THURSDAY, APRIL 24, 1873

SCIENTIFIC ENDOWMENTS AND BEQUESTS

SOME weeks ago we published the notice issued by Trinity College, Cambridge, respecting a Fellowship offered by that corporation for Natural Science, in which Zoology is one of the subjects by which it may be obtained. Candidates are required to send to the electors "any papers which they may have published containing original observations, or experiments, or discussions of scientific questions, or any similar matter in manuscript," and they "will be liable to be examined in the subjects of their papers and in subjects connected with them, or in the branch of science to which they refer."

A fortnight ago, a New York correspondent gave us the details of a munificent bequest made by Mr. John Anderson, a wealthy merchant of that city, to Prof. Agassiz, and through him to the University of Cambridge, Massachusetts, of Penikese Island, situated about 170 miles east by north of New York, and 12 miles south of Boston, on the New England coast, as a station for the study of Practical Zoology, mainly marine. Finding that pecuniary aid was also absolutely necessary to put the whole in working order, Mr. Anderson, with a liberality almost unprecedented, put 50,000 dollars at Prof. Agassiz's disposal, "as a nucleus for a permanent endowment fund" in the formation of his Marine Naturalists' School.

The above-cited cases are two of the most important steps that have been taken of late to advance the thorough study of zoology either in England or America, but the method employed by the one to arrive at this result is so different from that adopted by the other, that the question may well be asked, which of the two in the long run will produce the most satisfactory results? Is it better, as done by Trinity College, to offer considerable and substantial rewards to students of promise, or, as in the case of Mr. Anderson's gift, to simply place undoubtedly great facilities in the way of untried beginners on the subject?

Notwithstanding the extreme liberality shown by Mr. Anderson in his bequest, we cannot help feeling that most of the previous attempts that have been made to advance science by providing increased facilities for work, without at the same time improving the general prospect of a sufficient livelihood for those who devote the whole or the most of their time to it, have met with but little success; and perhaps there is nothing more disappointing to those who are anxious for the progress of the subject, to see the way in which establishments excellently planned at great cost, are often almost at a standstill for want of their most important element—pupils. Such a method of procedure, if numbers are obtained, is likely but to produce an assemblage of amateur students, whose work, as it must be from the lack of sufficient stimulus to great mental effort, is poor from its want of thoroughness, and therefore comparatively useless in the long run, only encumbering the subject and leading lookers-on to suppose, from the few results arrived at, that the science is not worthy of deeper consideration. Zoology and Biology generally have suffered much already from such kind of work.

The tendency of all observation as to the origin and development of the sciences which are now firmly established, is to prove quite clearly that what was required in each of them to give it a start, and make it continue to advance rapidly, was that it should have a practical bearing of some kind or another. There cannot be the least doubt that the rapid advances which have occurred in the study of electricity, and the large number of valuable discoveries and important laws that have been found out concerning it, are but the expression of the mercantile value of the telegraph system as it now exists; the forensic and manufacturing importance of chemistry has in great measure raised it to the important position it now holds; and the money voted for the observations of the transit of Venus is indirectly connected with the importance of astronomical observation in facilitating navigation. But it is not at all easy to show clearly that there are any direct practical results to be arrived at from the study of zoology; the knowledge of the facts that our relationship with the higher apes is more intimate than has been till lately supposed, and that we must consider an Ascidian as the Noah of our zoological pedigree, may be of interest to many as curious results, but they do not lead to or suggest fresh methods of action on the part of anyone, and cannot otherwise be made profitable. Consequently other means must be employed to cause the science to progress in a manner which does credit to the large number of new facts which are continually being brought forward, and the method adopted by Trinity College is one which promises the best results. That the prospect of a Fellowship is a strong inducement to work is undisputed, and what all biologists would like to see, is a little more willingness on the part of other colleges in both Universities, to give them to deserving students of the subject. Some profess to place natural science on the same footing as the other University final examinations, with regard to pecuniary rewards, but it is very seldom, scarcely ever indeed, that we have the opportunity of recording in our columns any elections to natural science fellowships. As long as classics hold the position that they do—one maintained only by the funds and appointments which, but from an excessive and short-sighted conservatism, would have been in great measure diffused in other directions long before now, no complaint can be made of the comparatively non-practical bearing of zoology and comparative anatomy; for though classics may be a good mental training, so is the latter, and the study of the former has certainly not a more practical bearing.

The principle on which the election to the New Trinity Fellowship is to be conducted, is evidently the result of mature consideration and experience, partly no doubt arrived at after the unsuccessful experiment in the same direction a little more than two years ago, in which it was made too evident that a simple examination in the subject could not ensure the discovery of a genuine Zoologist. A much more successful result may be anticipated from the new system of election, for it is difficult to believe that any candidate, who at the time of election has completed sufficient good work to satisfy the electors, can possibly, on account of its intrinsic

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interest when he has arrived so far, give up the further pursuit of scientific work. When the governors of any institution can bring men up to this point, and can then supply them with the necessary means, they may consider that their work is finished.

CLERK-MAXWELL'S ELECTRICITY AND MAGNETISM

A Treatise on Electricity and Magnetism. By James Clerk-Maxwell, M.A., F.R.S., Professor of Experimental Physics in the University of Cambridge. (Clarendon Press Series, Macmillan & Co., 1873.)

IN his deservedly celebrated treatise on "Sound," the late Sir John Herschel felt himself justified in saying, "It is vain to conceal the melancholy truth. We are fast dropping behind. In Mathematics we have long since drawn the rein and given over a hopeless race." Thanks to Herschel himself, and others, the reproach, if perhaps *then* just, did not long remain so. Even in pure mathematics, a subject which till lately has not been much attended to in Britain, except by a few scattered specialists, we stand at this moment at the very least on a par with the *élite* of the enormously disproportionate remainder of the world. The discoveries of Boole and Hamilton, of Cayley and Sylvester, extend into limitless regions of abstract thought, of which they are as yet the sole explorers. In applied mathematics no living men stand higher than Adams, Stokes, and W. Thomson. Any one of these names alone would assure our position in the face of the world as regards triumphs already won in the grandest struggles of the human intellect. But the men of the next generation—the successors of these long-proved knights—are beginning to win their spurs, and among them there is none of greater promise than Clerk-Maxwell. He has already, as the first holder of the new chair of Experimental Science in Cambridge, given the post a name which requires only the stamp of antiquity to raise it almost to the level of that of Newton. And among the numerous services he has done to science, even taking account of his exceedingly remarkable treatise on "Heat," the present volumes must be regarded as pre-eminent.

We meet with three sharply-defined classes of writers on scientific subjects (and the classification extends to all such subjects, whether mathematical or not). There are, of course, various less-defined classes, occupying intermediate positions.

First, and most easily disposed of, are the men of calm, serene, Olympian self-consciousness of power, those upon whom argument produces no effect, and whose grandeur cannot stoop to the degradation of experiment! These are the *à priori* reasoners, the metaphysicians, and the *Paradoxers* of De Morgan.

Then there is the large class, of comparatively modern growth, with a certain amount of knowledge and ability, diluted copiously with self-esteem—haunted, however, by a dim consciousness that they are only popularly famous—and consequently straining every nerve to keep themselves in the focus of the public gaze. These, also, are usually, men of "paper" science, kid-gloved and black-coated—with no speck but of ink.

Finally, the man of real power, though (to all seeming) perfectly unconscious of it—who goes straight to his mark with irresistible force, but neither fuss nor hurry—reminding one of some gigantic but noiseless "crocodile," or punching engine, rather than of a mere human being.

The treatise we have undertaken to review shows us, from the very first pages, that it is the work of a typical specimen of the third of these classes. Nothing is asserted without the reasons for its reception as truth being fully supplied—there is no parade of the immense value of even the really great steps the author has made—no attempt at sensational writing when a difficulty has to be met; when necessary, there is a plain confession of ignorance without the too common accompaniment of a sickening mock-modesty. We could easily point to whole treatises (some of them in many volumes) still accepted as standard works, in which there is not (throughout) a tithe of the originality or exhaustiveness to be found in any one of Maxwell's chapters.

The main object of the work, besides teaching the experimental facts of electricity and magnetism, is everywhere clearly indicated—it is simply to upset completely the notion of *action at a distance*. Everyone knows, or at least ought to know, that Newton considered that no one who was capable of reasoning at all on physical subjects could admit such an absurdity: and that he very vigorously expressed this opinion. The same negation appears prominently as the guiding consideration in the whole of Faraday's splendid electrical researches, to which Maxwell throughout his work expresses his great obligations. The ordinary form of statement of Newton's law of gravitation seems directly to imply this action at a distance; and thus it was natural that Coulomb, in stating his experimental results as to the laws of electric and magnetic action which he discovered, as well as Ampère in describing those of his electro-dynamic action, should state them in a form as nearly as possible analogous to that commonly employed for gravitation.

The researches of Poisson, Gauss, &c., contributed to strengthen the tendency to such modes of representing the phenomena; and this tendency may be said to have culminated with the exceedingly remarkable theory of electric action proposed by Weber.

All these very splendid investigations were, however, rapidly leading philosophers away towards what we cannot possibly admit to be even a bare representation of the truth. It is mainly to Faraday and W. Thomson that we owe our recall to more physically sound, and mathematically more complex, at least, if not more beautiful, representations. The analogy pointed out by Thomson between a stationary distribution of temperature in a conducting solid, and a statical distribution of electric potential in a non-conductor, showed at once how results absolutely identical in law and in numerical relations, could be deduced alike from the assumed distance-action of electric particles, and from the contact-passage of heat from element to element of the same conductor.

But we must give Maxwell's own frank and ample acknowledgment of his debt to these two men.

"The general complexion of the treatise differs considerably from that of several excellent electrical works, published, most of them, in Germany, and it may appear that scant justice is done to the speculations of several eminent electricians and mathematicians. One reason of this is that before I began the study of electricity I resolved to read no mathematics on the subject till I had first read through Faraday's 'Experimental Researches on Electricity.' I was aware that there was supposed to be a difference between Faraday's way of conceiving phenomena and that of the mathematicians, so that neither he nor they were satisfied with each other's language. I had also the conviction that this discrepancy did not arise from either party being wrong. I was first convinced of this by Sir William Thomson, to whose advice and assistance, as well as to his published papers, I owe most of what I have learned on the subject.

"As I proceeded with the study of Faraday, I perceived that his method of conceiving the phenomena was also a mathematical one, though not exhibited in the conventional form of mathematical symbols. I also found that these methods were capable of being expressed in the ordinary mathematical forms, and thus compared with those of the professed mathematicians.

"For instance, Faraday, in his mind's eye, saw lines of force traversing all space where the mathematicians saw centres of force attracting at a distance: Faraday saw a medium where they saw nothing but distance: Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids."

