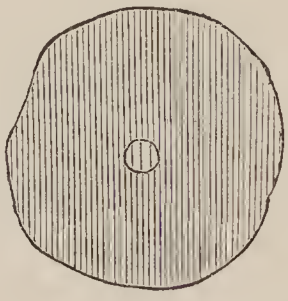
2 B.



Base.

3.

Section.

semi-opaque, with hard white centre, thinner at the axis than at the circumference.

3rd. Opaque and pear-shaped. These were numerous.

4th. Ordinary circular hail-stones, opaque and softish.

On the falling of these hail-stones the air became chilly.

At about three minutes past five o'clock, on looking out of a window facing the E., Mr. Stevenson's attention was attracted by seeing a small pony, closely followed by the sheep and cattle, rushing in terror and at great speed from the S.S.E. Opposite the house the pony stopped and looked back, and then started off at still greater speed, as if pursued. On looking in the direction from which the cattle came, he saw the sky quite obscured by a strange dark wall of cloud, which was approaching; then a large quantity of hay and straw, which seemed to fill the air, followed by clouds of the blossom of the horse-chesnut and small twigs; then at once, with a roar which is indescribable, came a furious blast, which seemed as if it would sweep the land of all which stood on it. Great trees went down before it torn up by the roots, levelled as if by a sudden blow. The impression was that the house must be swept away. This continued rather more than a minute, and was accompanied by gleams of lightning so frequent as to seem continuous. When it passed there was a torrent of rain, with extremely vivid lightning.

The gardener, who was out in this storm, says that he observed it hurling down the trees to the south of him passing by, and then throwing them down in the north; and that from where he stood, he considered that in two minutes every thing was destroyed within his view, which extended a mile and a half.

My brother, who was with his regiment about a mile from Beaconfield, describes the storm-cloud seen from this distance as tapering to a point like a waterspout, and exceedingly black and dense. He measured many hail-stones an inch and a half in diameter, and some few were larger. He says the hail fell with great force, yet not with sufficient violence to pass through glass without cracking it; it was, therefore, the force of the gale that propelled them like bullets shot from a rifle. These bullet-like holes were drilled through the windows both on the east and west side of the house, showing the circular movement of the air. From the keeper's house I had several of these panes of glass cut out of the windows, in order to preserve them. I also procured the circular pieces of glass that had been punched out.

It is interesting to observe that, whilst at Highfield House there was a gale from the W. of nine pounds pressure on the square foot, at Beaconfield the hurricane was in a S.S.E. current, and that whilst the hurricane was passing the wind changed to this quarter, and then returned to W.N.W. Probably these gales combined, and the southerly one being the most powerful, a rotation was caused moving in the direction of W. to S. That this was the case was very readily proved on examination, not only from the direction of the twist of the wood on the snapped-off trees, but from an avenue of chesnuts situate on the extreme eastern edge of the hurricane, all the torn-off boughs lying on the S. or storm side, and carried back beyond the level of these trees. Then, again, the dividing of the hurricane at Mr. Thorpe's house was a further proof of the rotation being from W. to S., as no doubt the substantially-built house and stables to the W. of it saved the trees, yet those left standing were such as would have received no protection if the force had been either *direct,* or if it had rotated from S. to W.

The fall of 22°·6 of temperature in two hours at the Highfield House Observatory (twenty miles away) was no doubt owing to this gale.

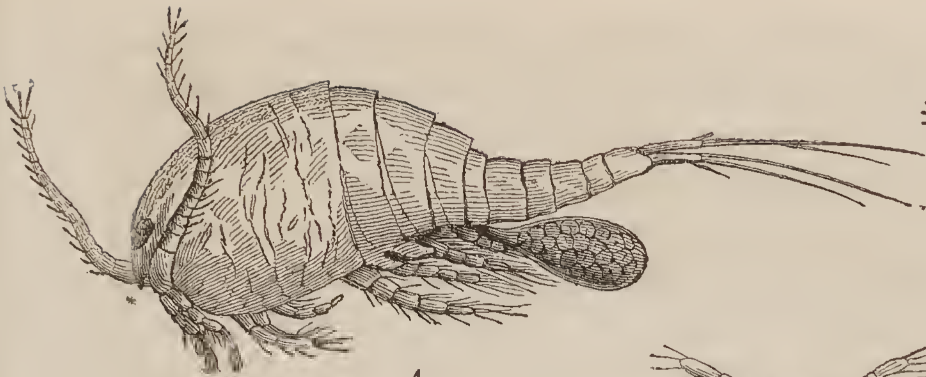
A number of photographs were taken along the path of the gale with "Dr. Hill Norris's Dry Plates." I name this as these plates had previously travelled with me to Spain in July 1860, and although this box was only opened in May 1862, they were in excellent condition.

ENTOMOSTRACA* (WATER-FLEAS).

BY G. S. BRADY, M.R.C.S.

Among the many groups of minute organisms to which microscopic observers are accustomed to devote their attention, there is scarcely any that is more calculated to interest the student inquiring into the curiosities of animal life, or to fascinate one who seeks only for amusement from the employment of his microscope, than that which embraces the strange beings known as Entomostraca. They are objects too particularly easy of access to almost everyone; for wherever water is they are abundant. It is, indeed, scarcely possible to dip a net into any weedy pool without bringing out of it some examples of the tribe; though probably in this case only common species, such as *Cyclops quadricornis* or *Chydorus sphæricus.* These two animals must be known by sight, if not by name, to every one who has examined microscopically a drop of water from a stagnant pond. And not only in fresh water do Entomostraca abound; they exist, likewise, in prodigious numbers in the sea, in brackish waters, and even in the concentrated brine of salt mines. Many species are parasitic on the skin, gills, and eyes of fishes, and some are found living even in the interior of zoophytes, etc. Though thus almost ubiquitous in habitat, they are seldom found in rapidly-running streams—delighting rather in the clear, still and sweet waters of lakes and large ponds: these, when

* The class Crustacea is divided as follows:—*Podophthalma,* or stalk-eyed Crustacea (crabs, lobsters, etc.); *Edriophthalma,* or sessile-eyed Crustacea (sand-hoppers, etc.); *Entomostraca* (water-fleas, fish-lice, etc.) By some authors the *Podosomata,* or sea-spiders, and the *Cirripedia* (Barnacles), are included amongst Crustacea. The *Rotifera* have also been considered to belong properly to this class, but probably with less propriety. Mr. Gosse, who has paid great attention to them, thinks that they have closer affinity with the insects.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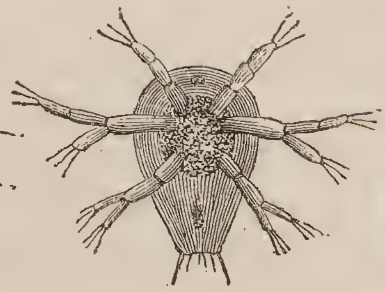
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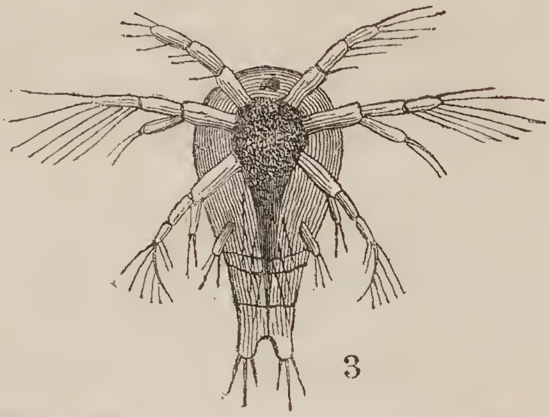
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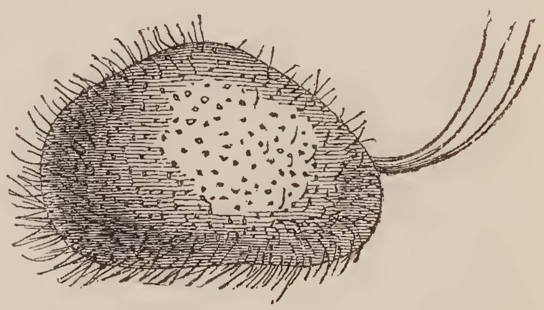
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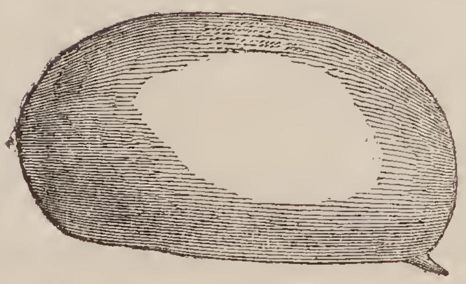
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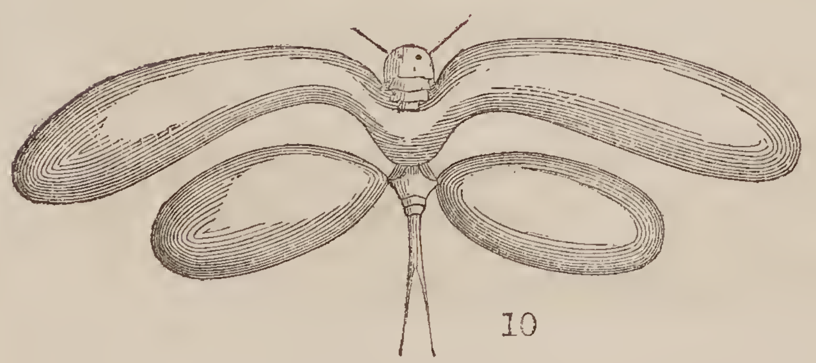
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well supplied with growing weeds, are the best "hunting grounds." It is a mistake to suppose that a dirty, foul-smelling, stagnant pool is the likeliest to afford a rich harvest to the collector in any branch of natural history; a pond, to be good, should be of tolerable size, long-established, and stocked with aquatic plants. These, by the constant liberation of oxygen, tend to keep the water pure, besides affording food and a home among their branches to countless animals which could not thrive without them. There are, however, several species of Entomostraca, whose congenial habitat is the muddy bottom of ponds and ditches.

The rate of increase amongst these creatures is prodigious. "Specimens of the *Cyclops quadricornis* are often found carrying thirty or forty eggs on each side (fig. 4); and though the other species, which have only one external ovary, do not carry so many, still the number is very considerable. Jurine has, with great fidelity, watched the hatching and increase of the *Cyclops quadricornis* in particular, and has given a calculation which shows the amazing fertility of the species. He has seen one female isolated lay ten times successively; but in order to speak within bounds he supposes her to lay eight times within three months, and each time only forty eggs. At the end of one year, this female would have been the progenitor of 4,442,189,120 young!! The first mother lays forty eggs, which at the end of three months, at eight layings during that time, would give 320 young. Out of this number he calculates eighty as males (there being in every laying a great proportion of females) the remaining 240 as females. The following table will show the prodigious extent of their fecundity* :—

	No. of layings.	Time employed for these eight layings.	Each laying supposed to be of forty young.	Subtract for males.	Females remaining.
1st mother .	8	From 1st Jan. to end of March,	320	80	240
1st family of females .	8	From 1st April to end of June,	76,800	19,200	57,600
2nd family of females .	8	From 1st July to end of Sept.	18,432,000	4,608,000	13,824,000
3rd family of females .	8	From 1st Oct. to end of Dec.	4,423,680,000	1,105,920,000	3,317,760,000
		Total . . .	4,442,189,120	1,110,547,280	3,331,641,840

Among the most remarkable phenomena connected with the natural history of the Crustacea, are the transformations which

* Baird, *British Entomostraca*, p. 189 *et seq.*

the young undergo from the time of their escape from the ovum to the attainment of their fully matured specific form. And it is of the highest interest to remark, that in obedience to a law which, if not universal, is at any rate widely prevalent in the animal kingdom, these temporary or larval forms are themselves closely analogous to the *perfect* forms of groups still lower in the scale of nature; so that many of these undeveloped beings were formerly, before their life-history was known, classed as distinct species, in a position very far from that which they are now seen to occupy. These changes have been closely studied in the common shore crab (*Carcinus mœnas*). The embryo of this species before, and for a short time after, its liberation from the ovum, presents both in size and general outline a strong resemblance to some Entomostraca. In this stage it was of old assigned to a distinct genus under the name of *Zoea*, and having undergone a still further transformation was called *Megalopa*. In this latter stage it puts on somewhat the appearance of the "lobster-crab" (*Galathea*), and after another step attains its true crab form, being the highest development of which it is capable. These changes are not produced gradually, but by a succession of "moults," the animal becoming for a time sluggish, casting its hard covering, and reappearing in a new guise. It is a well-known fact that the after-growth of crustacea is carried on by the system of moulting—the hard calcareous case of the animal preventing its growth in any other fashion. And as in the higher orders of Crustacea, so also amongst the Entomostraca, are transformations of this kind constantly apparent. For example, let us take the same species which we have just noticed as a characteristic instance of reproductive energy—*Cyclops quadricornis*. When first born, these little creatures (figs. 1, 2) are totally unlike their parent, being of an ovoid shape, and having only two short antennæ and two pairs of feet; but by three moultings the animal reaches its perfect form, having then two pairs of antennæ and five pairs of feet, besides which the body is seen to be divided into several distinct rings or segments. These changes will be best understood by reference to the plate (figs. 1, 2, 3, 4), the drawings in this instance being copied from Dr. Baird's work. The length of time occupied by these changes varies much according to the temperature. In February and March, Jurine found it to extend over twenty-eight days, whereas Dr. Baird has seen the process completed in eleven days during the warm weather of June.

Among the many interesting phenomena connected with the reproductive process in the Entomostraca, there remain one or two which we cannot pass over without brief notice. It is in members of this group that several of the most undoubted instances of Parthenogenesis* occur. It is certain that with many species one copulation is sufficient to impregnate the female for life. And not only this, but that the young which she produces are likewise fecundated and capable, without further impregnation, of continuing the species for many successive generations. In *Chydorus sphæricus* (a common form), Jurine observed the process through *fifteen* generations, and through *nine* in *Alona quadrangularis*. Dr. Baird has followed up the successive generations in *Daphniæ Pulex* as far as the *fourth* in the *Daphnia* born from the ordinary ova, and as far as the *third* in those born from ephippial eggs. These ephippia, or "winter eggs" require, probably, a few words of explanation. They are, in fact, ova covered with envelopes of more than usual hardness and thickness, and thus enabled to withstand an excess of cold, which would surely prove fatal to the parent. They are borne (in the *Daphniæ*) near the back of the shell in a considerable open space termed the matrix. (Fig. 5 represents *Daphnia rotunda* bearing an ephippium.) Here they may be seen in the form of a dense mass of hexagonal cells, through which appear one or two oval bodies, each of which contains an ovum covered with a shell. The ephippium with its enclosed eggs is set free at the fifth moulting of the animal, and floats on the water until spring, when the young are called into active life by the rays of the "world-reviving sun." The authors of the *Micrographic Dictionary*, however, reject this theory of the use of the ephippia, saying :—"The formation of this coat can scarcely have any relation to temperature, either from its structure, or from its requirement in an organism which *has no heat to retain*. Its presence would be perfectly intelligible, however, as a means of protection from evaporation when the pools become dry; and for this purpose its structure is well adapted. It might also afford a protection against the attacks of predatory animals, many of which could easily devour an ovarian ovum, while they could not break through the horny cases of the winter ova; and these winter ova are only formed when the ova are not to be hatched soon after extrusion from the parent." It is somewhat startling to read in a scientific work of animals which "have no heat to retain." Why, even a block of ice has heat in it, and although Entomostraca are what we call "cold-blooded" animals they are only *relatively* so, and cannot bear more than a moderate decrease of temperature with impunity. If these winter-eggs are meant chiefly as a protection against drought and not against cold, it seems strange that they should not be most

* For further information on this subject see Owen's *Lectures on Parthenogenesis*, and Dallas's Translation of Von Siebold on *A True Parthenogenesis in the Honey Bee and Silkworm Moth*,—the last a most interesting work.

abundant during the hot summer months when pools are most subject to be dried up. Moreover, it is probable that in many cases the animals themselves would bear such a desiccation without loss of life. Thus Dr. Baird "has found, upon examining ponds which had been filled again by the rain after remaining two months dry, numerous specimens of the *Cyclops quadricornis* in all stages of growth." It seems, indeed, to be almost a condition of existence with some species that their habitats should be exposed to alternations of wet and drought; as for instance *Chirocephalus diaphanus.* This, which is one of the largest (being upwards of an inch in length), and certainly the most beautiful of Entomostraca, inhabits cart-ruts and shallow pools mostly near the edges of plantations, but never any, so far as I can learn, which are not liable to be dried up easily. The *Chirocephalus* is rare in Britain, most of the known localities for it being in the south of England. The only living specimens I have seen were taken at Tillmire, near York, the most northern point at which it appears to have been hitherto found. Some species are much more susceptible of cold than others. For instance, *Polyphemus pediculus* is killed on the first approach of frost, while the *Daphniæ* and *Cyclops* may be found living the winter through, and, indeed, may be positively frozen and yet recover. For the following interesting table, exhibiting the effect of temperature on the species of Entomostraca, I am indebted to the Rev. Alfred Merle Norman. The table shows the number of species taken at a single gathering in the same piece of water, during the successive months of 1861:—

January (after the intense frost of 1860-61)	4 species.	July	14 species.
February	7 "	August	? "
March	7 "	September	17 "
April	17 "	October	17 "
May	10 "	November	10 "
June	? "	December	12 "

Mr. Norman remarks that the deficiency in the May number may perhaps arise from the day when the gathering took place not having been fine, the animals for that reason withdrawing into deeper water. While thus tolerant of all but very intense cold, it is interesting to note that Entomostraca will also live and thrive in water of very considerable heat. There is a reservoir connected with the engine of the Monkwearmouth colliery, the water of which is somewhat irregular in temperature, but mostly sufficiently hot to steam profusely. On one occasion I found the heat to be 100° Fahrenheit, and I suppose this may be taken as about the general temperature of the water. A pond-weed (*Potamogeton perfoliatus*), and a *Callitriche,* grow freely in this hot bath (though their stems and leaves are plentifully encrusted with a deposit of calcareous matter), and sporting amongst the vegetation are myriads of Entomostraca, belonging chiefly to two species, *Cypris aculeata* (fig. 7), and *Cypris strigata* (fig. 6), the former, I believe, hitherto unknown in Britain. Beside these there were found *Cypris vidua, Candona reptans, Daphnia vetula,* and *Cyclops quadricornis.* It is worthy of remark that the two latter species were of stunted growth, while all the bivalve species (*Ostracoda*) attained a fine development. But it is not only under extreme conditions of heat, cold, and drought, that these creatures are capable of existence. We find at least one species which luxuriates in a *brine* strong enough to destroy almost any other animal. This is the *Artemia salina,* a species approaching in form the beautiful *Chirocephalus diaphanus* before alluded to. It is found abundantly in the brine-pits at Lymington in Hampshire, and it is remarkable that it is only in the most concentrated brine—containing four ounces of salt in the pint—that it makes its appearance. It is said that even if this solution be slightly diluted by rain the animal disappears. "During the fine days in summer they may be observed in immense numbers near the surface of the water, and as they are frequently of a lively red colour, the water appears to be tinged of the same hue. 'There is nothing more elegant,' says M. Joly, 'than the form of this little crustacean; nothing more graceful than its movements. It swims almost always on its back, and by means of its fins and tail it runs in all directions through the element it inhabits. It may be seen to mount, descend, turn over, spring forward, curve its body into the form of an arch, and then rebound, and deliver itself up to a thousand bizarre and capricious gambols. Their feet are in constant motion, and their undulations have a softness difficult to describe.' . . . 'If we observe, in a small quantity of liquid, the mother at the time of parturition, we see the young group themselves round her body, and there is nothing more pretty, more agile, more graceful than this little troop. But soon the scene changes; one, two, or three young ones are involved in the current which the motion of its fins causes, they pass into the gutter situated between these organs, and from thence come to the mouth of the mother. She at first disperses them as being inconvenient bodies, but soon afterwards they present themselves again, and pressed upon by the stiff hairs which form the branchiæ, then by the papillæ, lastly by the jaws, they arrive at the mandibles reduced nearly to pulp, and they are swallowed as any other substance would be.'" *

Though mostly found, as has been stated, in brine pits, this species also occurs in saltmarshes. The cause of its red colour

* Baird's *Entomostraca,* p. 59.

has been ascertained by M. Joly to depend on its food, which consists to a great extent of a small monad (*Monas Duvallii*) which colours the marshes and reservoirs of Montpellier. Whether the same cause exists in the saltpans at Lymington I do not know, but it is remarkable that the spontaneous vegetation which arises in vessels of stagnant salt water has often a red hue. Thus, Mr. Gosse tells us* that a tank of sea water on one occasion produced in great profusion patches of a "rich crimson-purple colour," which spread rapidly over the bottom and sides of the vessel, as well as over the surface of the water. This proved to be a sea-weed of the genus *Oscillatoria*, apparently undescribed in Dr. Harvey's *Phycologia*. But it seems unnecessary to resort to phenomena of this kind for an explanation of the colour of the *Artemia*. There is a very common tendency to redness amongst Entomostraca, which appears to be quite independent of the colour of their food. I have seen a variety of *Cyclops quadricornis* so red as to appear like brilliant spots amongst the mud in which it was taken; and amongst a gathering from Grisedale Tarn, in Westmoreland, were multitudes of *Diaptomus Castor*, which looked like animated scraps of red sealing-wax. The marine species (*Cetochilus septentrionalis*, &c.) may sometimes on a fine summer day be taken in such abundance as to resemble a mass of red paint in the bottom of the net. The Great Salt Lake of the Mormons is stated to contain twenty per cent. of saline constituents—precisely the strength of the solution which *Artemia* inhabits—and is also said to be quite devoid of animal life. We do not read, however, that it has ever been examined with a view to the discovery of minute forms. Possibly it may contain curious examples of this much-enduring race, for that its waters are not fatal to all phases of animal existence is proved by the multitudes of caddis-cases which are found washed up on its banks.

Bearing in mind the excessive fecundity of Entomostraca, we need feel no surprise at the prodigious shoals in which they are met with. Some of the *Daphniæ* have been observed in numbers large enough to give to the water in which they swam the appearance of blood. Dr. Baird says that he has himself seen "large patches of water assume a ruddy hue, like the red rust of iron, or as if blood had been mixed with it, and ascertained the cause to be an immense number of *D. pulex*. The myriads necessary to produce this effect is really astonishing, and it is extremely interesting to watch their motions. On a sunshiny day, in a large pond, a streak of red, a foot broad, and ten or twelve yards in length, will suddenly appear in a particular spot, and this belt may be seen rapidly changing its

* Gosse's *Romance of Nat. Hist.* 2nd Series, p. 105.

position, and in a very short time wheel completely round the pond. Should the mass come near enough the edge to allow the shadow of the observer to fall upon them, or should a dark cloud suddenly obscure the sun, the whole body immediately disappear, rising to the surface again when they have reached beyond the shadow, or as soon as the cloud has passed over." I on one occasion gathered a curious species, *Cyprideis torosa*, Rupert Jones (fig. 8), in such numbers, that when the contents of the net were turned out into a bottle of water they resembled a huge mass of mites in constant motion. Though naturally unable to swim, they were literally "all alive and kicking; this was in a salt marsh on the Northumberland coast, but it is in the sea that Entomostraca reach their most astonishing development as to numbers. So numerous are they in the South Atlantic, that they form the chief food of the whale; and the red streaks which have been noticed as sometimes occurring in freshwater ponds, may in those regions be seen in the sea on an infinitely larger scale, stretching over many miles of its surface. "They swarmed in myriads," says Vauzème, "and when the wind was boisterous, a whole bank of them would be taken up by a wave, and carried on board the vessel, covering the deck and the clothes of the sailors." On our own coasts they may be seen in scarcely inferior numbers. The Rev. Mr. Norman has noticed them in a sheltered bay among the Shetland Islands, so numerous that the water was literally thick—viscid with them, so that when a net was dipped amongst them, and allowed to drain, quite a consistent mass remained. And Mr. Goodsir says, respecting the Firth of Forth :—"On looking into the water it was found to be quite obscured by the moving masses of Entomostraca, which rendered it impossible to see anything even a few inches below the surface; but if a clear spot is obtained, so as to allow the observer to get a view of the bottom, immense shoals of cod-fish are seen swimming lazily about, and devouring their minute prey in great quantities. Occasionally small shoals of herring are seen pursuing them with greater agility. Great numbers of Cetacea often frequent the neighbourhood in the summer months, droves of dolphins and porpoises swimming about with great activity; and occasionally an immense rorqual may be seen, raising his enormous back at intervals from the water, and is to be observed coursing round and round the island."