It certainly appears, at least at first sight, and in comparison with the excessively simple distance action, a very formidable problem indeed to investigate the laws of the propagation of electric or magnetic disturbance in a medium. And Maxwell did not soon, or easily, arrive at the solution he now gives us. It is well-nigh twenty years since he first gave to the Cambridge Philosophical Society his paper on *Faraday's Lines of Force*, in which he used (instead of Thomson's heat-analogy) the analogy of an imaginary incompressible liquid, without either inertia or internal friction, subject, however, to friction against space, and to creation and annihilation at certain sources and sinks. The velocity-potential in such an imaginary fluid is subject to exactly the same conditions as the temperature in a conducting solid, or the potential in space outside an electrified system. In fact the so-called equation of continuity coincides in form with what is usually called Laplace's equation. In this paper Maxwell gave, we believe for the first time, the mathematical expression of Faraday's *Electro-tonic* state, and greatly simplified the solution of many important electrical problems. Since that time he has been gradually developing a still firmer hold of the subject, and he now gives us, in a carefully methodised form, the results of his long-continued study.

A sentence like the following has a most cheering effect when we meet with it in a preface; and we need only add that our author has been thoroughly successful in the endeavour he promised:—

"I shall avoid, as much as I can, those questions which, though they have elicited the skill of mathematicians, have not enlarged our knowledge of science."

He might with truth, and with propriety, have added that he would also avoid, as far as possible, those so-called experimental illustrations which require in the operator training akin to that of a juggler, and which are calculated to mystify, and to retard the progress of, the real student, while gratifying none but the mere gaping sight-seer.

It is quite impossible in such a brief notice as this to enumerate more than a very few of the many grand and valuable additions to our knowledge which these volumes contain. Their author has, as it were, flown at everything;—and, with immense spread of wing and power of beak, he has hunted down his victims in all quarters, and from each has extracted something new and invigorating —for the intellectual nourishment of us, his readers.

The following points, however, appear to us to be especially (we had almost said exceptionally) worthy of notice:—

1. Though not employing the Quaternion *Calculus*, Maxwell recognises its exceeding usefulness in exhibiting (merely by the extraordinary simplicity and comprehensiveness of its notation) the mutual relations of various directed, or vector, quantities; together with their derivation from scalar quantities, such as potentials, by the use of the Hamiltonian ∇, the operator whose square is the negative of the scalar operator in Laplace's equation. There can be little doubt that in this direction must lie the next grand simplification of the somewhat complex mathematics of electro-dynamic investigations.

2. The notion of electric *Inertia*, first clearly pointed out by Helmholtz and Thomson, is here developed in a most splendid style. The mechanism whose inertia has to be overcome before a steady current of electricity can be started or stopped in a conductor, and which opposes a resistance exactly analogous to the inertia equivalent of an ordinary train of wheels, is treated by means of the general equations of motion in the forms given respectively by Lagrange and by Hamilton. Maxwell has adopted from Thomson and Tait's "Natural Philosophy" the idea of commencing with the impulse required to produce a given motion of a system, and has developed in this way the general equations in a form suitable for electric problems where the mechanism is as yet entirely unknown.

3. The chapter dealing with *Electrolysis* we may specially refer to, as containing, not merely an admirable summary of what was previously known but also, several new ideas apparently of great value.

4. Another curious feature of the work is the amount of labour bestowed upon the exceedingly useful, but dry and uninteresting, pursuit of accuracy in the tracing of the forms of *Lines of Force* and determinations of strengths of electric and electro-magnetic fields, and their deviation from uniformity under various conditions, some of excessive complexity. For the theory of the newer instruments, especially Thomson's electrometers and galvanometers, and also for their applicability to problems in quite different branches of physics, these results are very valuable.

5. Another feature in which this differs from all but a very few of the very best scientific works is the particular care bestowed upon the modes of measurement, the units employed, and the *Dimensions* (in terms of these units) of the various quantities treated of—such as, for instance, Electric Quantity, Electric Potential, Electric Current, Electric Displacement, &c.

6. The subject of *Electric Images* is developed at considerable length, and the reader is led up by easy steps to a sketch of the grand problem which, though solved in simple finite terms a quarter of a century ago by Thomson, has remained unnoticed till very recently, viz., the statical distribution of electricity upon a spherical bowl.

7. The subject of *Spherical Harmonics* (Laplace's coefficients) is also treated at some length, and in a somewhat novel way, which leads to one of the quaternion methods of attack though without actually employing that calculus itself.

8. Further, there is given, for the first time, the complete solution of the problem of *Induction of Currents* in a disc rotating in the magnetic field, taking account of the mutual action of the currents on one another—a condition which very materially increases the difficulty of the problem. The result is a very curious one; and it appears especially curious when we compare the very simple, almost homely, methods employed by Maxwell with the elaborate analysis by means of which Jochmann and others, some years ago, attacked the incomplete and (comparatively) easy statement of the problem where the mutual action of the currents is not taken account of. This piece of work is worthy of being placed beside that of Thomson, referred to under (6) above, as among the very best things ever done in Mathematical Physics.

9. The ratio of the electro-magnetic to the electrostatic unit of electricity is a *Velocity* whose absolute value is independent of the magnitude of the fundamental units employed. This has been shown by Maxwell to be the velocity with which waves of transverse vibration will be propagated in the medium whose stresses &c. account on his theory for the apparent action at a distance. Neither the velocity of light in free space, nor the ratio of the electric units, is *certainly* known as yet within five or six per cent., but it is assuredly a most striking fact that (in millions of metres per second) three of the best determinations of the former of these quantities give

314, 308, 298,

while apparently equally good determinations of the latter give

311, 288, 282.

Such approximation is evidently much more than a mere fortuitous coincidence, it shows that a great step has been taken in the grand question of the connection between radiation and electrical phenomena.

Having said so much in hearty admiration of this noble work, a work which will do more to raise our country in the eyes of really competent judges than cartloads of more pretentious publications, it is only natural to seek some of its defects. There are spots on every sun; and they are, as phenomena, sometimes more instructive and therefore more worthy of observation than the sun itself. But, as they are not visible save to those whose eyes can bear the full glare of the glowing orb, and who therefore do not require our aid, it is unnecessary to point them out. Such a proceeding would be mere pandering to that miserable form of envy which leads inferior minds to gloat over the defects of their superiors.

The concluding section of the work is particularly well fitted to terminate our article.

"We have seen that the mathematical expressions for electrodynamic action led, in the mind of Gauss, to the conviction that a theory of the propagation of electric action in time would be found to be the very keystone of electrodynamics. Now we are unable to conceive of propagation in time, except either as the flight of a material substance through space, or as the propagation of a condition of motion or stress in a medium already existing in space. In the theory of Neumann, the mathematical conception called Potential, which we are unable to conceive as a material substance, is supposed to be projected from one particle to another, in a manner which is quite independent of a medium, and which, as Neumann has himself pointed out, is extremely different from that of the propagation of light. In the theories of Riemann and Betti it would appear that the action is supposed to be propagated in a manner somewhat more similar to that of light.

"But in all of these theories the question naturally occurs:—If something is transmitted from one particle to another at a distance, what is its condition after it has left the one particle and before it has reached the other? If this something is the potential energy of the two particles, as in Neumann's theory, how are we to conceive this energy as existing in a point of space, coinciding neither with the one particle nor with the other? In fact, whenever energy is transmitted from one body to another in time, there must be a medium or substance in which the energy exists after it leaves one body and before it reaches the other, for energy, as Torricelli* remarked, 'is a quintessence of so subtle a nature that it cannot be contained in any vessel except the inmost substance of material things.' Hence all these theories lead to the conception of a medium in which the propagation takes place, and if we admit this medium as an hypothesis, I think it ought to occupy a prominent place in our investigations, and that we ought to endeavour to construct a mental representation of all the details of action, and this has been my constant aim in this treatise."

OUR BOOK SHELF

Medizinische Jahrbücher Herausgegeben, Von der K. K. Gesellschaft der Aerzte redigert von S. Stricker. Jahrgang 1872. Hefte i. ii. iii. iv., pp. 513; mit xii. Tafeln.

THE second volume of Stricker's *Medizinische Jahrbücher*, now before us, maintains the promise of the first. It is made up of a number of separate essays on various subjects, physiological, pathological, and medical; the physiological essays predominating over the others.

Amongst these the following deserve notice.

1. Researches on the heart and blood-vessels, by Dr. Sigismund Mayer. In this paper Dr. Mayer shows that the extraordinary increase of pressure of the blood against the walls of the blood-vessels which occurs as a result of the administration of strychnia is due to intense excitation of the vaso-motor centre in the brain, which leads to contraction of the small arteries.

2. A paper by Ewald Hering on the influence of the respiration upon the circulation. In this he shows that moderate expansion of the lungs by insufflation causes diminished blood pressure in the arteries and increased rapidity of the heart's action. This latter effect, however, is not due to the increased pressure exerted upon the external surface of the heart, nor to alterations in the conditions of resistance in the circulation; nor to differences in the exchange of gases; nor to any dislocation of the heart's position, but is effected reflectorially through the pneumogastrics in such a manner that the activity of the cerebral centre of the inhibitory nerves is lowered.

3. MM. Oser and Schlesinger give the details, in an elaborate essay, of many experiments they have made to determine the causation of the movements of the uterus, and state that they have arrived at the conclusion that these movements can be induced by suspension of the respiration; by rapid loss of blood; or by arrest of the supply of arterial blood to the brain.

4. M. M. Rosenthal contributes an interesting essay on the death of the muscles of the body, and on apparent death. He made many experiments on about twenty sub-

* *Lezioni Accademiche* (Firenze, 1715), p. 25.

jects on the time after death, or rather after the last respiration to show that contraction of the muscles could still be induced by electricity, when applied to them either in the form of the interrupted or of the continuous current. The excitability of the muscles appears to be the same as before death, for a short time after death has taken place; then contractility departing rather sooner in chronic disease than in cases where death has been occasioned by an accident or other sudden event. In most cases contractions may be excited for from 1½ hour to 3 hours after death. The reaction to induced currents falls in a centrifugal direction; the sphincter palpebrarum retaining its irritability longest. From these experiments he was led to think that the absence of irritability in the muscles might be taken as a good means of distinguishing between real and apparent death, and accidentally very shortly afterwards a case of apparent death in an hysterical patient permitted him to satisfy himself as well as others of its value.

5. C. Heitzmann gives the results of his researches on healthy and inflamed bone, and agrees with Rokitansky, that blood is formed in the mother shells that under certain conditions appear in bone.

Other physiological papers are, one by Prof. Bizzozero, of Pavia, on the so-called endogenous formation of cells. Another by Dr. Kolisko, on the mechanics of the heart, and another by Schiff on the round ligament. The papers dealing with therapeutics, are (1) an essay by Dr. Basch on the action of nicotin, especially bearing on the question of the relation of the blood pressure to the periods of rest and contraction of the muscular tissue of the intestines; (2) a number of minor communications from Schroff containing the results of investigations made in the Vienna Pharmacological Institution. The pathological papers of most importance are (1) the remarkable essay of Lostorfer which has led to so much discussion in Germany, in which he declared that he was able to diagnose a certain specific disease (syphilis), by a microscopic examination of the blood; (2) an account by Dr. Philipp Knoll of a case of the rare disease termed paralysis pseudo-hypertrophica; (3) an essay by Dr. J. Popoff on pneumomycosis; (4) investigations on the organisation of thrombus by Dr. Durante; (5) on the changes taking place in ligatured vessels by Dr. Dudokaloff; (6) the diagnosis of disease of the optic thalami. Besides these are several others. The plates are very fairly executed, and our readers will see that Prof. Stricker has done good service in publishing these papers and essays in a collected form. H. P.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Reflected and Transmitted Light

[The following correspondence has been sent us by Prof. Tyndall]:—

Cliff House, Greenhithe, April 8

A CURIOUS thing in connection with colour having come under my notice, and never having before seen it remarked in any scientific journal, I take the liberty of bringing it before your notice; if it is new to you it will interest you, if not I must ask you to excuse me for troubling you. On looking through a piece of blue glass (of which I forward you a sample) at a plant or tree lit up by the sun, those leaves that are lit from behind, or rather by transmitted light, appear of a rich crimson, the other leaves, seen only by reflected light, merely take the colour given by the glass. In the case of a geranium plant, those leaves become almost the same colour as the flowers. As a scientific fact, if new, it is curious.

To Prof. Tyndall WALTER B. WOODBURY

THE observation you describe is interesting, and if you have taken care to exclude subjective colouring, is, I should think, to be explained in this way.

The light from your leaves contains a quantity of red: it appears as a yellowish green, I suppose, and contains little or no blue.

Your glass is of a kind which transmits the two ends of the spectrum while cutting out its centre. It is very hostile to the yellow, hence, on placing it before the eye, and receiving through it light which has already been deprived of its blue, the glass quenches the yellow, and red alone remains.

April 9 JOHN TYNDALL

I detained this note until the arrival of sunshine, which enables me to say that the explanation here given is correct. Employing a blue medium, which does not transmit red you get no effect of the kind you describe. The tender leaves of spring are best suited for the experiment: the hard green leaves of ivy, for example, do not produce the effect.

It is not necessary, nor indeed desirable, to have the leaves between the eye and the sun.

April 15

The Zoological Collections in the India House

PERMIT me to offer my testimony in general support of the view taken by P.L.S., in the able article which appeared in your last number. Rather more than a year ago it was a matter of importance for me to examine the type of Horsfield's *Turdus varius*, contained in the Museum of the Old East India Company. I applied in the proper quarter for leave to examine the specimen, but received a polite answer informing me that it was inaccessible. The official statement therefore said to have been made in the House of Commons on March 14, 1871, by the Under-Secretary of State for India, as to the collections being still "available to men of science" is untrue, and I trust that some member of Parliament will not allow this subject to be lost sight of, but, by continually recurring to it, compel the Administration to open their valuable Museum to the public—its owners. To the two solutions of the difficulty, suggested by P.L.S., allow me to add a third. If neither the authorities at South Kensington nor in Great Russell Street can properly exhibit the East India Museum, let it be transferred (of course under suitable guarantee), to some other National Institution.

Cambridge, April 22 ALFRED NEWTON

On the Affinities of Dinoceras and its Allies

IN the April number of the *American Journal of Science and Art* there is a paper by Prof. O. C. Marsh, entitled "Additional Observations on Dinocerata," in which we learn that Dinoceras has only four toes. The author still continues to consider the genera *Dinoceras* and *Tinoceras* a separate order intermediate between the Proboscidia and the Perissodactylata. The facts at my disposal are now sufficient for me to state with considerable certainty that *Dinoceras* and *Tinoceras* are members of the Ungulata Artiodactylata. The following are my reasons:—

1. The palate is complete between the posterior molars, as is seen clearly in a photograph of *Tinoceras grandis* (*Loxolophodon cornutus* Cope) in my possession.
2. There is no third trochanter to the femur (Marsh).
3. The astragalus has a well-marked cuboid facet (Marsh).
4. The posterior molar has a small but well-developed third cusp, as proved conclusively by an inspection of my photograph.
5. The anterior premolar is wanting, six only being present.
6. The premaxillæ are edentulous.
7. There are four toes, an even number.

A. H. GARROD

11, Harley Street, April 22

Auroral Display

A SHORT but very brilliant display of aurora was visible here this evening, making its first appearance soon after sunset, and reaching its greatest intensity between nine and ten o'clock. Some notes of its phases which I was able to make in a perfectly clear sky will perhaps afford useful comparisons with descriptions furnished by observers of its appearance at other places.

The sun had set behind cirrus clouds, surrounded by a slight halo, and with a faint mock-sun on its northern side. As darkness approached, the hazy clouds in the north-west were surmounted by a faint light, and at half-past eight o'clock luminous streaks here and there across the otherwise clear sky, apparently of cirrostratus cloud, had considerable resemblance to auroral beams faintly visible in the twilight; a considerable extension of the twilight-glow towards the north-west also suggested the very possible character of their light. Towards nine o'clock Mars rose redly through a considerable haze in the east, and Venus, in full splendour, appeared setting among slight clouds in the west; the planet Jupiter, and all stars above a slight distance from the horizon, were altogether unobscured by clouds. A pretty bright white auroral arch, divided into low streamers, was at this time first distinctly formed, its lower edge being well marked by their bases, and the brightest streamers being clustered in two knots of the arch, in the middle of Cassiopeia, and of Lyra, the first immediately under Polaris, and the other close to the north-east horizon; the western prolongation of the arch was faint and diffuse, shining from behind and among the clouds around the planet Venus. Tall but faint streamers rose from it, none of which were conspicuous, excepting a pretty well defined one rising at $9^h\ 5^m$ from the strongly luminous light-cloud in Lyra, nearly to the tail-stars of Ursa Major. This beam grew sharper, and in the following minute it passed across σ Herculis, and ϵ Ursæ Majoris, but it shortly disappeared. Between $9^h\ 8^m$ and $9^h\ 12^m$ the two principal light-clouds in Cassiopeia and Lyra increased in strength, assuming with the contiguous part of the arch a perfect resemblance to the heavy fringe of a curtain gathered or folded upon itself at those points, and particularly in the group of streamers under α Lyræ. At $9^h\ 12^m$ another luminous patch marked the western end of the arch between Venus and Capella, growing brighter, and from it a bunch of rose-coloured streamers sprang upwards between Auriga and Gemini as far as the forefoot of Ursa Major. At $9^h\ 15^m$, the bright cloud-mass marking the eastern horizon-point of the arch under α Lyræ also acquired great strength, throwing up a torch-like, fire-coloured streamer of moderate height and great brightness, terminating the arch abruptly in that direction. It rose from the horizon across o, χ to π, ρ, Herculis. A fainter arch underneath the former one was visible at this time, but less well-defined, and streamers rising from both arches, and mingling together, soon quite overspread the northern sky; a bunch of these streamers of rich crimson colour appeared at $9^h\ 18^m$, extending for a short time across o, θ, and other neighbouring stars of Ursa Major, and fading gradually away, disappeared almost as quickly as it came. The number and sharpness as well as the height of the streamers rising from both the arches were now very great, and the light from all the surrounding streamers was so strong that I could read my watch and correct notes in my note-book at this time. A fourth bunch of red streamers rose from the arch at its extreme west end at $9^h\ 23^m$ from the neighbourhood of α Orionis to the stars γ, ν, in the feet of Gemini. This was the last strikingly red streamer seen during the display; its spectrum, like that of the white beams, which I examined with a small pocket spectroscope, appeared to consist only of the usual bright greenish line, which was very vivid in every phase of the aurora.

At $9^h\ 25^m$, the whole northern half of the sky was covered with streamers, and arches, gradually forming a corona overhead, and increasing rapidly to great intensity and brightness. The boundary of the light from east to west was a definite line passing through, or very little south of the corona, whose centre was 3° or 4° east from the stars ν, χ in Ursa Major. Northwards from the boundary line the aurora consisted of six or seven parallel arches (of which only the lowest two had before been visible), more or less distinctly succeeding each other between the zenith and the horizon. Both the arches and streamers were stationary, and presented no sensible tendency to motion, however slow, while they were visible. At this time the brightening streamers began to flicker in their light. Waves of light, rising from the north, succeeded each other rapidly, and appeared to flow swiftly over them towards the zenith. Arch after arch was visible as the waves passed over them, and fitful gleams among the auroral masses overhead shot to and fro there, like flashes of summer lightning. The rays and wisps of the corona, and belts, or fragments of the aurora overhead were rendered especially luminous by these discharges. Farther from the zenith, in the north, the waves rose smoothly and steadily, with a motion that was indeed very swift, but it was yet quite distinctly discernible, and more easily distinguishable there, than in their passage overhead. The arches, or belts of the streamers appeared to be lighted up instantaneously, as they were reached. Although their inter-mixture in the north made it very difficult to decide this clearly, yet the upward progress of the waves there was very evident, while no such ascending movements could be distinguished in the east and west quarters of the sky. The belts and arches stretching towards those parts of the horizon, through the zenith, and past, or through the corona, forming the termination of the aurora towards the south, were constantly lighted up by momentary flashes, extending almost simultaneously along their whole lengths. The brightness of the flashes in those parts of the aurora which included the corona, and arches or lateral branches extending from it towards the magnetic east and west points is easily accounted for by the belts and clusters of streamers in those positions being seen "on edge," or "end on," extremely foreshortened by perspective, so that the increase of light along their whole heights appeared to be concentrated, when the waves overtook them, to a single flash. The motion of the waves must be extremely swift, as they scarcely occupied more than a second in passing from an altitude of about 45° to the zenith. Supposing that (as the best observations of them have frequently agreed in showing) the heights of auroral arches, and of the bases of auroral streamers, are usually about 100 miles above the earth's surface, the velocity of propagation of these waves of electrical disturbance from north to south cannot have been much less than 100 miles per second. Such a prodigious velocity cannot possibly be ascribed to waves in the upper atmosphere driven by winds among its rarified strata, to which the sweeping motion of the light waves apparently wafted by gusts among the streamers otherwise bore a very singular resemblance.