As to diet, Entomostraca exhibit by no means a vegetarian tendency; on the contrary, they appear to be in many cases most ferocious in their mode of supplying the commissariat. Doubtless they fulfil a very useful purpose in destroying great quantities of decaying animal matter, and when put into an aquarium which does not afford a sufficient supply of this sort of food they quickly pine away. But it is not only on *dead* animal food that they subsist; they devour voraciously multitudes of infusorial animalcules, and even, as we have noticed in the *Artemia*, their own young. The *Cyprides* are among the most bloodthirsty of the race. They not only prey upon each other, but upon animals much larger than themselves, such as the *Chirocephalus*.

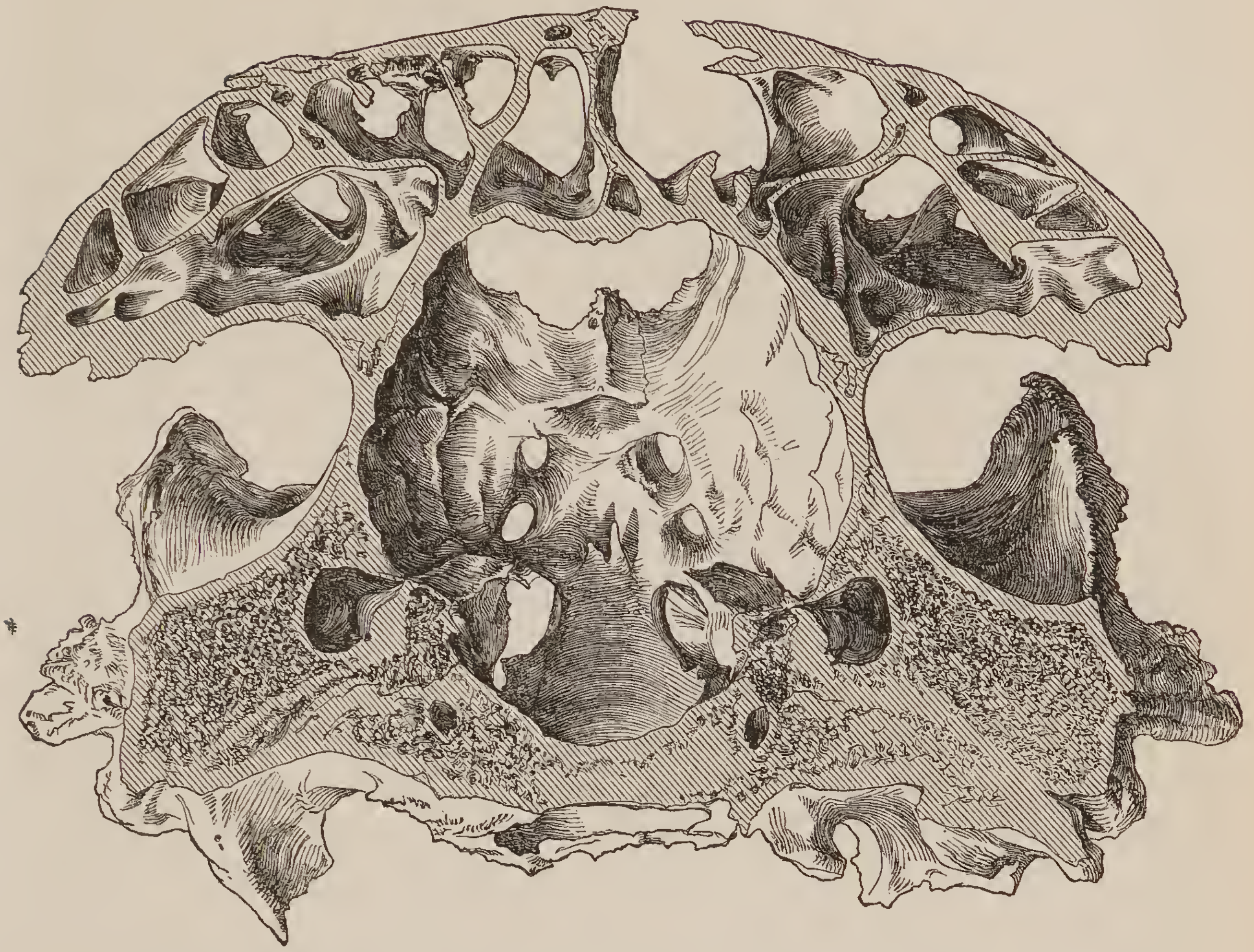
The free-swimming Entomostraca are mostly very active in their habits, but there is great variety in the character of their motions. *Cyclops* swims through the water with a succession of short, rapid jerks; the *Cyprides* work their bivalve shells along steadily, but rapidly, by means of their lower antennæ acting as a pair of paddles; whilst an allied genus (*Candona*) is unable to swim because these lower antennæ are not armed with the long filaments which give swimming power to *Cypris*. *Candona*, therefore, is content to crawl on the bottom, or on the leaves and stems of water-plants. The beautiful motions of *Chirocephalus* and *Artemia* have already been referred to. The most grotesque and amusing of the whole tribe are the *Daphniæ*; these curious creatures use a pair of long arms or antennæ as propellers, which they work up and down most energetically; and as the machinery comes to an occasional stand-still, they look, with arms raised high above their heads and great staring eye, as if transfixed with stupid astonishment.

Standing in strange contrast to the liveliness of the *Daphniæ* is the lazy helplessness of a nearly allied form, *Acantholeberis sordida*. This singular species has, within the last few months, been found for the first time in Britain by the Rev. A. M. Norman, whose account of it has not yet been published. It has been taken on the Continent by two naturalists, but they each found only one specimen, nor could they ever succeed in re-discovering it. Their attention was first drawn to the animal by observing it lying motionless—a bright red speck—at the bottom of their collecting bottle. Mr. Norman's experience was precisely similar, but he has been more fortunate as regards the *number* of specimens taken, his captures having amounted to four or five. Still, it is evidently a species of excessive rarity, and not more rare than curious. The creature is built, so to speak, on the model of a Daphnian, for swimming, but its antennæ, which ought to raise and propel it through the water, seem too weak for their purpose; and as no crawling apparatus is provided, it lies on its back, waving its clumsy arms, and reminding one forcibly of the man who, when his cart got into the mire, did nothing but throw up his hands and call to Jupiter for help. The only progression which I have ever seen it make was a sort of jumping, produced by using one arm like a leaping-pole against the bottom of the vessel. When full grown, it is mostly covered with diatomaceæ and other confervoid growths, so that the continental authors alluded to suppose this to be the reason of its inactivity. Such, however, is not the case, as the following observations will show. A specimen which was sent to me by Mr. Norman to make drawings from, produced, while in my possession, five young ones. These, though they were for a few hours rather more active than their parent, presently took to the same mode of life, and though at first perfectly free from any parasitic growth, they soon became covered with diatoms, etc.—the *result,* not the cause, of their inactivity.

Pertaining to the anatomy and physiology of the Entomostraca, there is much of the highest interest which we have not at all noticed.

There is also a large group of parasitic species, deriving their nourishment chiefly from the juices of fishes and the larger Crustacea, concerning which a very few words must for the present suffice. These curious beings infest both marine and freshwater fishes, mostly attacking such as are in a sickly condition—unless, indeed, the sickliness be a *consequence* of their presence. Fish thus infested are called by the fishermen *lousy.* Some of these species attach themselves by suckers; others possess hooks, or anchors, which they bury in the tissues of their unfortunate victim, obtaining by this means a hold which baffles every effort at dislodgement. No part of the fish's body is secure from the vermin; most of the commoner species live on the skin, fixing themselves in the interstices between the scales; but some forms are found only on the gills and eyes. Fig. 9 is a representation of *Lerneonema Spratta,* a species which has been found attached to the eye of the sprat. Fig. 10 is *Nicothoe Astaci,* whose habitat is the gills of the common lobster.

In conclusion, we may say that scarcely any field of research offers more abundant chances of success in the discovery of new species, or more room for investigation towards solving doubtful physiological problems. There are but few labourers in this field, and whilst the student will find in the monograph of Dr. Baird, published by the Ray Society, and in Mr. White's excellent little *Manual of British Crustacea,* admirable guides to his researches, he will, in all probability, before he has gone very far, prove for himself, by the discovery of undescribed forms, how little labour has as yet been spent over this interesting group of beings.



THE FRONTAL SINUSES OF BOS BUFFALUS.

BY SHIRLEY HIBBERD.

In making a sectional division of a skull of Bos buffalus, the immense development of the frontal sinuses were a matter of surprise, and as but few sections of heads of this and other species of Bos have been published, it was thought advisable to place the section in the hands of the engraver. The subjoined cut is in every detail faithful to the original; and the reader will doubtless agree with the writer, that the frontal bones have a strange conformation. The animal which supplied this skull was full grown and of grand proportions. The horns were remarkably symmetrical, and in every respect conformable to the figure and description of the species in Vasey's monograph of the genus Bos (p. 76). The characteristics of the species are, convex forehead, horns flattened at the base, bent down, and recurved at the tip. The Arnee is said to be a variety of the species with larger horns, not bent down.

Placing the section aslant at an angle of 45°, with the occipital below, we have presented to view the sawn face of the section, extending through the frontal and temporal bones, just above the plane of the auditory foramina, and within the eighth of an inch of the foramen magnum. The brain-case is large and deep anteriorly, the sphenoid considerably depressed, optic foramina small, the structure of the whole dense and heavy, the diploë in some places scarcely distinguishable from the external tables, which are hard as flint. It will be seen by the cut that the frontal forms a huge protecting shield over the brain-case, and that it projects right and left by horn-like processes, and is throughout its whole bulk divided into a series of partitions or sinuses, the walls of which are arranged symmetrically. They are very dense, and the spaces between them vary in form and size, though if a vertical line be drawn through this portion of the skull at the sagittal suture, the sinuses on one side are very exact counterparts of those on the other. From the upper exterior edge of the frontal at the sagittal suture, to the sectional line over the foramen magnum, the measurement is $7\frac{7}{8}$ inches. The extreme width of the frontal, measured from the extreme points of the horn-like projections is $11\frac{1}{2}$ inches. The two lateral sinuses differ slightly in size; that on the left hand in the cut, measures $3\frac{7}{8}$ inches in length, and $1\frac{5}{8}$ inches across at its widest part, by a line drawn across it vertically. The other has a length of $3\frac{5}{8}$ inches, and $1\frac{7}{8}$ inches respectively. The loss of a portion of the intersecting walls of the sinuses to the right of the sagittal suture, was owing to an accident in making the section, owing to the extreme hardness of the bone. The cavity of the cerebrum is, in the opinion of the writer, proportionately large, but this opinion is hazarded in the absence of means of comparison with similar sections. In the section the measurement across at the line of the two wings of the sphenoid is $4\frac{3}{4}$ inches, and vertically, from the central dip of the inferior surface of the frontal to the superior ridge of the temporal, over the foramen magnum, is 5 inches. It was not possible to measure the internal capacity of the brain-case in this instance, the portion of the skull figured being the only one which remained for leisurely examination, and that was kept solely on account of the curious conformation of the sinuses.

No doubt many reasons may be conjectured to account for the peculiar structure of the frontal. It evidently possessed immense strength, both for the support of the horns and for their use as weapons of offence. But it is worthy of remembrance that this buffalo is semi-aquatic in its habits, and thrives best in regions most infected with malaria. May not the sinuses be in some way connected with the function of respiration, to enable the creature to bear submersion for some length of time while fording a stream, or when taking shelter in the swamp from the myriads of insects which annoy it?

JENYNS'S MEMOIR OF HENSLOW.*

THE career of the late Professor Henslow was well worth its memorial in a biographical form. As a man, he possessed an honesty of purpose and force of character which led him, in spite of serious obstacles, to make his own knowledge and powers of observation the means of benefiting all with whom he came in contact. From childhood his tastes were scientific, with special tendencies to botany, entomology, and other branches of natural history. He carried his pursuits with him to Cambridge, and instead of sinking under the dead routine of mere classical and mathematical studies, he was one of the few gifted men who infused a new life into that venerable place, which was thus rescued from being a mere museum of mediæval notions, and brought into something like harmony with the wants and the spirit of a more enlightened age. Let us not depreciate either literature, or pure mathematics; but however permanent may be the value of the masterpieces of Greek and Roman writings, or the importance of studies directed to the consideration of the properties of number and form, it is quite clear that thousands of young men might go through the old form of scholastic training, and be left with very narrow minds, and feeble conceptions of a host of matters of primary importance at the present day. From bygone periods we are mainly distinguished by our advances in positive knowledge, and from the number of directions in which scientific principles are applied to the affairs of life. We recognize the dominion of law—which is nothing more than the continuous, unchanging expression of Divine intelligence and will—in every department which human thought can penetrate, or human action effect, and we endeavour to shape our conduct so as to make the powers and forces of nature the executive ministers of our commands. Wordsworth grandly tells us—

> "Winds blow, and waters roll
> Strength to the brave;"

but the brave must neither be ignorant nor stupid if they wish the elements to serve them. It is knowledge that gives the talisman by which their services are compelled. Simple as this fact is, modern intellectual reformers have had a hard task to enforce its recognition, and though Professor Henslow had predecessors and fellow-labourers in the good work, still to him must be assigned a large portion of the honour of forcing the physical sciences into the educational scheme.