At $9^h\ 34^m$ some of the strongest waves passing across the corona lighted up a faint white arch in the south, extending from Arcturus across the northern part of Virgo to the head of Leo, several degrees in width. At $9^h\ 37^m$, when the wave disturbance, after continuing in full activity for about ten minutes, ceased as rapidly as it began, this arch and the corona still remained faintly visible; but together with all the other arches and streamers of any altitude lately lighted up by the waves, they soon vanished, and the whole appearance of the sky at $9^h\ 40^m$ was about the same as when the aurora was first seen. At $9^h\ 43^m$, however, the northern sky was again crowded in every part with thin white streamers scattered indiscriminately over it, like groves of slender fir-trees on a hill-side, among which one very sharp and bright ray shone for a few seconds, springing from the horizon to a considerable altitude in the west, where it passed across ζ Tauri. At $9^h\ 50^m$ a streamer, starting from a base of intense whiteness near the same place, and tinged at the top with a pinkish hue, ascended across the stars μ, ν, as far as the star ι in Gemini, another very similar streamer almost simultaneous with it, also extended from between Gemini and Auriga to near the forefoot of Ursa Major; a few spots of very intense white light were at the same time visible here and there among the low clouds near the north-west horizon. At $9^h\ 55^m$ all conspicuous streamers had disappeared, leaving only a general glow, among the brighter parts of which the wave disturbance began again, and with less intensity than before, but with the same regularly ascending motions; the undulations succeeded each other without intermission until $10^h\ 5^m$; they then ceased, and the faint appearances of the aurora which were visible after this time were, so far as I could observe them, until half-past eleven o'clock, of a very insignificant and inconspicuous character. The times in this description are from a comparison of my watch with the clock in the Carlisle railway station, and its hand and the figures on its dial being always distinctly visible by the light of the aurora, they have probably been recorded rightly to the nearest minute. Although the dates of the April meteoric shower usually occurring on the nights of the 19th —21st of April are near at hand, I saw but one small shooting-star during the hour of the auroral exhibition. It had a short course in one of the brightest parts of an auroral cloud, and in its light and the aspect of its nucleus it did not appear to be affected in any way remarkably by its passage near or underneath the beams of the aurora. A. S. HERSCHEL

Carlisle, April 18

April Meteors

DURING the evenings of April 19 (9^h to 11^h) and 20th ($8^h\ 45^m$ to $11^h\ 15^m$) 20 shooting stars were observed here. The sky was cloudless on both nights, and on the 18th and 19th bright displays of auroræ were noticed. Of the 20 meteors 12 were well observed, and their tracks accurately marked; 8 of these radiated from near α Lyræ, or from a point at R. A. 274°, D. 37 +. The following are the details:—

Date.	Time.		Beginning. R. A.	Beginning. D.	Ending. R. A.	Ending. D.
April 19	9.28	1st mag. *	295°½	46° +	316°	51° +
„	10.31	2nd mag. *	305	38 +	309	37½ +
„	10.43	3rd mag. *	277	36½ +	278½	35 +
„	10.50	4th mag. *	256½	17 +	254	13 +
April 20	9.10	3rd mag. *	266	17 +	264½	13 +
„	9.50	3rd mag. *	319	45 +	329	45 +
„	11.4	2nd mag. *	282	22 +	285	16 +
„	11.13	2nd mag. *	264½	16 +	261½	9 +

The other four showed a well-marked radiant point at R. A. 221°½, D. 20 + in Bootes. The observed paths of these were as under:—

Date.	Time.		Beginning. R. A.	Beginning. D.	Ending. R. A.	Ending. D.
April 19	9.58	2nd mag. *	307°½	43° +	285°	33° +
April 20	9.9	3rd mag. *	247	28 +	258	29 +
„	9.54	1½ mag. *	244	53 +	268	67 +
„	10.55	1st mag. *	225	19 +	246	16 +

The brightest meteor seen was one that appeared at 9^h 28^m on April 20. It diverged from the radiant in Lyra, and was about equal in brilliancy to α in that constellation. This meteor left a train which remained visible about 1½ sec. after the disappearance of the head.

Bristol, April 21 WILLIAM F. DENNING

I SEND the following observations of the shooting stars of the April period, viz., the 19th and 20th. On the 19th I began to watch at 10^h, but saw no more until 11.45. I then watched them until 3^h 15^m. I found they seemed to come in the region of the heavens about Corona, so I confined my observations to that part as I had not a situation where I could see the opposite side as well. By 10 o'clock Hercules was quite above the buildings, so there may have been some meteors visible earlier, when these constellations were too low for me to see. The first night they were all comprised in a triangle, which would be formed by a line stretching from Vega by way of Ophiuchus to Mars, and thence up to Arcturus and by Corona back to Vega. They were pretty equally distributed over this region. The next night they were much more concentrated in Ophiuchus and Hercules and towards Libra. I was not able to determine the radiant, so I confined myself to reckoning them accurately in intervals of fifteen minutes, which time I had conveniently marked for me by the church clocks, and only observed their tracks approximately. On the second night I noted the position and direction of each which shows their concentration about the part named. On the nineteenth there were 25—15 horizontal, 10 vertical. On the 20th from 9.45 to 2.45 there were 33—22 vertical and 11 horizontal. Those I call vertical by distinction were almost all just half way between horizontal and vertical, *i.e.* at an angle of 45°. It was curious how this angle predominated. It was also curious that the first night the horizontal ones predominated, and the second night the vertical. I do not know if I am wrong (1) in assuming that we pass through the node of the orbit of the meteors at this time, and (2) in inferring from this assumption that the angle at which they principally appear to us would be a guide to the inclination of the node. Would the fact of their being horizontal be any proof that the inclination of their orbit is small, and their being vertical a proof that it is much greater, and of a somewhat similar angle? But this would not explain the fact of the majority being horizontal the first night and the majority at a greater angle the next night. One seen on the 20th was intermittent, it ran for a long distance, and became visible at intervals of a few seconds a little way further on. Only a few were of any size, and the first night all but two were extremely small and very faint, with very short tracks. The next night they were not only greater in number but larger, brighter, and with longer tracks. A few left tracks lasting a second or two. One only moved very fast. The first night there was one quite vertical *upwards*. This was the only instance. The majority were from E. to S. or E. to W. on both nights; and the only two of any length on the 19th were one running out of Corona and one running into it. It seemed curious to me how these should be so much longer than all the others and yet lie so close to the point of apparent divergence of them all. The following is a list for the two nights of the number in each 15 minutes: April 19.—From 11.45 to 12, 2; 12.15, 5; 12.30, 2; 12.45, 2; 13, 1; 13.15, 5; 13.30, 1; 13.45, 0; 14, 3; 14.15, 2; 14.30, 0; 14.45, 1; 15, 1; 15 to 15.30, 0; Total: 25.

April 20.—From 9.45 to 10, 1; 10.15, 3; 10.30, 1; 10.45, 0; 11, 5; 11.15, 2; 11.30, 2; 11.45, 1; 12, 0; 12.15, 1; 12.30, 1; 12.45, 1; 13, 2; 13.15, 4; 13.30, 2; 13.45, 2; 13.45 to 14.30, 0; 14.45, 5; Total: 33. P. B.

Bath

Instinct

A Mechanical Analogy

MR. DARWIN, in his article on "The Origin of certain Instincts," in NATURE, of April 3, appears inclined to think that what we may call the instinct of direction in animals is of the same kind as the faculty by which men find their way: and he instances the power of the natives of Siberia to find their way over hummocky ice. He afterwards, however, raises without discussing the question "whether animals may not possess the faculty of keeping a dead reckoning of their course in a much more perfect degree than man, or whether this faculty may not come into play on the commencement of a journey when an animal is shut up in a basket." I wish to point out that this peculiar power of animals is one that cannot be explained as a higher degree of any power that man possesses. What man can do is to find the third side of a triangle after travelling the other two sides *with his eyes open*. Animals can do the same after travelling the two sides *with their eyes shut*. The former power does not in any degree involve the latter. Moreover, the power of man here spoken of depends on the careful use of his powers of observation. This does not appear to be the case with animals. Among the many instances of animals finding their way home after being conveyed away without any opportunity of seeing their way or taking their bearings, there must in all probability be many in which the animal slept on the journey: and if so, the mental or organic process whereby it was able to know its way back must have gone on during sleep. There is nothing in man's mind similar to such a process as this. It can be made conceivable only by a mechanical analogy, if at all.

If a ball is freely suspended from the roof of a railway carriage, it will receive a shock sufficient to move it, when the carriage is set in motion: and the magnitude and direction of the shock thus given to the ball will depend on the magnitude and direction of the force with which the carriage begins to move. While the carriage is in uniform motion the ball will be relatively at rest; and every change in the velocity of the motion of the carriage, and of its direction, will give a shock of corresponding magnitude and direction to the ball. Now, it is conceivably quite possible, though such delicacy of mechanism is not to be hoped for, that a machine should be constructed, in connection with a chronometer, for registering the magnitude and direction of all these shocks, with the time at which each occurred; and from these data—the direction of the shock indicating the direction of the motion of the carriage, the magnitude of the shock indicating its velocity, and the interval of time between two shocks indicating the time during which the carriage has run without change of velocity or direction—from these data the position of the carriage, expressed in terms of distance and direction from the place from which it had set out, might be calculated at any moment. The automatic register of the journey may be conceived as exactly resembling the records of the velocity and direction of the wind produced by one of Robinson's or Beck's self-registering anemometers, where one pencil-mark indicates the direction of the wind, at any past hour, and another its velocity.

Further, it is possible to conceive the apparatus as so integrating its results as to enable the distance and direction of the point where the journey began to the point it has reached, that they can be read off, without any calculation being needed:—a hand on a dial pointing to the direction expressed in degrees of the circle, and the distance being shown in figures expressing miles and decimals of a mile.

Now, I suppose such an integrating process as this (though of course not by any similar mechanism) to be effected in the brain of an animal unconsciously, and that the animal has the power of reading off the result—that is to say, bringing it into consciousness when wanted. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim, April 11

Sense of Orientation

YOUR article on this subject in the issue of March 20, insists very properly on the objection to Mr. Wallace's theory that "if it be solely by the aid of this memory of smells that the dog is to return to the place whence it was taken, it must needs *make haste* back." I wish to contribute an anecdote of which the hero did not make haste back, and which seems to me to confirm rather the theory already suggested in this correspondence, namely, of a sense of polarity or *orientation* possessed by so many of the lower animals both domesticated and wild. Last summer I was at North Bridgewater, Mass., a shoe-making town about twenty miles south of Boston. At the railroad station I remarked an intelligent dog, whose owner told me, with a good deal of feeling, that he had sold the animal some time previously to be taken to Somerville—a suburb adjoining Boston on the north-west, therefore distant from North Bridgewater at least twenty miles. The dog was carried thither in a closed box-car, probably making a change at Boston, where the railroad terminates. For some two or three weeks the dog made himself at home in his new premises as if perfectly contented, when suddenly he disappeared, and turned up again not at North Bridgewater, the home of his former owner, but at Bridgewater, a mile or two further south, where he had been raised, at the house of that owner's father; evidently not meaning to be sold again.

I am not sure that it is quite germane to this discussion to call attention to the fact pointed out by the late George Catlin in his "Life amongst the Indians" (p. 96), "that the wild horse, the deer, the elk, and other animals, never run in a straight line: they always make a curve in their running, and generally (but not always) to the left."

"I never have forgotten one of the first lessons that I had from my dear friend Darrow, in deer-stalking in the forest. 'George,' said he, 'when a deer gets up, if the ground is level, never follow him, but turn to the left, and you will be sure to meet him; he always runs in a curve, and when he stops he is always watching his back track.' But *man* 'bends his course;' man, lost in the wilderness or on the prairies, travels in a curve, and always bends his curve to the *left*; why this?"

Of the latter fact Mr. Catlin gives an illustration drawn from his own experience, and adds:

"On arriving at the Sioux village, and relating our singular adventure, the Indians all laughed at us very heartily, and all the chiefs united in assuring me that whenever a man is lost on the prairies he travels in a circle; and also that he invariably turns to the *left*; of which singular fact I have become doubly convinced by subsequent proofs similar to the one mentioned."

New York, April 8 N. Y.

UNITED STATES SIGNAL SERVICE

THE United States Signal Service Bureau has rapidly risen to great and deserved importance. The chief officer, General Albert J. Meyer, is a physician by education, who, during the civil war, was placed at the head of the Signal Corps. In that position he rendered great service, and developed a remarkably complete system of signals. The service now consists of a school of instruction, a central office at Washington, and stations over the country at such points as will enable the observers to note accurately the varying conditions of temperature and the progress of storms. The school is at Fort Whipple, Virginia. "A principal duty of the school has been the drill and instruction of the Observer-Sergeants and the assistant observers for the signal service. In the preparation for these duties each man is required to enlist in the signal detachment at Fort Whipple as a private soldier, and to pass afterwards a preliminary educational examination before he is put under especial instruction. He is then given some knowledge of the theories of meteorology, and is taught the practical use of the various instruments, forms, &c., in vogue at the several stations of observation, while he is practised at the same time in his regular drills of the service. When considered competent he is ordered as an assistant observer to a station where, in addition to perfecting himself in the practical details of the duties at the station, he continues his studies, regularly under the Observer-Sergeant in charge. A service of six months in this capacity renders an assistant eligible as a candidate for promotion. He may then be ordered back to the school to review his studies, and to appear for his final examination before a board of officers appointed for the purpose. Passing this examination, he is promoted to the grade of observer-sergeant, and is considered competent to take charge of a station. This course has been followed successfully during the past year, and each man's fitness has been clearly determined by this probationary service as assistant before his assignment to a more responsible position.

The central office at Washington is in telegraphic communication with all the stations, and each night reports are received at 11 o'clock, P.M., and the results of the digest are telegraphed to all the principal cities in time for the daily morning papers.

From a detailed report of the operations of each of the established stations it appears that during the year there have been issued and distributed at the different lake, sea-coast, and river ports, and in the inland cities a total number of bulletins, maps, &c., as follows:—

Total number of bulletins	187,617
Total number of maps	203,533
Total number of Press reports	50,878

The accuracy of the predictions of the Bureau as to the weather changes is stated in the report as follows:—"A comparison of the tri-daily forecasts, or 'probabilities,' as they have been styled, with the meteoric condition afterward reported, and, so far as known, has given an average of sixty-nine per cent., as verified up to November 1, 1871. Since that date to the present time (October 1, 1872) the average of verifications has been seventy-six and eight-tenths per cent. If regard be had to those predictions verified, within a few hours after the time for which they were made, this percentage is considerably increased. In view of the deficiency of telegraphic facilities during the year, and the great irregularities of the working, it was not anticipated that these predictions, based as they are upon the tri-daily telegraphic reports, would increase in accuracy. Whatever success has been attained must be considered an indication of what success might be with well organised and full telegraphic facilities."

The number of "cautionary" signals on the inland lakes and on the sea-coast, and their value are thus stated:—"Three hundred and fifty-four cautionary signal orders have been issued during the year, each display of the cautionary signal at any station being considered a separate order. This signal was announced as to be shown 'whenever the winds are expected to be as strong as 25 miles an hour, and continue so for several hours within a radius of 100 miles from the station.' The percentage of the cautionary signals verified by the occurrence within a few hours after the display of the winds described, either at the port at which the signal was exhibited, or within the radius of 100 miles from that port, is estimated to have been about 70 per cent. The instances of signals displayed, reports not verified, are those in which they have not been proven necessary at the station where exhibited. The signal is wholly 'cautionary,' forewarning probable danger. It has been aimed to err on the side of caution. The delays such errors may cause are retrievable—the disasters of shipwreck are not. Since the 1st of July of the present year (1872) thirty-two cautionary signals, forewarning the approach of six different storms, have been displayed at different ports. Of these storms five were destructive, justifying the display of twenty-eight of the signals—one in advance of which four signals were displayed was not considered dangerous."

The operations of the service have been considerably extended by co-operation of the Canadian authorities, and negotiations are in progress designed to furnish signal reports from the West India Islands, and even from Europe.

THE ZOOLOGICAL AND ACCLIMATISATION SOCIETY OF VICTORIA

THE first volume of the Proceedings of this Society, contains upwards of 400 pages, and the prefixed report is altogether very satisfactory. The council of the society rightly think that Melbourne, from its size and importance, ought to number among its attractions a good zoological collection. If they succeed in obtaining a sufficiently large number of subscribers, they intend, in the first instance, to form as complete a collection as possible of the fauna of Australia, and thereafter, when in a position to do so, to add those of other countries. The Government, we are glad to see, very liberally placed the sum of 1,000*l.* on the estimate for the past financial year.

A considerable amount of success attended the operations of the society during the year previous to March last. A number of pheasants of the silver (*Phaseanus nycthemerus*) and common (*Phaseanus colchicus*) varieties, had been reared, and were to be liberated in suitable places. Upwards of 150 guinea-fowl had been placed in various secluded spots, in forests far removed from settlement, where it is confidently hoped they will increase, and in a few years yield both food and sport.

About 3,500 live trout, hatched at the society's establishment at the Royal Park, Melbourne, had, during the previous season, been placed in different streams. The deer which have been liberated in many parts of the colony are spreading and increasing rapidly, and the society possess a fine collection of six varieties in their grounds at the Royal Park. The valuable stock of Angora goats and the ostriches belonging to the society are thriving and increasing.

Although the society is anxious to encourage and promote sericulture, they find it difficult to advance this industry in a really practical manner so as to be of benefit to the colony. Baron von Mueller has, however, as well as the society, supplied many parts of the colony with white mulberry plants, and when they come into bearing, silk growing will, they hope, become an important industry of the colony.

On account of the services rendered to pisciculture by Sir Robert Officer and Mr. Morton Allpart, of Tasmania, the society have awarded to both these gentlemen their silver medal; their bronze medal has been awarded to Captain Babot, of the *Hydrastes*, for his enterprise in bringing out sea-turtle.

In conclusion, the council are glad to state that the condition of the society is sound and prosperous, and they only require more liberal co-operation from the public to enable them to produce great results in the cause of acclimatisation. We sincerely hope the Australian public will see it to be to their own interest to respond liberally to the desire of the society for assistance in carrying out their benevolent work.

The bulk of the volume is occupied by two papers. The first is a valuable monograph on the "Ichthyology of Australia," by Count F. de Castelnau, in which he gives an account of the different sorts obtainable in the Melbourne fish market: their number is 142. In the introduction the author speaks with great admiration of Dr. Günther's Catalogue of the Fishes in the British Museum, from which he has continually to quote; further on, he criticises that author's views on the distribution of fishes. He also thinks that the learned doctor is too severely condemnatory of the imperfections of his scientific comrades. The second paper is a list by Baron F. v. Mueller of "Select plants readily eligible for Victorian industrial culture."

NEW FRENCH INSTITUTION FOR THE EXPERIMENTAL SCIENCES

AMID all her political turmoil and strife it seems to us a hopeful sign of the real progress of France that she has citizens with energy, enterprise, and enlightenment enough to undertake and carry out a scheme of the magnitude and importance of the one about to be realised at Lyons. It is to be exclusively devoted to scientific research, and the *Revue Scientifique* thinks it deserves to be classed with the richest establishments of a similar kind in England, Germany, and Paris.

For more than a year, it seems, the municipal administrators of Lyons have had it under consideration to form laboratories of physiology and experimental medicine, provided with all the most modern and most approved means of investigation. To settle the plan of such an institution, the muncipality nominated a Commission of scientific men, consisting of MM. Ollier, Perroud, and Tripier. This Commission has given in its report, and the following is the scheme it suggests with regard to the biological sciences alone:—

1. A great central laboratory, equipped for the operations and observations which are required in the experimental study of the physiological and pathological phenomena of the animal economy. In it will be collected and methodically arranged all the instrumental apparatus commonly required for such observations and experiments, especially the registering apparatus.

2. A central hall or store-house of apparatus. This will be the depôt for apparatus and instruments not in daily use, and which are used only in certain circumstances.

3. A laboratory of biological chemistry.

4. A laboratory of biological physics.

5. A laboratory of histology.

6. A room for geological researches relative to the study of parasites and parasitical diseases, including those of the silkworm.

7. A room for autopsies.

8. A room for minute dissections and for the mounting of specimens intended to be preserved.

9. A workshop for construction and repairs, in which will also be set agoing the moving forces intended to work the apparatus.

10. A cabinet of specimens.

11 and 12. A room of design and a small photographic studio.

13. A library.

14. A hall for meetings and lectures.

15. Places for keeping animals.

16. A conservatory and enclosure for researches in vegetable physiology.

17. General offices, houses for the director and assistants, for fuel, water, &c.

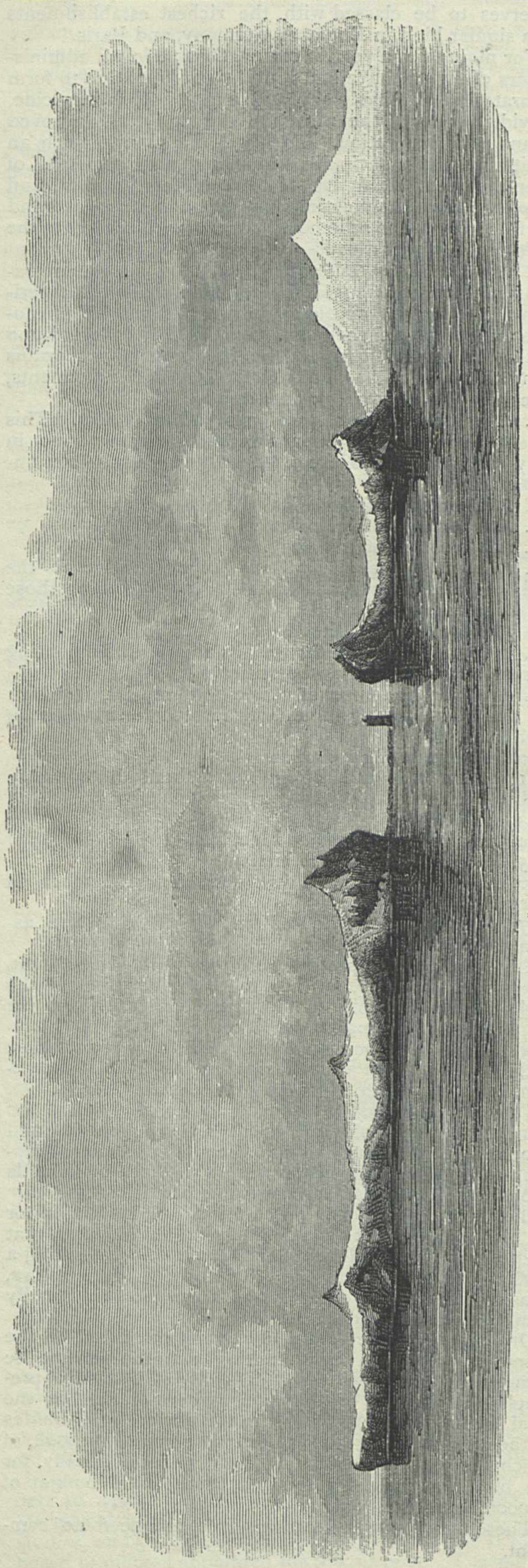
The *personnel* comprehends a director and his assistant, a librarian, who will also see to the publication of the works of the establishment, three assistants, one for operations and autopsies, the second for work in biological physics and chemistry, and the third for microscopic studies and work in experimental zoology; finally workmen, laboratory attendants, concierge, groom, &c.

These laboratories are intended for the study of all the branches of the biological sciences, from general and comparative physiology to experimental medicine, questions of hygiene and public health, diseases of animals (especially silkworms), and vegetable physiology.

But, although specially intended as an institution for the biological sciences, the Commission has indicated that the programme would be rendered complete by adding a physico-chemical institute for the study of brute nature, so as to unite in the same establishment the whole body of modern experimental sciences.