* *Memoir of the Rev. John Stevens Henslow, M.A., F.L.S., F.G.S, F.C.P.S.,* late Rector of Hitcham, and Professor of Botany in the University of Cambridge. By the Rev. Leonard Jenyns, M.A., F.L.S., F.G.S., F.C.P.S. [Van Voorst.

In 1822, Dr. Clark, the Cambridge Professor of Mineralogy, died, having done much by the excellence of his lectures to kindle an ardour for scientific pursuits. Mr. Henslow was his temporary successor, although he had not completed his M.A. degree. In 1825 the chair of Botany became vacant, and it had long been the object of Mr. Henslow's desire. Mr. Jenyns tells us that the previous professor, Martin, was at the time of his decease a very old man, who ceased to lecture, or even reside at, the University. Sir James Edward Smith had indeed offered to supply the deficiency in 1818, but the tutors of the Colleges prevented his delivering lectures, "on the ground of his being neither a member of the University nor a member of the Church of England." "Darkness rather than light from any candle but our own," was the motto of these distinguished pedagogues, and, so far as botany was concerned, they remained in the dark, till fortune sent them a teacher whose qualifications they did not dispute. Except in the hands of a real man of science, botany is apt to degenerate into the mere acquisition of a multitude of hard words. An unfortunate vegetable, or any of its parts, is treated to a nickname with which the pupil does not associate the ghost of an idea; and the mind is no more cultivated by the process than if the memory had been burdened with an equal number of unexplained terms from the extinct dialects of the Caribbean Sea. This vain pretence of learning did not satisfy Mr. Henslow, who provided his pupils with baskets filled with living plants, which he taught them to dissect, and thus follow his expositions of their structure and modes of growth. In the same spirit he made the botanical examinations of the London University realities—not shams—in which the real knowledge of the student could be tested, and positive acquisition preferred to useless cram. Part of his system, as a teacher, consisted in excursions to various districts, which were attended by entomologists and others, as well as by botanists—all being glad to avail themselves of the Professor's extensive information, and his readiness to help all who were in need.

After being allowed to labour for many years in honourable poverty, he was fortunate enough to obtain the living of Hitcham, in Suffolk, worth more than £1000 a-year. Whether an honest change to liberal opinions, and service to the Whigs, induced Lord Melbourne to give him this preferment in 1837 does not very clearly appear, but it opened for his energies a new sphere of exertion, in which he laboured with great zeal and success, continuing to perform the duties of his professorship all the while. He found his new flock in a deplorable state, but not worse than many agricultural districts were at that time, and perhaps not worse than some still remain. A straggling street held about a thousand persons, amongst whom was a sad proportion of vagabonds and unemployed. The real property was assessed at £6000 a-year, but the village had no better educational apparatus than a single dame school. Ignorance, crime, beggary, vice, and destitution had possession of the charming place, and supplied enough dragons for the knight of science to assail. Hitcham might have had a new rector of equal benevolence, but less knowledge, and then in spite of well-meaning exhortations, the dragons would have won the day. Not so with Professor Henslow. He studied the characters he had to reform. Cricket, and other manly games which rose under his auspices, prepared their minds as well as their bodies for healthy admonitions of a moral kind, while an annual exhibition of fireworks on the parsonage lawn attracted many to look at specimens of natural or artificial curiosities which no one knew better how to explain.

He lost no time in establishing a better school, and he instituted ploughing matches, and promoted allotments, to raise the labourer in the social scale. The farmers raised an outcry against this latter innovation. "They held their men," says Mr. Jenyns, "in grievous subjection. They viewed them as little better than slaves to do their work." It was a terrible task to teach these thick-headed farmers that their own interests would be served by doing their duty to the labourers. So high did their antagonism rage, and so fully were they imbued with the kind of feeling that actuated the Cambridge tutors in their opposition to Sir J. E. Smith, that they actually passed a resolution to "refuse all employment, and show no favour to any day labourer who should hold an allotment." Nothing daunted by these threats, Professor Henslow circulated a printed statement of his unalterable determination to sustain the rights of the poor, and so the allotments flourished, and the ignorant prejudice was in time put down.

Another benevolent scheme, in which Science taught Benevolence what to do, was the establisment of Horticultural Shows, in which prizes were given for things such as wood-carving not specially connected with the object indicated in the name. At these meetings the Professor had his "Marquee Museum," in which he delivered what he called "lecturets" to all who chose to come. The objects exhibited were selected to suit all tastes, even the children had their case containing a "heap of shells and corals," and a "new device from the last horticultural show in Fairy Land." Among the prizes distributed on these occasions were some to the village botanists—botany being a subject of instruction in his village school. On Monday he spent one or two hours in this pursuit, "the botanical pupils were all volunteers, and limited in number to forty-two.

They varied in age from eight to eighteen, and mostly entered with great spirit into the work set before them, seeming thoroughly to enjoy it." In dealing with his uneducated students, the Professor displayed uncommon tact. So far as practicable, the difficulties were diminished, but those inherent to the subject were as fairly met and as fully conquered as if the village children had been members of his university class. As technical terms could not be dispensed with, the boys and girls who wished to learn botany, had to begin with spelling dicotyledons, monocotyledons, angiospermous, and other afflicting looking words, which in due course were practically explained. Deal stands furnished with vials afforded the means of displaying the wild flowers that could be obtained in blossom, and which the children were encouraged to collect, in order that they might be properly labelled and form the subjects of the lesson to be conveyed. Each pupil was supplied with a dissecting board "made of deal, twelve inches long and nine wide. Across the upper half of each board was pasted a paper with four compartments. Opposite these, the names of the four floral whorls, and their subordinate parts, were printed, together with the adjective terminations for expressing botanically the numerical and other relations between them."

The children pulled their flowers to pieces, and wrote the results of their examinations upon their slates, which were all sent to the rectory to be looked over and corrected. For further details of this admirable method of teaching, we must refer to Mr. Jenyns's work, but we must not forget to allude to the annual excursions, in which he conducted his pupils to some pleasant place, and to the larger excursions in which the adult villagers joined. In one instance he conducted a large party to Ipswich, where they saw the town and the Museum which he arranged. Another time they went to Harwich, and many had there their first sight of the sea. In other years Norwich, Cambridge, and Felixstowe received the happy parties, the funds for their trip being provided partly by the Professor, who thus appropriated the sum that his predecessor expended upon a tithe dinner, partly by other donations, and partly by the subscriptions of the people themselves. Such continued goodness, guided by intelligence, converted even the farmers, and in testimony of their estimation they presented their rector with a silver cup.

Such a man was Professor Henslow, as a teacher of science, and a social reformer, of a type which had no existence in prescientific days. We have regarded him under two aspects only, and passing over his claims to honour as an original investigator, or in his purely clerical capacity—subjects which would exceed our limits—we find the spirit of knowledge strong in death at the close of his career; for as disease was busy changing his mortal state, he studied the phenomena of a dissolution, of which his religious nature had no fear.

His greatest works remain behind in the moral and intellectual elevation of his pupils, his parishioners and his friends; but his writings were numerous, not the least important being the elementary, such as the "Practical Lessons in Botany," compiled for the South Kensington Museum, and his admirable "Dictionary of Botanical Terms,"* which is an invaluable aid to the regular student, and a work of constant usefulness in family circles where scientific tastes prevail. In this excellent little volume each word is clearly explained, and its derivation given, while numerous woodcuts convey at once to the eye the information which words alone might fail to give.

BALBIANI ON THE REPRODUCTION OF INFUSORIA.†

Our present object in dealing with M. Balbiani's researches is expository, not critical, so for the sake of brevity we omit historical details and pass at once to his declaration that "Infusoria, like other animals, propagate at certain epochs with the aid of elements characterizing sexual generation." These elements originate in the interior of organs known as the *nucleus* and *nucleolus*. The nucleus is the producer of germs or ovules, the nucleolus develops fecundating corpuscules, or zoosperms. The first may be considered as the ovary, the second as the testicle of infusoria. These two organs constitute all the sexual apparatus of these animals. In some cases an excretory channel seems added to the ovary, and perhaps also to the testicle, and appears to open directly outside. The reproductive organs are always distinct, though united in one individual; but the hermaphrodism which results from this arrangement is not complete, as the concurrence of two individuals is always needful for the process of fecundation, which takes place inside the creatures, and requires the transport of the male elements of one to the female organs of the other.

The situation of these organs varies considerably, not only in different groups, but also in different species of the same

* *A Dictionary of Botanical Terms*, by the Rev. J. S. Henslow, M.A., Professor of Botany in the University of Cambridge, new edition, illustrated by nearly Two Hundred Cuts. Groombridge and Sons.

† *Recherches sur les Phénomènes Sexuels des Infusoires*, par le Docteur G. Balbiani. Victor Masson, Paris, 1861.

genera. The nucleus, or female organ, exhibits three principal varieties: (1) spherical, or ovoid; (2) tubular; (3) moniliform, or like a chaplet of beads. The nucleolus is much smaller than the nucleus. "The male and female corpuscules are often united simply by their common envelop; but in other cases, not less numerous, the first is received in a depression (*échancrure*), more or less deep, of the second, where it sometimes disappears entirely, but nevertheless preserves its own envelop, although the confusion of the two bodies may be so complete, that the hiding-place of the male corpuscule can only be discovered by the employment of re-agents, such as diluted acetic acid, which determines the condensation of their substance and the visible separation of their walls." M. Balbiani divides Infusoria into (1) "species whose ovary has the form of a little utricle, or bag, of a rounded or ovoid form, containing an undivided mass of vitelline matter. In these the testicle during its existence exhibits a similar appearance." Among these he places Colpods, Glaucomas, Paramecia, some of the Trachelia, Nassula, Chilodons, etc. "In these species the ovary has constantly the form of a little vesicle, usually situated in the middle of the body, and completely filled with a granular matter, in the interior of which the ovules are developed at the time of sexual reproduction." (2.) "Species with an elongated ovary, cylindrical, or tubular, variously curved or twisted, containing a vitelline mass not presenting divisions (*non fragmenté*). Testicle as in the former." To this division Euplotes, Aspidiscus, most of the Vorticellids, Trachelius ovum, etc. belong. In it "the male organ does not participate in the elongated or cylindrical shape of the nucleus," but in the instances in which M. Balbiani has detected it, appears as "a little globular or oblong corpuscule, free, or more or less entangled (*engagé*) with the substance of the ovary." (3.) "Species with an elongated ovary, straight or bent, containing a vitelline mass divided into two or more distinct fragments (ovary bi or multilocular). Testicle usually composed of an equal number of elements which accompany the vitelline fragments, more rarely of a single element." M. Balbiani remarks, "In the preceding group we have seen the ovary affect the form of a tube more or less elongated, in the interior of which a granular mass extends without interruption from one extremity to the other of the organ. If, instead of supposing this mass equally distributed through the ovarian tube, we conceive it divided into a certain number of fragments which succeed each other with regularity, and in the intervals we imagine the tube more or less constricted, we shall have an exact picture of the arrangement that we shall meet with in all the species composing this group. The family of the Oxytrichians, reduced to its principal

Ehrenbergian types, *Oxytricha*, *Stylonichia*, *Kerona*, and *Urostyla*, exhibits this arrangement in its greatest simplicity." In this division of his subject M. Balbiani describes what is commonly considered to be the mouth of *Trachelius ovum* as a generative aperture.

M. Balbiani considers that species have been erroneously made on account of the appearance presented by the ovary at different epochs. He says, " Since my observations on the singular transformations which the ovary of the infusoria undergoes during the spontaneous division of those animals, it is evident that one phase of these transformations is characterized by the elongated ribbon-like aspect which this gland assumes, shortly before it divides itself between the two new individuals. In this respect the ovoid and moniliform nuclei behave in precisely the same way, and recall for the moment, under this aspect, the form which this gland presents among the vorticellids and other types previously mentioned. These modifications, transitory and purely physiological, have more than once been taken by classifying authors for permanent forms, and employed under this idea for the characterization of certain species. It is thus that under the name of *Stentor Rœselii*, Ehrenberg describes an animalcule which differs from all others of the same genus by its *testicle* (ovary) which takes the shape of a long sinuous band destitute of articulation, while amongst the other stentors it is usually disposed as a chaplet. To this peculiarity we must reduce the difference which Ehrenberg establishes between this species and *S. Mülleri*. . . . . It is only necessary to look at his four figures of S. Rœselii to be satisfied that two of them refer to specimens observed at the moment of spontaneous division. As to the others it is probable that they also relate to individuals about to divide themselves, but in whom the signs of this process, and especially the existence of a longitudinal ciliary crest, which is the first indication of it, had escaped the celebrated microscopist."

Let us now pass to the mode of fecundation, under which title we read, " The facts by which I was led to study the phenomena of the propagation of these animalcules, have received from all the naturalists and physiologists of our epoch, a signification entirely different from that which I assign to them. All these authors in fact see only a longitudinal self-division in the appearance which I shall demonstrate to arise from the sexual union of two individuals, and admit in consequence that the greater part of the species of this class are able to multiply indifferently by transverse or longitudinal fission. The favour with which this opinion—so little conformable to the real state of things—has been received, and generally accepted as one of the best ascertained facts of science, has induced me to describe in detail the phenomena of infusorial reproduction. To restore to them their true significance it is enough that I should show, by reference to pure and simple facts, that the infusoria couple for the purposes of fecundation like most other animals. . . . . We have seen that hermaphrodism is the rule among Infusoria . . . . and in mode of fecundation they approach certain gasteropods and worms, which, having both sexes united in a single animal, nevertheless require the co-operation of a second individual to produce fertile germs;" but while these latter are usually provided with well-developed organs for the intromission of the prolific fluid, "the infusoria are totally destitute of them," and to supply their absence, nature has recourse to other means. Describing these, M. Balbiani divides Infusoria into two classes—one having the mouth situated at one anterior extremity of the body, and in the direction of its longitudinal axis, and in others, which form the great majority, this orifice is placed beyond the axis, on one side of the body, and usually in its anterior half; and he speaks of the animals coupling by bringing together the "depressed region placed in front of the mouth; or where it only exists in the form of a minute and simple depression, or narrow groove, by the contact of this part only, the remainder of the body being free. "The exudation of a glutinous substance at the point of contact serves to consolidate their adhesion, by soldering them intimately together; so that their premature separation becomes impossible, notwithstanding the energetic strains to which they expose each other." At first he considered the mouth was the organ for the transmission of the fertilizing fluid, and this opinion was strengthened by noticing its position during the process, but by examining the *Paramecium aurelia* with a good illumination, and powers of 700 or 800 diameters, and treating the objects with very dilute acetic acid, or aqueous solution of iodine, he states he was "able to demonstrate that not only the ovary, but also the testicle, was provided with an execretory duct, whose course he could follow, from its origin in the glands to a point situated below the mouth, towards the posterior extremity of the buccal furrow." The annexed sketch (fig. 1) from M. Balbiani represents the appearance of two Paramecia aurelia slightly compressed, and acted upon by dilute acetic acid: *a* is the ovary; *c* its execretory duct; *b* the

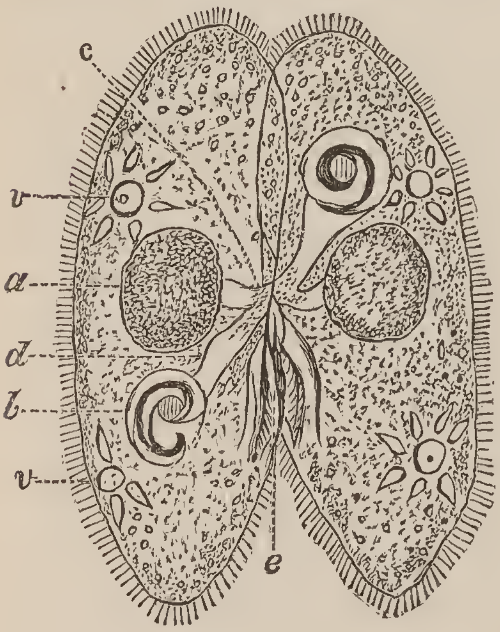


Fig. 1.

male capsule, containing a bundle of spermatozoa bent into an arc; *e* the mouth; *v* the contractile vesicles. M. Balbiani has not been able to ascertain whether the ducts of the two organs unite in one cloaca, or have distinct orifices. In some genera he has not even satisfied himself of the existence of a genital orifice. The coupling lasts from twenty-four hours to five or six days, according to the development of the organs. When they exist only as a simple rounded granule, which is their lowest condition, the longest time is required, and it diminishes as their evolution is advanced. "This remark applies not only to species in which the ovary and testicle are developed simultaneously and attain the end of their transformations at the same time, but also to those in which the evolution takes place in an unequal and successive manner. Constantly the female organ precedes the male organ, in order both of appearance and development, so that in some species (Stentors, Spirostomes) the ovary contains a number of eggs almost fully developed, while no vestige exists of the male elements."

M. Balbiani describes the nucleus as always present, but varying in appearance according to its development. In young animalcules it is a colourless, transparent, minute roundish mass, the contents of which appear granulated when acted upon by acetic acid. "Among most infusoria, the male and female organs disappear completely after each effort of propagation, and are immediately replaced by other productions of the same nature, which, commencing their existence in a rudimentary form, rapidly pass through the phases of their evolution, and re-establish a complete sexual apparatus in a short time. From their first appearance the new organs are of larger dimensions than in young individuals, and thus offer a greater resistance to the action of re-agents, and enable their structure to be better appreciated. If we examine a Stylonichia, Oxytricha, Stentor, or other animalcule possessing this property, immediately after reproduction has taken place, we do not find the nucleus under the characteristic form belonging to the species, but in its stead we note a body which offers the greatest resemblance to the nucleus which the same infusoria presents in a young stage." In some species, M. Balbiani tells us, that the "primitive female ovule" enlarges, and reaches maturity without multiplying itself, except that it divides when spontaneous fission of the animal occurs; in most kinds, however, the primitive egg gives rise to a number of other eggs by transverse division. He observes: "The number of eggs which enter into the composition of the same chain, is often considerable. I have often counted from twenty-five to thirty in certain large Trachelians (*Amphileptus cygnus, Loxophyllum meleagris*), and from forty to fifty in adult specimens of *Spriostomum ambiguum*, immediately after reproduction. At other times they are so numerous that their chain can only lodge in the interior of the body on condition of folding several times on itself, as occurs in certain Urostyla." In another place the writer informs us, "When the eggs have reached their full development they exhibit the appearance of little spheres whose bulk is noticeably uniform in the same individual. But at this epoch their transparency is so great, that they only appear in the greater number of species as simple spots surrounded by darker granulations of the parenchyma. It is therefore indispensable, in order to form an idea of their shape and structure, to treat them with a reagent like acetic acid, which augments their cohesion and refractive power. The action of this agent immediately exhibits little globules of a bluish or yellowish-grey, and endowed with considerable powers of refraction. The vitellus, of a homogeneous,

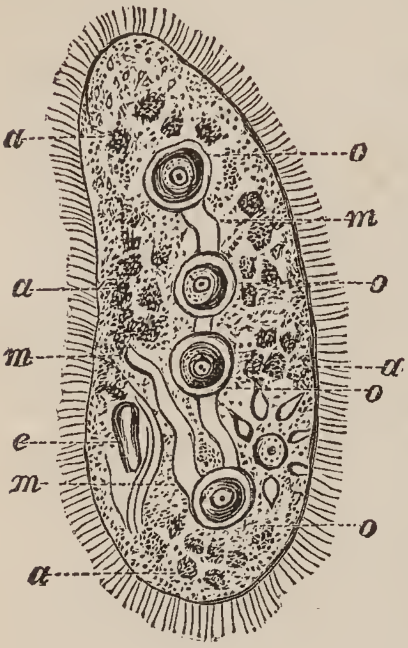


FIG. 2.

or finely granulated appearance, is seen, on being crushed, to be composed of larger or smaller granules loosely adherent, and connected by a mass composed of fine molecular granulations. The germinating vesicle is usually completely masked by the


FIG. 3.

vitelline granulations, and cannot be seen. Sometimes, however, it can be shown by employing first a very dilute solution of caustic potash, and then a little iodine in water, or acetic acid. For the same purpose ammonia and carmine may be employed, which gives the vitellus a rose tint, and causes the vesicle to appear as a more clear central spot."

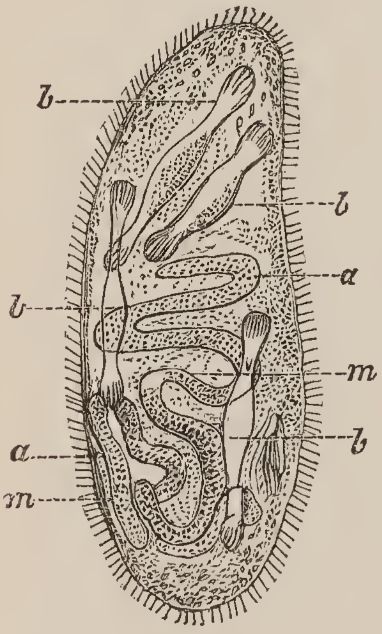


FIG. 4.

Although the eggs appear free in the cavity of the body, M. Balbiani affirms that they are enclosed in a membranous canal, which is only the terminal portion of the long, bent, tube resulting from the metamorphosis of the ovary. His view is exhibited in the annexed drawing (fig. 2), taken from his published work, in which *o, o, o, o,* represent the eggs, *m, m,* their tube open in *m′* in the buccla groove, *a, a,* are sterile fragments of granular matter, and no trace remains of the spermatic capsules; those not having been employed in fecundation being absorbed. In fig. 3 the male capsule is seen fully developed; the fine lines representing the spermatozoa. In fig. 4 several of them are seen elongated, and ready to multiply by division (*b, b, b*); the *o*'s again represent fertile ovules in their duct, the *a*'s and *m*'s the ovarian tube, the latter letters indicating empty spaces.

Mr. Balbiani's experiments and observations will no doubt be repeated by other observers, and while recognizing their importance, we must await their confirmation or confutation.

AUSTRALIAN NATURALISTS.

FROM the *Melbourne Argus*, February 28, we extract the following particulars concerning the Australian "Sea Horses." The specimen alluded to was obtained by Mr. Joseph Harrison, who received it with a statement that it was found on the beach at Lacepede Bay. This same naturalist has formed an extensive collection of Australian entomology, which is said to be particularly rich in beetles, and to contain about seven hundred moths, varying in size from five inches across the wings to the minute dimensions of a mosquito. The colours are described as being very fine. The *Argus* says:—

"A very fine and perfect specimen of the sea-horse—*Hippocampus* (?)—(the Australian species not being yet defined) has been sent to our office by Mr. Joseph Harrison. The most interesting peculiarity in the order to which the sea-horse belongs is that of the males of most species carrying the eggs about them till they are hatched. In some, the egg-pouches are on the breast, in others, on the tail, or the eggs are merely glued on in rows, and not covered by a membrane. In this they seem to resemble the marsupials of Australia, upon the coast of which continent they are common, as well as in the seas which divide it from New Guinea. Notwithstanding the odd and stiff appearance of the sea-horse, and other small members of the order *Lophobranchii*, some have prehensile tails, like those of the American monkey; and when kept in vases furnished with slender twigs to which they can suspend themselves, they form pleasing objects of study. It is said that they resemble the chameleon, in being able to direct one eye backwards and the other forwards. This, however, is not an established fact, though their eyes are certainly movable either backwards or forwards, even if not separately so. We believe that small specimens of this singular fish are pretty frequently found on the coast at Brighton and Glenelg; but the southern species are at present only partially known, and have not, as we remark above, been properly classified."