On March 7 the Maire of Lyons presented to the Municipal Council a report asking that the scheme be immediately proceeded with. The city of Lyons has presented the grounds of the ancient corn-market on the Quai St. Vincent. According to the plans and estimates of the city architect, the buildings will cost 900,000f., of which this year 330,000f. have been raised. Finally, for the biological sciences alone, a first annual budget of 30,000f. has been set aside.

These figures speak for themselves, and need no comment.



Possession Islands. * From a sketch by Dr. Hooker, C.B., F.R.S.

POSSESSION ISLANDS

SEEING is believing. The fitness of Possession Islands for the residence of an observing party during a whole year may be best judged from the accompanying illustration, which is accurately copied from a sketch made by Dr. Hooker at the time a landing was effected. (See NATURE, vol. vii. p. 384.) This was *in midsummer*, and with an exceptionally calm sea. The spot where the crew landed is indicated by an * underneath. A sketch of the place by Captain Davis is given at the beginning of chapter vii. in the first volume of Ross's Voyage.

ON THE ORIGIN AND METAMORPHOSES OF INSECTS*

II.

IN the Coleoptera, the larvæ differ very much in form. The majority are elongated, active, hexapod, and more or less depressed; but those of the Weevils (Pl. 2, Fig. 6), of Scolytus, (Pl. 2, Fig. 4), &c., which are vegetable feeders, and live surrounded by their food, as, for instance, in grain, nuts, &c., are apod, white, fleshy grubs, not unlike those of bees and ants. The larvæ of the Longicorns, which live inside trees, are long, soft, and fleshy, with six short legs. The Geodephaga, corresponding with the Linnean genera Cicindela and Carabus, have six-legged, slender, carnivorous larvæ; those of Cicindela. which waylay their prey, being less active than the hunting larvæ of the Carabidæ. The Hydradephaga, or water-beetles (Dyticidæ and Gyrinidæ) have long and narrow larvæ (Pl. 4, Fig. 6), with strong sickle-shaped jaws, short antennæ, four palpi, and six small eyes on each side of the head; they are very voracious. The larvæ of the Staphylinidæ are by no means unlike the perfect insect, and are found in similar situations; their jaws are powerful, and their legs moderately strong. The larvæ of the Lamellicorn beetles (cockchafers, stag-beetles, &c.) feed either on vegetable or on dead animal matter. They are long, soft, fleshy, grubs, with the abdomen somewhat curved, and generally lie on their side. The larvæ of the Elateridæ, known as wireworms, are long and slender, with short legs. Those of the glowworm are not unlike the apterous female. The male glowworm, on the contrary, is very different. It has long, thin, brown wing-cases, and often flies into rooms at night, attracted by the light, which it probably mistakes for its mate.

The metamorphoses of the Cantharidæ are very remarkable, and will be described subsequently. The larvæ are active and hexapod. The Phytophaga (Crioceris, Galeruca, Haltica, Chrysomea, &c.) are vegetable feeders, both as larvæ and in the perfect state. The larvæ are furnished with legs, and are not unlike the caterpillars of certain Lepidoptera.

The larva of Coccinella (the Ladybird) is somewhat depressed, of an elongated ovate form, with a small head, and moderately strong legs. It feeds on Aphides.

Thus, then, we see that there are among the Coleoptera many different forms of larvæ. Macleay considered that there were five principal types.

1. Carnivorous hexapod larvæ, with an elongated, more or less flattened body, six eyes on each side of the head, and sharp falciform mandibles (Carabus, Dyticus, &c.).

2. Herbivorous hexapod larvæ, with a fleshy, cylindrical body, somewhat curved, so that the animal lies on its side (Lucanus, Melolontha).

3. Apod grub-like larvæ, with scarcely the rudiments of antennæ (Curculio).

4. Hexapod antenniferous larvæ, with a subovate body, the second segment being somewhat larger than the others (Chrysomela, Coccinella).

* Continued from p. 446.

5. Hexapod antenniferous larvæ, of oblong form, somewhat resembling the former, but with caudal appendages (Meloe, Sitaris).

The pupa of the Coleoptera is quiescent, and * "the parts of the future beetle are plainly perceivable, being incased in distinct sheaths; the head is applied against the breast; the antennæ lie along the sides of the thorax; the elytra and wings are short and folded at the sides of the body, meeting on the under side of the abdomen; the two anterior pairs of legs are entirely exposed, but the hind pair are covered by wing-cases, the extremity of the thigh only appearing beyond the sides of the body."

In the next three orders, the Orthoptera (grasshoppers, locusts, crickets, walking-stick insects, cockroaches, &c.), Euplexoptera (earwigs), and Thysanoptera, a small group of insects well known to gardeners under the name of Thrips, the larvæ when they quit the egg (Pl. 1 and 2, Figs. 1 and 2) already much resemble the mature form, differing in fact principally in the absence of wings, which are more or less gradually acquired, as the insect increases in size. They are active throughout life. Those specimens which have rudimentary wings are, however, usually called pupæ.

The Neuroptera present, perhaps, more differences in the character of their metamorphoses than any other order of insects. The larvæ are generally active, hexapod, little creatures, and do not differ in appearance so much as those, for instance, of the Coleoptera, but the essential difference is in the pupæ; some groups, as, for instance, the Psocidæ, Termitidæ, Libellulidæ, Ephemeridæ, and Perlidæ, remaining active throughout life, like the Orthoptera; while a second division, including the Myrmeleonidæ, Hemerobiidæ, Sialidæ, Panorpidæ, Raphidiidæ, and Mantispidæ, have quiescent pupæ, which, however, in some cases, acquire more or less power of locomotion shortly before they assume the mature state; thus, the pupa of Raphidia, though motionless at first, at length acquires strength enough to walk, while still enclosed in the pupa skin, which is very thin.†

One of the most remarkable families belonging to this order is that of the Termites, or white ants. They abound in the tropics, where they are a perfect pest, and a serious impediment to human development. Their colonies are extremely numerous, and they attack woodwork and furniture of all kinds, generally working from within, so that their presence is often unsuspected, until it is suddenly found that they have completely eaten away the interior of some post or table, leaving nothing but a thin outer shell. Their nests, which are made of earth, are sometimes ten or twelve feet high, and strong enough to bear a man. One species, *Termes lucifugus*, is found in the South of France, where it has been carefully studied by Latreille. He found in these communities five kinds of individuals—(1) males; (2) females, which grow to a very large size, their bodies being distended with eggs, of which they sometimes lay as many as 80,000 in a day; (3) a kind described by some observers as Pupæ, but by others as neuters. These differ very much from the rest, having a long, soft body without wings, but with an immense head, and very large, strong jaws. These individuals act as soldiers, doing apparently no work, but keeping watch over the nest and attacking intruders with great boldness. (4) Apterous, eyeless individuals, somewhat resembling the winged ones, but with a larger and more rounded head; these constitute the greater part of the community, and like the workers of ants and bees, perform all the labour, building the nest and collecting food. (5) Latreille mentions another kind of individual which he regards as the pupa, and which resembles the workers, but has four white tubercles on the back, where the wings will afterwards make their appearance. There is still, however, much difference of opinion among entomologists, with reference to the true nature of these different classes of individuals. M. Lespés, moreover, who has recently studied the same species, describes a second kind of male and a second kind of female. The subject, indeed, is one which offers a most promising field for future study.

Another interesting family of Neuroptera is that of the Ephemeræ, or mayflies (Pl. 3, Fig. 1), so well known to fishermen. The larvæ (Pl. 4, Fig. 1) are semi-transparent, active, six-legged little creatures, which live in water, and having at first no gills, respire through the general surface of the body. They grow rapidly and change their

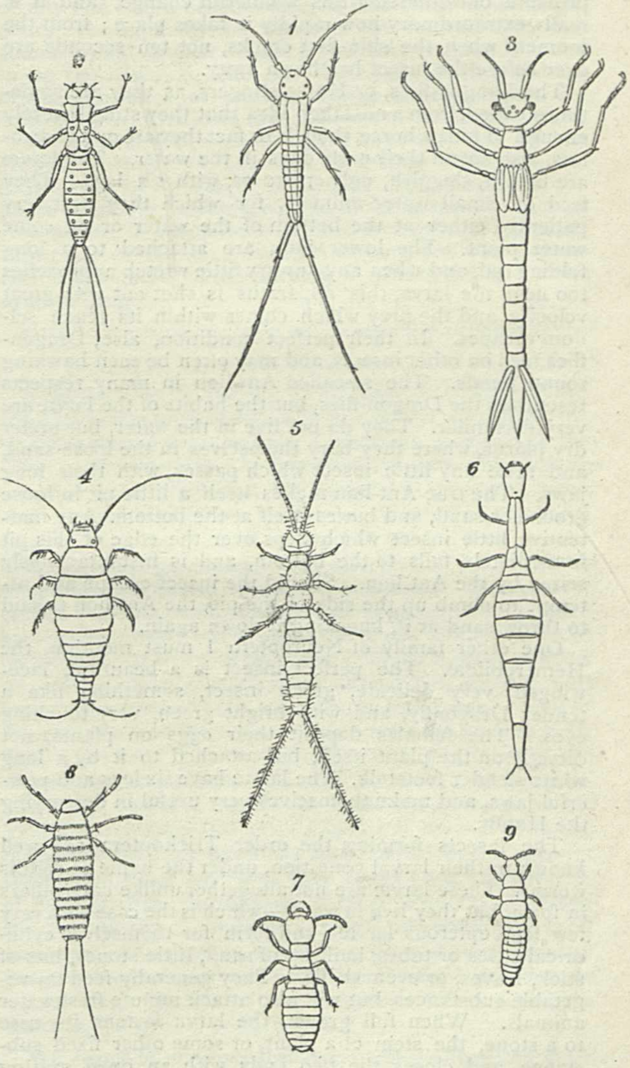


PLATE 4

PL. 4.—FIG. 1, Larva of Chloeon. 2, Larva of Meloe (after Chapuis Candeze). 3, Larva of Calepteryx (after Leon Dufour). 4, Larva of Sitaris 5, Larva of Campodea (after Gervais). 6, Larva of Acilius. 7, Larva of Termes (after Blanchard). 8, Larva of Stylops. 9, Larva of Thrips.

skin every few days. After one or two moults they acquire seven pairs of branchiæ, or gills, which are in the form of leaves, one pair to a segment. When they are about half grown, the posterior angles of the two posterior thoracic segments begin to elongate. These elongations become more and more marked with every skin. One morning, in the month of June, some years ago, I observed a full-grown larva, which had a glistening appearance, owing to the pre-

* Westwood's Introduction, vol. i. p. 36. † Ibid. vol. ii. p. 52.

sence of a film of air under the skin. I put it under the microscope, and then, having added a drop of water with a pipette I put the instrument down and looked through the glass. To my astonishment, the insect was gone, and an empty skin only remained. I then caught a second specimen, in a similar condition, and put it under the microscope, hoping to see it come out. Nor was I disappointed. Very few moments had elapsed, when I had the satisfaction of seeing the thorax open along the middle of the back; the two sides turned over; the insect literally walked out of itself, unfolded its wings, and in an instant flew up to the window. Several times since, I have had the pleasure of witnessing this wonderful change, and it is really extraordinary how rapidly it takes place; from the moment when the skin first cracks, not ten seconds are over before the insect has flown away.