The naturalization of English and other foreign creatures is making considerable progress, and there is a project on foot for renting "Betsy's Island" from Lady Franklin's agent, in order to convert it into a nursery for game. Efforts have also been made, but as yet without success, to introduce the *Guramie* from the Mauritius, where it has the reputation of being the best pond fish in the world. Captain Lowrie, addressing the president of the Acclimatization Society, said that he obtained about 300 of these fish, most of them being very young, but about fifty from three to eight inches long. These specimens were divided between an aquarium, furnished by Mr. Jones of the *Argus*, and a seasoned water-cask, hung upon gimbals, each in a skylight. During the first days (the ship sailed on the 19th of January) a good many of the small fry died in the aquarium, but none in the cask. Having provided abundance of fresh water, about five gallons a day were removed from the cask and replaced, and the fish were supplied with a little bran, which the captain says they eat. After getting to sea, those in the aquarium died quickly, while the inhabitants of the cask continued well. Every five days the whole of the water was changed, and air was pumped into the water every hour. On the eleventh day a S.W. gale arose, and the temperature fell to 60°. In the morning all those in the aquarium were dead, except about half a dozen of the largest, which were removed to the cask, whose inhabitants had not been diminished to the extent of five per cent. On the 18th and 19th of February another S.W. gale came, and lowered the temperature to 57°, and by the morning all the finny passengers had perished. Captain Lowrie thinks that on another voyage he may manage to transport the Guramies safely, if he employs a stove to prevent the temperature falling below 70°, but if they should arrive safely in Australia, it is by no means clear that they would thrive in any but the warmest spots.

THE DOMESTICATION OF SCIENCE.

A COUNTRY may contain a considerable amount of scientific knowledge, and may take a high stand for the variety and originality of its investigations, and yet the majority of its homes may remain in a comparatively ignorant state. The university may have its learned professors, the schools of medicine may possess able demonstrators and lecturers; and yet the general condition of society may be feebly affected by the elevating influence of scientific tastes. While this is the case, science cannot be said to be domesticated. It may manifest its power in great national undertakings, in the improvement of particular branches of manufacture, or in arrangements for the public health; but it contributes nothing to the intellectual or moral dignity of the homes of the people. Such was the state of England until a very recent date; and although we have now emerged from the profound barbarism of the Georgian era, we are only at the very commencement and threshold of those beneficent changes by which social relations will be modified and improved. Compared with other countries in Europe, or in America, we may have a large number of persons capable of appreciating scientific reasoning, or engaged in some kind of scientific pursuit; but many families in the middle and upper classes are still deplorably ignorant of elementary laws and facts; and vanity and frivolity too often rule their leisure hours, because they are not sufficiently cultivated to appreciate the delights which any form of study can afford. In ordinary schools the physical sciences are as much neglected as if Nature offered no phenomena to investigate, no principles to discern; and although so-called "mechanics'" and other institutions are scattered by hundreds over the land, the lecture system has been degraded into a mere amusement for idleness; and the subjects selected, succeed each other in defiance of any method by which positive knowledge can be increased. On the other hand, we may note with satisfaction the rise of naturalists' field clubs, and other societies by whose agency a large amount of information is pleasantly obtained, and likewise the extensive sale of numerous publications of a more or less elementary kind. There is also the striking fact of the great increase in the number of purchasers of microscopes and telescopes, which are becoming necessary portions of the furniture of every well-ordered home.

In London and many other great towns, the means are now provided by which systematic study may be carried on at a moderate cost; and thousands of young men destined for industrial pursuits are preparing for their future career by laying a foundation of natural philosophy, chemistry, and geology, and other researches of a scientific kind; nevertheless, it too often happens that the scientific member of a family is an isolated being. He, or she, may be applied to as a convenient dictionary to explain any hard word that occurs in casual reading, or to elucidate any startling fact that forces itself upon the attention, but his pursuits are not contagious, and his tastes seldom elevate the household to which he is attached. Where the microscope is habitually used, the beneficial influence of a good example is more easily felt, as few can resist the opportunity of viewing the exquisite objects which a skilful manipulator can so readily display. But in this as in other occupations, the presence of unsympathetic persons is disagreeable, and families can gain little from a microscopic member unless they make him sufficiently comfortable in the general circle to draw him from his special retreat. Similar remarks may be made with reference to telescopic inquiries. Most people are delighted to see the sun rise and set upon the jagged peaks of the crescent moon, or behold on the full face of our satellite the appearance of seas,* continents, and volcanic cones. In both cases, however, the interest is evanescent, unless the mind is prepared by previous knowledge to speculate upon the objects presented to the view. Where there is no idea of the relation between life and organization, no conception of physiology, natural history, or biology, the microscope is no better than a toy, from which only temporary amusement can be obtained; nor can the telescope minister to a more permanent delight, if some previous study does not indicate the meaning of lunar formations, or tell the story of the planet or the star. In all the aspects of Nature those see most who know most, and unless the faculty of attention is cultivated, the difficulties which beset the porch of science cannot be removed.

The existence of our own magazine, and the wide welcome it has received in every town, may be taken as a convincing proof that intellectual tastes already possess an extended sway. Twenty years ago, no sane publisher would have ventured on such an experiment, and many who expressed their personal delight at our proceedings, thought we made a great mistake in offering matter of so high a class at so low a price. For the select few, they knew strong meat would be required, but they doubted the existence of many who could digest anything better than the milk-and-water that is deemed suitable for babes. We knew more of British society than our faint-hearted friends; we did not expect to circulate with the velocity of the penny novel or the startling romance; but we did

* Most of our readers are aware that the moon is supposed to be destitute of water, and that her seas are dry.

not forget the adage that "many a little makes a mickle;" and although in any given street or town, the cultivators of science are an undoubted minority, yet when all are put together they make a mighty host. We aimed at the homes of the intellectual, and there we are.

During the past six months we have had a swarm of correspondents; and although the extent of our constituency rendered it impossible that we could reply to individual communications, we have not lost sight of any useful hint; and although we have not repeated our programme in so many words, we have not forgotten to provide our readers with something to do, while we have endeavoured to lay before them abundant matter about which they might pleasantly and profitably think. From our own observations during many years, and from portions of our correspondence, we have discerned in many individuals and families a want of self-help. In reference to popular astronomy, people deficient in this quality are apt to forget how easy it is to learn from an almanac—like Dietrichsen and Hannay's—a host of necessary facts about the rising, southing, and setting of the sun, moon, planets, and stars. In chemistry they forget the number of cheap manuals which they can easily use, but which we cannot undertake to reprint. In microscopy they do not perceive that every atom they come into contact with is an object that they may examine, and that every description of minute anatomy, or organization, supplies hints concerning what they are to observe. Persons whose tastes are decided, and mental fibres firm, may do wonders by themselves, but co-operation, invaluable to all, is indispensable to most. The members of a good local society can see what others do, and how they do it. They can refer to one colleague for the name of a plant, to another for the description of a fossil, to a third how to get over a difficulty in using an instrument of research. In many circles this kind of mutual help takes place without formal arrangements for its provision. Families fond of any branch of science naturally associate together—and how far preferable is a gathering for any rational purpose, to a conglomeration of tedious mortals bent upon a millinery and tailorcraft display.

The domestication of science and literature—which are the closest allies—is a most important incident for civilization and happiness; and although the male part of creation may do their share of the good work, it cannot be accomplished unless the women choose to aid. The very general failure of mechanics' and similar institutions to provide the means for scientific culture, has naturally arisen from the average condition of the families from whom their members were derived. Even in the metropolis—if we except the feeble efforts of the London Institution, which although rich in funds, has sunk into a state of intellectual paralysis—it is in Albemarle Street only, that any association of the kind does really serviceable work; and even there the pay of the professors does not equal that of a first-class bookkeeper, or an attorney's managing clerk. In 1801 Davy was secured for a hundred guineas a year, "one room, coals, and candles." Faraday began with twenty-five shillings a week, and it was only in 1853 that his remuneration reached the annual value of £300. Tyndall was captured in 1853 for the small sum of £200, and in 1859 his income was raised to £300. We mention these facts as specimens of the difficulties which still beset the pursuit of science, for although considerable incomes may now be gained in some departments, original research, and the best kind of popular exposition are as unremunerative as of old. What we want for the domestication of science is, that each town and district should regularly supply two courses of instruction, the one elementary, and the other intended to keep pace with the advancing knowledge of the day. But whether the means of study be public or private, a logical system should be pursued. Thousands of intelligently disposed people find every scientific subject difficult, because they have never mastered the elements of a single one. If the principle of the lever, the nature of fluid pressure and motion, the simplest incidents of electric repulsion, attraction, or induction, the chemical phenomena of combustion and combination are not understood, no progress can be made. Such matters ought to be taught alike to boys and girls in school, and easily secure their attention if illustrated by appropriate experiments. We say these things *ought* to be taught in the scholastic routine; but as the great majority of the pupils of expensive establishments learn no more of them than if they had been placed under chloroform as soon as the term commenced, and only revived for the holidays, the neglect of the pedagogues must be repaired after their inefficient labours have been performed.

In 1810 Sir Humphry Davy appealed to the "higher female classes" in words which are now applicable to women of all ranks. He said, "Let them make it disgraceful for men to be ignorant, and ignorance will perish; and that part of their empire founded upon mental improvement will be strengthened and exalted by time, will be untouched by age, will be immortal in its youth." Unhappily, we have still a number of uncultivated young men who do not feel at ease in the society of intelligent women; and mothers of a certain order look upon their girls as a kind of live stock, to be grown so as to suit the taste of the market, whatever it may be. Notwithstanding these circumstances, the demand for stupidity, whether male or female, is less than it was; and both sexes are beginning to perceive that, where ignorance rubs against ignorance, dulness is the result. Domestic life without ideas is worse than a bottle with no wine in it. When the actual business of the day is transacted, ignorant people have nothing to interchange, and they suffer the disadvantage of solitary confinement in a crowd of the same sort. Quarrelling, under such circumstances, is Nature's effort to break a monotony which their constitution cannot endure. The happy home is the intelligent one, where each member communicates something to the common stock of thought and knowledge, and where the family does not consist of an ill-assorted aggregation of babies great and small, dependent for their amusement upon some rattle of frivolity, or the chance of a stranger tickling them with a fashionable straw. Of such happy homes there are thousands in our country, and we say of their possessors, "May their tribe increase." To them the capture of an insect, the opening of a flower, the skimming of a pond, or the movements of a star, furnishes occupation and delight. Nor are human interests forgotten, because all Nature speaks with a million voices, proclaiming truths which the ignorant do not hear. As a rule, the most cultivated families are the most efficient workers in every useful direction. They may not choose to go out of doors for purposes of no worth; but, by making all with whom they come into contact wiser, they augment the forces which are employed in removing evil, and add to the powers which labour effectively for good.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

CHEMICAL SOCIETY.—*May* 29.

Action of Mordants in Dyeing.—On May 29th, several interesting papers were read. An elaborate memoir by Mr. W. Crum, "On the Action of Mordants in Dyeing," explained, with much detail, the nature of the union between fabric and dyeing materials. Mr. Crum repudiated the idea that any chemical union took place, but regarded the action in some cases as one of adhesion to an extended surface, in others where the colouring matter (or mordant and colouring matter) is in solution, absorption took place. The structure of the fibre bears out this view, for on examining cotton under the microscope it is seen to be composed of flattened tubes with translucent walls, permeable, no doubt, to fluids. When mordants are used they are often deposited within the fibre, and retained there mechanically, and afterwards, combining with the dye, serve to fix it in the material. What is technically termed *dead cotton* does not take the dye, for being immature or imperfectly formed fibre, it possesses no central tube; it occurs in small quantities along with ordinary cotton, and remains white and unaffected after mordanting and dyeing. Mr. Crum exhibited numerous specimens of dyed and printed cotton fabrics in which threads and bundles of undyed dead fibres were very well seen.

On the same evening Mr. Riley read a paper in which he announced the presence of titanic acid in a number of specimens of clay which he had tested for that substance; he believed that it was an invariable constituent of clay. He found also, that in all cases in which the blast furnaces produced good iron, titanium was present. This result is in accordance with the conclusions of several chemists and manufacturers, who have pursued experiments in the same direction.

CHEMICAL SOCIETY.—*June* 5.

Oxide of Ethylene: a Link between Organic and Inorganic Compounds.—The recent meetings of the Chemical Society have been peculiarly interesting, MM. H. St. Claire-Deville and A. Wurtz having delivered two instructive and eloquent discourses to a large concourse of its foreign and English members.

The first-named of these illustrious French chemists gave an account of the laws of Vapour-Densities, detailing more especially the chief results of those experiments of his own which tend to throw light upon certain apparent perturbations of these laws; the lecturer's comparison of such perturbations to analogous phenomena in astronomy and other sciences was most happily conceived and clearly enounced.

Professor Wurtz's discourse on "Oxide of Ethylene, considered as a Link between Mineral and Organic Chemistry," was given on June the 5th. It is to M. Wurtz that we are indebted for the discovery of many of the most important facts in the history of that well-known hydrocarbon, ethylene, or olefiant gas. The first glimpse into the true character of this interesting product was obtained by Herr H. L. Buff in 1855, but in the following year M. Wurtz obtained from it several new derivatives, one of these, more especially remarkable, having given him the means of procuring the substance which formed the topic of his discourse.

The gaseous hydrocarbon ethylene, represented in chemical symbols by the formula C_4H_4, has been long known to combine with two equivalents of chlorine, forming a heavy oily liquid, $C_4H_4Cl_2$, termed Dutch Liquid, or Oil of the Dutch chemists. Now these expressions suggest nothing as to the constitution of this product, but many views have been held with regard to it; some chemists, for instance, believing it to be a compound of hydrochloric acid and chloride of vinyle (C_4H_3Cl), because, when acted upon by caustic potash, hydrochloric acid was removed from it, in this way :—

$$\underset{\text{Dutch Liquid.}}{C_4H_4Cl_2} = \underset{\text{Hydrochloric Acid.}}{HCl} + \underset{\text{Chloride of Vinyle.}}{C_4H_3Cl.}$$

A simpler view regards it as a bichloride, presenting some analogy with the inorganic chlorides, such as that of platinum :—

$$\underset{\text{Bichloride of Ethylene.}}{(C_4H_4)Cl_2.} \qquad \underset{\text{Bichloride of Platinum.}}{PtCl_2}$$

On heating bichloride of ethylene with acetate of silver the following change takes place :—One equivalent of the former substance, containing two equivalents of chlorine, removes, from two equivalents of acetate of silver, two equivalents of silver in the form of chloride, while the remainder of the constituents of the two bodies unite to form acetate of ethylene. The chemical equation representing this change may be put thus :—

$$\underset{\text{Bichloride of Ethylene.}}{C_4H_4,Cl_2} + \underset{\text{Acetate of Silver.}}{2AgC_4H_3O_4} = \underset{\text{Chloride of Silver.}}{2AgCl} + \underset{\text{Binacetate of Ethylene.}}{C_4H_4,2C_4H_3O_4}$$

Or thus :—

$$C_4H_4,A_2 + \left.\begin{matrix} C_4H_3O_2 \\ Ag_2 \\ C_4H_3O_2 \end{matrix}\right\} O_4 = Ag_2A_2 + \left.\begin{matrix} C_4H_3O_2 \\ (C_4H_4)'' \\ C_4H_3O_2 \end{matrix}\right\} O_4$$

The two dashes placed after the symbol for ethylene, show that it is equal to two equivalents of silver, Ag_2.

On exposing binacetate of ethylene to caustic potash, acetic acid is removed, and hydrate of ethylene formed. Hydrate of ethylene is also termed glycol, and is an alcohol, standing in the same relation to ethylene as ordinary alcohol does to ethyle :—

$$\underset{\text{Ethyle.}}{\left.\begin{matrix} (C_4H_5)' \\ (C_4H_5)' \end{matrix}\right\}} \quad \underset{\text{Alcohol.}}{\left.\begin{matrix} (C_4H_5)' \\ H \end{matrix}\right\} O_2} \qquad \underset{\text{Ethylene.}}{(C_4H_4)''} \quad \underset{\text{Glycol.}}{\left.\begin{matrix} (C_4H^4)'' \\ H_2 \end{matrix}\right\} O_4}$$

When glycol, C_4H_4, H_2O_4, or C_4H_4, O_2, H_2O_2, is exposed to the action of hydrochloric acid, a substance intermediate in composition between Dutch liquid and glycol is formed, namely, C_4H_4, O_2, HCl, which, when decomposed by caustic potash, yields oxide of ethylene, C_4H_4, O_2. This is the ether of the series, and stands in the same relation to ethylene as ordinary ether does to ethyle :—

$$\underset{\text{Ethyle.}}{\left.\begin{matrix} (C_4H_5)' \\ (C_4H_5)' \end{matrix}\right\}} \quad \underset{\text{Oxide of Ethyle.}}{\left.\begin{matrix} (C_4H_5)' \\ (C_4H_5)' \end{matrix}\right\} O_2} \qquad \underset{\text{Ethylene.}}{(C_4H_4)''} \quad \underset{\text{Oxide of Ethylene.}}{(C_4H_4)''O_2}$$

The action of oxydizing agents on this substance gives rise to many compounds comparable with inorganic bodies ; one series of ethylene derivatives may be placed side by side with the series derived from hydrochloric acid, namely :—

$$C_4H_4O_4 \;;\; C_4H_4O_6 \;;\; C_4H_4O_8$$
$$HClO_4 \;;\; HClO_6 \;;\; HClO_8$$

Oxide of ethylene is a gas at ordinary temperatures; but below three degrees centigrade it is a liquid. When a glass tube containing this body is opened, a jet of vapour rushes out, and may be lighted. If this vapour be conducted in a jar of hydrochloric acid gas, it immediately enters into union with it, with almost the energy and rapidity of ammonia. It is an unique base, without nitrogen, and without a metal; but it connects these two classes of bases together. It bears a remarkable analogy to an oxide of a metal, yielding definite compounds with acids, and even displacing some mineral bases from their combinations with acids. Its salts form double compounds with salts of barium, calcium, iron, zinc, copper, lead, and mercury, and these compounds invariably contain two equivalents of the metal. From various considerations, however, Professor Wurtz is led to conclude that the equivalents of these metals should be doubled; an argument in favour of this conclusion being drawn from their specific heat, which is half that of many of the other elements. If the equivalents were doubled, these metals would occupy a position in the salts above named identical with that occupied by ethylene. Oxide of ethylene is capable of combining directly with water, in the same manner as some metallic oxides; if the water be in excess, glycol is formed; if the oxide preponderate, other hydrates are produced, containing two, three, or four equivalents of the oxide to one of water. An analogy may be traced between these hydrates and certain complex hydrates of silicic and stannic acids, the relations of which had previously seemed somewhat doubtful.

But oxide of ethylene unites not only with hydrochloric and other acids, to form a great variety of saline compounds, but also with ammonia, forming bodies containing one, two, or three equivalents of oxide to one of ammonia. Of these there are several analogous to the ammonia compounds of copper, mercury, and platinum.

ROYAL GEOGRAPHICAL SOCIETY.—*June* 16.

Surveying Voyage in the Pacific.—Dr. Shaw read a paper on the Surveys of H.M.S. *Herald*, in the Pacific, under the command of Capt. H. Mangles Denham, R.N., F.R.G.S. This surveying voyage, undertaken in consequence of the representations made to Her Majesty's Government of the benefits which would result to commerce and navigation from a thorough examination of the dangers of the Western Pacific, extended from the year 1852 to 1861. A slight conception of the results of this voyage may be realized when it is mentioned that no fewer than 163 determinations of latitude and longitude were obtained, besides 2601 magnetic results, 41 islands carefully mapped, with 42 reefs and shoals, and 450 miles of the Australian coast-line. One of the many practical results is, that ships making the voyage from India and China to Australia can now save one-fifth of the distance usually traversed, owing to many supposed reefs having been expunged from our chart, etc. In the South Atlantic, in lat. 37° S., lon. 37° W., soundings were obtained in 7706 fathoms; more than 16,000 feet deeper than the highest mountains are high.

DISCOVERIES IN CANAAN.—Dr. Charles Beke then read the second paper, entitled "Notes on an Excursion to Harran in Padan Aram, and thence over Mount Gilead into the land of Canaan." The town of Harran, near Damascus, having been long since identified by Dr. Beke with the Harran or Charran of Scripture; this journey was undertaken by him, accompanied by Mrs. Beke, in December last, for the purpose of verifying this identification. Their road was from Beyrout to Damascus, and thence about fifteen miles further east to Harran of the Columns, so called from three Ionic columns, which, with numerous other architectural remains, attest its great antiquity. At the entrance to the town from the west is an ancient draw-well, which Dr. Beke regards as representing "Rebekah's well." On the first of January of the present year, the travellers proceeded to trace the "seven days' journey" of the patriarch Jacob in his flight from Padan Aran. They "passed over the river (Pharpar or Awaj), and set their faces towards the Mount Gilead;" which, unconnected with any other mountain system, serves as a landmark and guide to travellers crossing the plains of Hauran from the north or east. Their route lay along the great Haj road from Damascus to Mecca, passing through Eshmiskin, the residence of Ahmed-et-Turk, the Sheikh of the Sheikhs of Hauran, of whose noble and disinterested conduct in protecting the Christians of Edr'a during the massacres of 1860, Dr. Beke made honourable mention. Near Mispeh, at the summit of Gilead, was discovered a *cromlech*, resembling Kit's Cotty House in Kent. Passing Mahanaim, and following always in the footsteps of the patriarch, they reached the Jordan near the "ford Jabbok," where Jacob was met by his brother Esau. Here they were nearly drowned in crossing the river, after which they were attacked by Beduins; but in spite of those mishaps, they arrived in safety at Nablus, the Shechem of Scripture, on the tenth day after their departure from Harran.

Mr. Rutherford Alcock, F.R.G.S., H.B.M.'s Envoy Extraordinary etc., in Japan, then read a short paper giving an account of his journey, overland, from Nagasaki to Yeddo, in Japan, principally in order to see the newly-opened port of Osaca. He started from Nagasaki on the first of June last year, and in consequence of the many obstructions on the part of the natives, owing to their unconquerable hatred to foreigners of all nations, had the greatest difficulty in bringing his travels to a successful termination. The paper also gave an interesting description of the curious customs of the natives, character of the soil, and the state of our relations with the Japanese government. Mr. Alcock did not seem to consider it wise to force on the Japanese commercial relations for which they were not prepared, and the effect of which would probably be to disturb the existing state of society in Japan without substituting anything better.

ROYAL INSTITUTION.

On Force.—Dr. Tyndall's Lecture on the Correlation of Mechanical Force and Heat, delivered before the members of the Royal Institution, offers so many remarkable facts, that we are desirous to reproduce them in a condensed form. A substance suspended at a height of sixteen feet above the earth's surface, and allowed to fall, reaches the surface in one second of time, its velocity, which has been regularly accelerated, being then at the rate of thirty-two feet per second. If the movement of this falling body is arrested, the force is not lost, but converted into heat. Thus the force of a body falling sixteen feet is sufficient, if suddenly arrested, to raise its temperature three-fifths of a degree Fahrenheit. The work done, or the mechanical force exerted by any moving object, augments with the square of the velocity; thus, doubling the weight of a cannon-ball doubles its power; but doubling its velocity, though the original weight is retained, quadruples its effect. Hence the efforts of artillerists to augment the velocity of their projectiles. A rifle bullet has at least forty times the velocity of a body falling for one second: hence, when suddenly arrested, as by an iron target, the heat generated, provided it could be concentrated in the bullet, would raise its temperature to about 960°, sufficient to melt the lead.

The conversion of muscular force into heat is strikingly shown in the concussion of flint and steel, as in the old method of obtaining a light. Energetic chemical union is always attended with the evolution of heat, which may be regarded as being produced by the falling together of atoms at a high velocity. The heat so evolved can be made to reproduce the exact amount of force that was arrested in its production. Thus, the union of a pound of coal with about two pounds of oxygen evolves an amount of heat capable, if properly applied, of raising a hundred pounds weight to a height of twenty miles. The coal raised every year in England amounts to 84,000,000 tons, which, were they all applied to the production of force, would be equal to 108,000,000 horses working constantly; or a pound of coal may be regarded as equal to the force of three hundred horses working for one minute.

The fact that force may be converted into heat has given rise to a theory which attributes the light and heat evolved from the sun to the falling of meteoric bodies on to its surface. Of the amount of heat produced by this luminary, some idea may be gained from the fact that the earth receives only 1-2,300,000,000th part. Moreover, it is calculated that the heat given out by the sun every minute is sufficient to boil 12,000,000 cubic miles of ice-cold water. This vast amount of heat is supposed by Dr. Mayer of Heilbron to be due to the falling into the sun of meteorites. The objection to the theory that these bodies are too few in number is met by the fact, that at one observatory alone as many as 240,000 have been observed in nine hours.

Meteoric bodies attracted by the sun would necessarily move with a high and rapidly-accelerating velocity, and it is calculated that a body falling into the sun at a velocity of 390 miles a second, would attain a temperature 9000 times that produced by the combustion of coal. A body the size of the earth falling into the sun would supply its heat for about one hundred years, but would make no appreciable increase in its bulk; and were the earth's motion suddenly arrested, the heat developed would raise the temperature to such a degree that the elements would be dissipated in vapour. Notwithstanding the difficulties in the way of receiving this theory of Dr. Mayer's, it was regarded by Dr. Tyndall as that which offered the best explanation of the cause of solar heat.