The Dragon-flies, or Horse-stingers, as they are sometimes called, from a mistaken idea that they sting severely enough to hurt a horse, though in fact they are quite harmless, also spend their early days in the water. The larvæ are brown, sluggish, ugly creatures, with six legs. They feed on small water animals, for which they wait very patiently, either at the bottom of the water or on some water plant. The lower jaws are attached to a long folding rod, and when any unwary little wretch approaches too near the larva, this apparatus is shot out with great velocity, and the prey which comes within its reach seldom escapes. In their perfect condition, also, Dragonflies feed on other insects, and may often be seen hawking round ponds. The so-called Ant-lion in many respects resembles the Dragon-flies, but the habits of the larvæ are very dissimilar. They do not live in the water, but prefer dry places, where they bury themselves in the loose sand, and seize any little insect which passes, with their long jaws. The true Ant-lion makes itself a little pit in loose ground or sand, and buries itself at the bottom. Any inattentive little insect which steps over the edge of this pit immediately falls to the bottom, and is instantaneously seized by the Ant-lion. Should the insect escape and attempt to climb up the side of the pit, the Ant-lion is said to throw sand at it, knocking it down again.

One other family of Neuroptera I must mention, the Hemerobiidæ. The perfect insect is a beautiful, lace-winged, very delicate, green insect, something like a tender Dragonfly, and with bright green, very touching eyes. The females deposit their eggs on plants, not directly on the plant itself, but attached to it by a long white slender footstalk. The larvæ have six legs and powerful jaws, and make themselves very useful in destroying the Hopfly.

The insects forming the order Trichoptera are well known in their larval condition, under the name of caddis worms. These larvæ are not altogether unlike caterpillars in form, but they live in water—which is the case with very few lepidopterous larvæ—and form for themselves cylindrical cases or tubes, built up of sand, little stones, bits of stick, leaves, or even shells. They generally feed on vegetable substances, but will also attack minute freshwater animals. When full grown, the larva fastens its case to a stone, the stem of a plant, or some other fixed substance, and closes the two ends with an open grating of silken threads, so as to admit the free access of water, while excluding enemies. It then turns into a pupa, which bears some resemblance to the perfect insect, "except that the antennæ, palpi, wings and legs are shorter, enclosed in separate sheaths and arranged upon the breast." The pupa remains quiet in the tube until nearly ready to emerge, when it comes to the surface, and in some cases creeps out of the water. It is not therefore so completely motionless as the pupa of Lepidoptera.

The Diptera, or Flies, comprise insects with two wings only, the hinder pair being represented by minute club-shaped organs called halteres. Flies quit the egg generally in the form of fat, fleshy, legless grubs. They feed principally on decaying animal or vegetable matter, and are no doubt useful as scavengers. When full grown they turn into pupæ which are generally inactive; those of some gnats, however, swim about. Other species, as the gadflies, deposit their eggs on the bodies of animals, within which the grubs, when hatched, feed. The mouth is generally furnished with two hooks which serve instead of jaws. The pupæ are of two kinds. In the true flies, the outer skin of the full-grown larva is not shed, but contracts and hardens, thus assuming the appearance of an oval brownish shell or case, within which the insect changes into a chrysalis. The pupæ of the gnats, on the contrary, have the limbs distinct and enclosed in sheaths. They are generally inactive, but some of the aquatic species continue to swim about.

One group of Flies, which is parasitic on horses, sheep, bats, and other animals, has been called the Pupipara, because it was supposed that they were not born until they had arrived at the condition of pupæ. They come into the world in the form of smooth ovate bodies, much resembling ordinary dipterous pupæ, but as Leuckart has shown,* they are true, though abnormal, larvæ.

The next order, that of the Aphaniptera, is very small in number, containing only the different species of Flea. The larva is long, cylindrical, and legless; the chrysalis is motionless, and the perfect insect is too well known, at least as regards its habits, to need any description.

Unlike the preceding orders of insects, the Heteroptera quit the egg in a form, differing from that of the perfect insect principally in the absence of wings. The species constituting this group, though very numerous, are generally small, and not so familiarly known to us as those of the other large orders, with indeed one exception, the well-known Bug. This was not, apparently, an indigenous insect, but seems to have been introduced. Shakespeare uses the word several times, but always in the sense of a bugbear, and not with reference to this insect. In this country it never acquires wings, but is stated to do so sometimes in warmer countries. The Heteroptera cannot exactly be said either to sting or bite. The jaws, of which, as usual among insects, there are two pairs, are like needles, which are driven into the flesh, and the blood is then sucked up the lower lip, which has the form of a tube. This peculiar structure of the mouth prevails throughout the whole order; consequently their nutriment consists almost entirely of the juices of animals or plants. In their metamorphoses the Heteroptera resemble the Orthoptera; they are active through life, and the young resemble the perfect insects except in the absence of wings, which are gradually acquired. The majority are dull in colour, though some few are very beautiful. The Homoptera agree with the Heteroptera in the structure of the mouth, and in the metamorphoses. They differ principally in the front wings, which in Homoptera are membranous throughout, while in the Heteroptera the front part is thick. As in the Heteroptera, however, so also in the Homoptera, some species do not acquire wings. The Cicada, so celebrated for its song, and the lanthorn fly, belong to this group. So also does the so-called Cuckoospit, so common in our gardens, which has the curious faculty of secreting round itself a quantity of frothy matter which serves to protect it from its enemies. But the best known insects of this group are the Aphides, or Plant-lice; while the most useful belong to the Coccidæ, or scale insects, from one species of which we obtain the substance called lac, so extensively used in the manufacture of sealing-wax and varnish. Several species also have been used in dyeing, especially the Cochineal insect of Mexico, a species which lives on the Cactus. The male Coccus is a minute, active insect, with four comparatively large wings, while the female, on the contrary, never acquires wings,

* Die Fortpflanzung und Entwickelung der Pupiparen. Von Dr. R. Leuckart. (Halle, 1848.)

but is very sluggish, broad, more or less flattened, and, in fact, when full grown, looks like a small brown scale.

The larvæ of Lepidoptera are familiar to us all, under the name of caterpillars. The insects of this order in their larval condilion are almost all phytophagous, and are very uniform both in structure and habits. The body is long and cylindrical, consisting of thirteen segments; the head is armed with powerful jaws; the three following segments, the future prothorax, mesothorax, and metathorax, bear three pairs of simple articulated legs. Of the posterior segments, five also bear false or pro-legs, which are short, unjointed, and provided with a number of hooklets. A caterpillar leads a dull and uneventful life; it eats ravenously, and grows rapidly, casting its skin several times during the process, which generally lasts only a few weeks, though in some cases, as for instance the goat-moth, it extends over a period of two or three years, after which the larva changes into a quiescent pupa or chrysalis.

JOHN LUBBOCK

(*To be continued.*)

ON THE STRUCTURE OF STRIPED MUSCULAR FIBRE

A HIGHLY interesting paper on the above subject was read before the Royal Society on April 3, by Mr. E. A. Schäfer, of University College. The muscle of the limbs of the large water-beetle formed the subject of the investigation, and it was examined immediately after removal from the living animal, without the addition of any reagent, to prevent the introduction of complications. According to the author, a muscular fibre consists of a homogeneous ground substance, which appears at first sight to be formed of two distinct substances, one dim and the other bright, arranged in alternate discs at right angles to the direction of the fibre; and a vast number of minute rod-like bodies, imbedded in the protoplasmic basis, having their axes coincident with that of the fibre itself. These are termed *muscle rods*; in the muscle at absolute rest they are uniformly cylindrical, and produce the appearance of a simple longitudinal fibrillation in the fibre, with no transverse striping. But when in action these muscle-rods are terminated at each extremity by a knob, and are consequently dumb-bell shaped. It is these knobs which give the appearance of the line of dots which is always described as existing in the middle of each bright transverse band of the muscle fibre, whereas the dim one is that in which the shafts of the muscle-rods are imbedded. In contraction of the muscle, the heads of the rods become enlarged at the expense of the shafts, the extremities of each muscle-rod consequently approaching one another; and the enlarged heads come nearer to their neighbours of the same series, and to those of the next series which meet them in the bright stripe, the line of dots now appearing as a dark transverse band with bright borders. As contraction proceeds the shaft of the muscle-rod tends to, and ultimately disappears, leaving an appearance of alternate dark and light stripes; the former however are in this case due to the enlarged juxtaposed extremities of the rods, the latter on the other hand being mainly due to the accumulation of the ground-substance in the intervals between their shafts. An examination of minute oil-globules imbedded in gelatine shows clearly that they give the appearance under the microscope of dark spots with a brilliant surrounding, and several side by side produce the effect of a bright band. From many considerations it can be shown that the bright transverse bands in muscle are similarly produced by the juxtaposition of the rod-heads, among which are the following:—1. When the rod-heads are smaller the bright bands are narrower. 2. When the rod-heads have become merged with the shafts in full contraction, the bright transverse stripes entirely disappear. 3. When in contraction the rod-heads enlarge and encroach on the shaft, their bright borders accompany them and encroach on the dim substance, so that at last all appearance of dimness becomes entirely obliterated, the bright borders becoming blended in the middle. 4. The part of the muscle-rod where the head joins the shaft, is rendered indistinct by the brightness around the rod-head; whereas if this brightness were inherent in the ground-substance, this part of the rod would stand out all the darker by the contrast. 5. The appearance of a transverse section is corroborated; for in this case the rod-heads are seen so close together that the optical effect of any one would become merged into those of its neighbours: consequently the whole of the intermediate substance would appear bright; and this is actually found to be the case. 6. The fact that both the dim and the bright substance of resting muscle appear doubly refracting, would indicate that they are of the same nature.

Mr. Schäfer with polarised light has found that *all* the ground-substance of the fibre is doubly refractive, the rods alone being singly refractive. He concludes the paper by offering a conjecture as to the mode of muscular contraction, in which he is inclined to regard the ground-substance as the true contractile part, and the rods as elastic structures, merely serving to restore the fibre to its original length.

NOTES

A RUMOUR as to the fate of Sir Samuel and Lady Baker, of a kind similar to those which have ever and anon filled the air with reference to the undying Livingstone, appeared in the *Times* of Thursday last. At the end of last year, with his force dwindled down to 200 men, Sir Samuel had penetrated south until he had reached the territory of the chief of the tribes squatting near the great lakes, who had hitherto been friendly to the Egyptian government. His reception of Baker and his companions was however the reverse of friendly. Whatever the cause, a desperate conflict with the natives ensued, and after much hard fighting, Baker was compelled to retreat with but 30 out of his 200 men. It was with the utmost difficulty that the survivors succeeded in intrenching themselves in a small fort, whence to beat back further attacks. Such, according to report, was the state of matters at the end of last year. The present rumour is that Sir Samuel and Lady Baker having at last been compelled to surrender, were immediately afterwards murdered. A telegram from H.M. Consul at Alexandria, dated the afternoon of last Thursday, announces that no intelligence of any sort respecting Sir Samuel and Lady Baker had been received by the Egyptian Government, or by any other, since March 5 last. A telegram of April 19, from the Alexandria *Daily News* Correspondent states that the rumour seems to be utterly unfounded. We have, moreover, been assured by one who has the best opportunities of knowing, that no news has really been received, and that the reports about Sir Samuel are inventions: "there is not," he writes us, "a word of truth in them."