NOTES AND MEMORANDA.

Diffusion of Rubidium.—M. Grandeau discovers this newly-recognized metal in coffee, tea, tobacco, grapes, and crude tartar. The tobacco employed came from Kentucky and Havannah. The leaves were acted upon by water, which was evaporated, and the residue calcined and tested by the method of spectrum analysis, which indicated potassium, a small quantity of lithium, and a notable proportion of rubidium. Coffee is still richer in rubidium than tobacco; but, as is the case with tea, yields no trace of lithium. He found no rubidium in colza, cocoa, and cane sugar, nor in certain kinds of fucus.

Distribution of Springs.—The Abbé Richard, Professor at the little school of Montlieu, announces his discovery of what he calls a "hydrogeologic" law, by which he professes to be able to tell, after a brief examination of the soil, the position and depth, together with the volume of the water to be found below. He gives numerous instances of successful predictions, but states that before explaining his method he wishes to verify it by further experiments.

Experiments on Solubility.—M. Gay-Lussac has ascertained that the "solubility of a body is not modified when it passes from the solid to the liquid state." The converse of this proposition is also affirmed, that is to say, "that the presence of a solvent does not modify the fusing temperature of a body if no chemical action takes place." Thus, if finely-divided sulphur is suspended in sulphuric acid, bichloride of tin, and amylic alcohol, which are three of its solvents, it is seen to enter into fusion (be dissolved) in the three liquids exactly at the same temperature of 111°·5 Cent. Phosphorus enters into fusion at 44° Cent. in water, the various alcohols, chloroform, bichloride of tin, etc. Similar observations have been made with iodine, and various fatty bodies, always with similar results.

Transit of Titan.—M. Chacornac has presented to the French Academy a drawing of the passage of Titan over the disk of Saturn. In addition to the shadow M. Chacornac perceived the satellite itself contrasting with the brilliant bands in the centre of the planet—near the margin the satellite became invisible. This phenomenon is the inverse of that which occurs when Jupiter's satellites make their transits, and indicates a difference in the atmosphere of the two planets. The observations were made with the great Foucault telescope.

The Great Spiral Nebula.—In our last number we mentioned the examination of this wonderful formation in *Canes Venatici*, by M. Chacornac, with the Foucault reflector. The following are the remarks of this astronomer in presenting his drawing to the French Academy:—"We must first notice the stellar appearance of the luminous centres of this double nebula, and observe that the central nebulosity of the greatest of them, has under high magnification the appearance of a whirlpool of little stars environing a principal star, which has not the planetary character indicated by Lord Rosse. These stars, of which those nearest the centre are seen through a nebulous veil, are not the only novelties, for as many as nine are found distributed in the whorls of the great nebula, and which are not shown in the drawings of Lord Rosse. In addition to these objects, of which I hope to discover more, I would call attention to divers branches of the spiraloid nebula as crossing each other in a different manner. The configuration of the most brilliant spirals, as indicated in our drawing, establishes the accuracy of the representation given by Sir J. Herschel. The branch which ties the smaller to the greater nebula, cuts the two principal spirals of the latter, near the place where these branches cross, in such a way that the interlacing of the curves presents the aspect of a spherical triangle. The companion nebula itself exhibits a spiral form, and not the appearance of a planetary disk, surrounded by an uniformly distributed atmosphere." In a communication with which we have been favoured by M. Chacornac, he informs us that he does not intend to compare the Foucault telescope in point of power with the giant at Parsonstown. This observation of the distinguished astronomer has reference to the remarks made in our last number.

Paraffin Oils.—At the request of the Manchester Sanitary Association, Mr. Charles O'Neil, F.C.S., has examined many specimens of paraffin oils. Out of twenty-five bought in Manchester, sixteen agreed with genuine samples of the Paraffin Company; the other nine differed from these, and from each other; three or four purported to be American, and were called petroline, kerosine, and photogene. He also obtained fourteen samples from the springs in Pennsylvania and Canada. One sample from London and one from Liverpool formed an explosive vapour with air at as low a temperature as 60° Fahr., and might be considered decidedly unsafe. At 85° there gave an explosive mixture with air. Of the remainder, only four formed an explosive mixture at 100°. Of the rest, three did the same at 120°, and the twenty that were left did so at 150°. Of the twenty that would not make an explosive mixture at 120°, two were American, and eighteen Young's, all of whose manufacture were found safe. Out of thirty-two samples, twenty were quite safe, three less so, and nine dangerous. In specific gravity, the American oils are generally below 816°, but two bad samples were as high as 865°. Thus specific gravity is no test of their safety. Nor is the boiling point, as many substances have so high a diffusive power as to compensate for high boiling points —coal naphtha, for example, which boils at 260°, gives an explosive mixture almost instantly even at the freezing-point.

Canine Madness.—M. Berthaud, writing in *La Patrie*, states that two mad dogs were recently taken to the Veterinary School of Alfort, and shut up in a cage. They exhibited all the symptoms of hydrophobia, and made desperate efforts to escape and attack the bystanders. After some days both had puppies, and in turns they manifested maternal affection, and gave way to paroxysms of their malady.. At the expiration of a time not named they died, and the puppies which survived are kept to see whether they will become afflicted with the maternal complaint.

Bolides.—Professor Newton, U.S., describes two of these meteors, which he saw on the 2nd and 6th of August, 1860. The first, he says, was dissipated in our atmosphere, or in the earth, and he thinks its enormous velocity would account for its dissipation before it reached the ground. Those which let fall meteoric stars he thinks travel at a lower speed.

The Companion of Sirius.—M. Lassell, on hearing of Mr. Alvan Clark's discovery, directed his telescope (at Malta) to search for it, and found it with a power of 231. The angle of position was 83°·85, the distance from the great star 4″·92. Mr. Lassell is astonished at the discrepancy in the measurements of distance, which at Cambridge, U.S., appeared 10″·37 on the 20th of February; at Paris, 20th March, 7″·4; at Malta, 11th April, 4″·92.

Railways and Health.—Dr. Gallard communicated to the French Academy a paper on this subject, in which he shows from statistical evidence that the stokers and guards are not subject to any special maladies peculiar to their vocation, and that with reference to throat and pulmonary attacks during winter, much good is effected by their taking a cup of tea or coffee, or a basin of soup every two hours, or less. In many districts, where intermittent fevers had prevailed from time immemorial, he states that the drainage effected by railway works has removed these disorders.

An Oyster Shell Island.—M. Aucapitaine describes an island composed of layers of oyster shells in the Lake of Diana, on the east coast of Corsica, and which bears some resemblance to the shell mounds of Saint Michel-en-Lherm in La Vendée. The Corsican island, like these masses, is formed of the shells of species still living. It is between three and four hundred yards in circumference, and the greatest elevation about thirty yards, the mean elevation being rather more than two yards above the sea-level. The fishermen say the Romans used to deposit there the shells of the oysters, which they salted for exportation, but he does not believe the island had an artificial origin.

Logwood as a Disinfectant.—M. Desmartis describes to the French Academy an ointment made with equal parts of fat and extract of logwood, as removing the nauseous odour of putrefying sores.

The Guinea Worm.—Mr. H. J. Carter, F.R.S., finds some confirmation of his idea that the Guinea worm is a monster growth of a worm whose natural habitat is not of the human body, and whose young may be introduced through the sudorific ducts in the skin, from the behaviour of certain Filaridæ who make their way into the tissues of fungi. He tells us that free microscopic Filaridæ frequent gelatinous algæ and large fungi by myriads, and that when examining a large digitiform Xyloria which grows on the decayed trunks of tamarind trees, he saw delicate thread-like bodies which appeared to exhibit animal motion, and which projected from the conceptacles of the plant one from each. Extracting a few with a fine needle, and transferring them to a little water on a slide, he found them to be young Filaridæ. The mouths of the conceptacles did not exceed 1-1880th of an inch in diameter, which is less than the size of the openings of the human sudorific ducts. These observations were read at the Medical and Physical Society, Bombay, and published in the *Annals of Natural History*, No. liv.

Fungous Disease.—The same authority considers that the fungous disease which ravages the bones and soft part of the feet and ankles is occasioned by the entrance through the sudorific ducts of minute spores in an amœboid state, and which attain a monstrous growth as the black fungus in the human body.

Mesozoic Life in Australia.—The *Annals of Natural History*, No. liv., p. 486, publishes a letter from Professor Owen to Dr. Francis, stating that Mr. J. S. Poare dredged up a living encrinite from eight fathoms at King George's Sound, Western Australia. Professor Owen adds, "This, in connection with Stutchbury's discovery of a living *Trigonia* at Fort Jackson, and other evidences of mesozoic life at the antipodes, noticed in the published descriptions of the fossil marsupials of British oolites, is an interesting fact.

Phosphorescence of the Sea.—According to *Cosmos*, this phenomenon was exhibited with extraordinary splendour at Cherbourg on the 18th of May.

Carbonic Acid as an Anesthetic.—Dr. Ozonam detailed to the French Academy on the 2nd of June his experiments on this subject. After forty trials with delicate animals, whose sleep he had prolonged for one or two hours at a time without accident, he operated upon a human subject suffering from a deep abscess in the thigh. He began by administering a mixture of three parts of carbonic acid and one of common air contained in a caoutchouc bag, and furnished with a long tube, terminating in an enlarged opening, capable of receiving the mouth and nose. This was applied so loosely that the patient could respire air as well as the gas mixture. In two minutes he was asleep with accelerated respiration and abundant perspiration from the face. This last phenomenon, Dr. Ozanam observes, appears to be the result of a specific action of carbonic acid, which produces it, if directed upon the skin as a douche, or in a bath. The patient evinced no consciousness when the incision was made, but the inhalation of the gas was suspended just before the last cut, which was felt, and the young man awoke. When the gas is properly administered, consciousness is recovered as soon as the process is suspended, and Dr. Ozonam claims for his method greater safety than belongs to chloroform. M. Flourens spoke very favourably of the new plan. It is quite impossible to tell from Dr. Ozanam's description what proportion of carbonic acid his patient really did inhale. Professor Miller says, "if the proportion exceeds three or four per cent. of the air, it acts as a narcotic poison." We mention this as a warning to our non-medical readers against foolish experiments.

Mountain Barometer.—Under this title Messrs. Horne and Thornthwaite have produced a very excellent aneroid, especially adapted to facilitate the measurement of heights. Being only 2½ inches in diameter, it is very portable, while from the excellent workmanship, no practical loss of efficiency is the consequence of its reduced size. The face is graduated in two circles, the outer one giving the barometrical pressure in inches and tenths of an inch. Below this is the second circle upon which the peculiar convenience of the instrument depends. This is graduated in spaces corresponding with hundreds and thousands of feet, so that a mere inspection is sufficient, without any calculation, for the measurement of ordinary heights. Thus if the hand points to 1000, and on being carried to an elevation indicates 1100, it is evident that the last station is 100 feet higher than the first. Where the elevation to be measured is considerable, there will be a difference of temperature between the upper and lower levels, which must be allowed for to obtain a correct result; and the makers of this instrument supply a convenient and easily worked table, calculated in degrees of Fahrenheit according to the formula of La Place. To test the accuracy of the instrument, we have made repeated trials with heights of twenty or thirty feet and upwards, always obtaining closely approximate results. We have also compared its indications with a mercurial barometer, and observed its prompt indications of slight changes in the density of the air. We have likewise carried it loose in our pockets during long walks, and on two railway journeys, to see if a good shaking would do it any harm. The result of these experiments has been very satisfactory, and we can, therefore, recommend it to the tourist as a pleasant companion, serving the double purpose of a good barometer and measurer of heights.

New Planet.—Mr. Tuttle, Cambridge, U. S., has discovered the 73rd planet. The asteroid resembles a 13 magnitude star, and was seen on the 8th of April, near β Virginis.

Soap Bubbles and Meteorology.—M. Felix Plateau having been requested by his father to throw away a liquid of a bad quality which had been employed to produce films, endeavoured to make it form a sheet of liquid in its descent, when to his surprise it took on the shape of a large bubble, and fell slowly. He repeated the experiment a good many times with soapsuds, and sometimes succeeded in making as many as fifteen bubbles at a time. He recommends a hemispherical vessel about five inches diameter, holding a considerable quantity of the fluid, which should be thrown at an angle of 45° with the horizon, and have a spinning motion communicated to it. In this experiment the elder Plateau saw an illustration of the formation of vesicles of vapour. The Abbé Moigno remarks in *Cosmos* that such a result was quite unexpected, and is eminently curious.

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