WE regret to announce that Baron Liebig's illness, to which we referred last week, has terminated in death. The great chemist died on the 18th instant, aged nearly 70 years, having been born at Darmstadt on May 12, 1803. His funeral took place with great ceremony at Munich on the 21st. We hope, in an early number, to be able to give a memoir of the late Baron.

IT is with the greatest regret that we announce the death, on the 20th inst., after a long, and latterly, severe illness, of Dr. Bence Jones, Secretary to the Royal Institution, the efficiency of which he has done much to promote. Dr. Jones was a distinguished chemist, and among his contributions to the advancement of science may be mentioned his Croonian Lectures on Matter and Force, Animal Chemistry in relation to Stomach and

Renal Diseases, Lectures on Pathology and Therapeutics, &c. His reputation has been latterly much extended by his work on the early history of the Institution, and by his excellent biography of Faraday. Dr. Jones was a member of many learned and scientific societies, at home and abroad. It will not be easy for the managers of the Royal Institution to find one capable of so efficiently discharging the duties of Secretary. Our readers will remember that a short time ago a movement was set on foot to get up a well-deserved testimonial to Dr. Jones, which, in agreement with his own wishes, is to take the form of a bust to be placed in the Royal Institution.

DR. F. ARNOLD LEES and Mr. T. B. Blow propose to form a club under the name of the Botanical Locality Record Club, the object of which shall be to collect and keep a record of the exact localities of all the rarer British plants, with the dates of the latest observance of each, to be published yearly at the end of each season. The yearly report, containing not only a detailed list of the localities, but also a geographical summary of each year's work, is to be published and distributed only to members of the club, and to certain learned societies; to the former a subscription of 5*s.* will be charged. The names of botanists desiring to become members are to be forwarded to Mr. T. B. Blow, Welwyn, Hertfordshire.

MR. N. HOLMES, Curator of the Museum of the Pharmaceutical Society, has been appointed Lecturer on Botany to the Westminster Hospital, in the place of Mr. A. W. Bennett.

DR. ACLAND, the Regius Professor of Medicine in the University of Oxford, has given notice that the following gentlemen have been appointed to Radcliffe Studentships for the ensuing Term: Mr. A. W. Harding, of University College Hospital; Mr. Joseph H. Philpot, of King's College Hospital; Mr. William Garton, of St. Thomas's Hospital; and Mr. Frederick W. Jordan, of the Manchester Infirmary.

AMONG the works recommended by the Board of Studies in Natural Science of the University of Oxford to students preparing for examination at the University, is Sachs's "Lehrbuch der Botanik." For the benefit of those unacquainted with the German language, the Delegates of the Clarendon Press have arranged with Prof. Sachs and with MM. Engelmann, of Leipzig, for an English translation of this work from the third edition, just published in Germany, and containing a large amount of additional matter; the whole of the 460 woodcuts with which the original work is illustrated will be reproduced in the English edition. The translation has been entrusted to Mr. A. W. Bennett, who will also annotate the work on points where sufficient prominence does not appear to be given to recent researches, or undue prominence seems to be asssigned to certain theories, in which part of the labour he will be assisted by Prof. Thiselton Dyer. The work is expected to be ready by about the end of the year.

THE Edinburgh Botanical Society offers a prize of ten guineas for the best and approved essay on the Reproduction of Lycopodiaceæ, to be competed for by students who have attended the botanical class of the Royal Botanic Garden, Edinburgh, during at least one of the three years preceding the award, and have gained honours in the class examinations. The author is expected to give results of practical observations and experiments made by himself on the subject, illustrated by microscopical specimens. The essay and specimens to be given in on or before May 1, 1876, with a sealed note containing the author's name, and a motto outside. Facilities will be given for carrying on observations and experiments at the Royal Botanic Garden, Edinburgh. A prize of ten guineas is offered, through the Council of the Botanical Society, by Charles Jenner, Esq., for the best and approved essay on the Structure and Reproduction of the Frondose and Foliaceous Jungermanniaceæ. This prize is subject to all the conditions specified in the case of the former.

MR. CHARLES B. PLOWRIGHT, of the Hospital, King's Lynn, proposes issuing, under the title of "Sphæriacei Britannici," a few sets, each containing one hundred specimens, intended to form a fair representation of the more important genera and species of the British Sphæriacei. The price will be 1*l.*

THE soirée of the Royal Society is to take place at Burlington House on Saturday evening next, the 26th inst.

WE regret to announce the death of Sir William Tite, M.P., at Torquay, on Sunday.

WE regret to hear of the serious illness of the Rev. George Henslow from a paralytic seizure, which has impaired the use of the lower limbs, but has not in any way affected his mental faculties, or the use of his arms. We understand that he has appointed Dr. B. T. Lowne to take his place for the present season as lecturer on Botany at Bartholomew's Hospital.

IN pursuance of the recommendation of a committee appointed at a former meeting, a conference, presided over by the Rev. H. Solly, took place on Saturday evening in further promotion of the movement for giving some of the advantages of University education to working men. The idea is to form a Guild of Operative tradesmen to arrange for the delivery of lectures in various places by lecturers provided by and sent from the University of Cambridge. Mr. Solly stated what had been done since last meeting. The Council of Trades' Delegates had passed a resolution expressing great satisfaction with the progress of the proposed scheme, while in the interviews which the chairman had had with the heads of the University every encouragement had been afforded to the project, provided that a firm organisation could be secured to deal with. The following resolution was passed:—"That, in the present defective state of technical and higher education for the workman, no adequate provision being made for those objects, either by the State or by private endeavour, this meeting hails with satisfaction the proposal to form a Trades' Guild of Learning to co-operate with the University of Cambridge and other parties willing to aid in the education of the people."

FREDERICH DAUTWITZ writes us that he will exhibit a collection of *Cactaceæ* at the Lustschloss, Schönbrunn, Vienna, where he will be glad to receive visitors. He is also desirous of effecting exchanges.

THE sum which was left as the proceeds of Prof. Tyndall's lectures in America, after paying expenses, was 13,000 dols. This balance has been placed in charge of a committee consisting of Prof. Henry, General Hector Tyndale (Prof. Tyndall's cousin), in Philadelphia, and Prof. Youmans, of New York, and these gentlemen are authorised to expend it in aid of students who devote themselves to original investigation. A suggestion has been made, and one worthy of encouragement, that efforts be initiated to secure an increase of this fund to at least 50,000 dols., the whole to bear the name of the Tyndall Fund, so that the objects of the professor may be carried out to a fuller extent.

SCIENCE is certainly in the ascendant in America at present. A fortnight ago we noted the princely gift of Mr. Anderson to Prof. Agassiz. The California Academy of Sciences has recently received from Mr. James Lick a magnificent gift of a building site in the city of San Francisco, valued at about 100,000 dollars.

FOR the purpose of more fully carrying out the law of Congress in reference to the propagation of useful food fishes in the rivers and lakes of the United States, the United States Commissioner of Fish and Fisheries made arrangements with Mr. N. W. Clark to hatch out several hundred thousand white fish eggs at his establishment at Clarkston, Michigan, with the special object of transferring them, in due season, to the waters of California. At the proper time, in February last, two hundred thousand eggs were carefully packed and forwarded to California; but, for some unexplained reason, they were nearly all dead on their arrival. In no way discouraged by this experience, the Commissioner directed the shipment of a second lot of two hundred thousand eggs, which arrived in good condition, and the greater number have since hatched out at the State hatching establishment at Clear Lake, into which body of water they will be put at the right time. The feasibility of shipping the eggs of white fish over so great a distance has now been satisfactorily solved, and there will probably be no difficulty in carrying on this work to any desirable extent. Mr. Stone has returned to the East with the view of procuring living black bass, eels, perch, and lobsters, which he will take back to California in a few weeks, in a special car arranged expressly for the purpose. The California Commissioners appear to be fully alive to the interests involved in the multiplication of the food-fishes in their State, and seem disposed to leave no method untried to accomplish this desirable object.

THE American Association for the Advancement of Science commences its twenty-second session at Portland, Maine, on Aug. 20.

THE Annual General Meeting of the Iron and Steel Institute will be held at Willis's Rooms, London, on April 29 and 30, and May 1.

PROF. O. C. MARSH has in the current number of the *American Journal of Science and Ars* done much to clear up the difficulties connected with the *Dinocerata*. He has had the opportunity of comparing his specimens with photographs of *Eobasileus* or *Loxolophodon cornutus* of Cope, for the first time, and finds that it is exactly the same as the species named by him (Marsh) *Tinoceras grandis* some time before the introduction of either of Prof. Cope's synonyms. Prof. Marsh says, "The species of *Dinocerata* at present known with certainty are the following:—*Tinoceras anceps* Marsh, *Tinoceras grandis* Marsh, *Uintatherium robustum* Leidy, *Dinoceras mirabilis* Marsh, *Dinoceras lacustris* Marsh." With regard to the osteology of the class, we are surprised to hear for the first time that in the foot the hallux is absent, and the astragalus articulates with the cuboid as well as the naviculare bone, features not Proboscidian at all.

IF we may judge from the "Register" of Lehigh University, South Bethlehem, Penns., U.S., that institution seems to be, in most respects, a model one. It was founded only a few years ago, and is the result of a magnificent gift of 500,000 dollars and 56 acres of ground, beautifully situated in the Lehigh Valley, South Bethlehem, by the Hon. Asa Packer. South Bethlehem is about fifty-four miles from Philadelphia. The education given by the staff of professors is free, the only expense to the student being his board, books, apparatus, &c. According to the plan of education laid down, the first three terms "are devoted, by all regular students, to the study of those elementary branches in which every young man should be instructed, for whatever profession or business in life he may be intended, viz., Mathematics, Languages, Elementary Physics, Chemistry, Drawing, History, Rhetoric, Logic, Declamation, and Composition." At the end of this preliminary period, by which time the Lehigh student will be not less than 17½ years old, he makes up his mind what particular direction his studies will take during the remaining five terms (2½ years) which complete the regular course. According as he decides, the student goes through the special course provided for one of the following subjects:—General Literature, Civil Engineering, Mechanical Engineering, Mining and Metallurgy, or Analytical Chemistry: three other departments have yet to be added to this special course. According to the prospectus before us, the training provided in each of the special courses is wise and thorough, and well calculated to put a diligent student in the way to make the furthest advances in the branch he adopts. Any student who wishes may pursue his studies at the University free for three years longer than the regular course. Latin and Greek are optional in all departments except that of Literature (which, by the bye, has a large infusion of physical science), while French and German are imperative in all. The institution is rendered complete by an excellent laboratory, a well-furnished observatory and a gymnasium.

PROF. PETERS has named the last two planets discovered by him, Nos. 129 and 130, Antigone and Electra.

AMONG Mr. Murray's list of forthcoming works are the following:—"The evil Effects of Interbreeding in the Vegetable Kingdom," by Charles Darwin, F.R.S.; Sir Charles Lyell's "Antiquity of Man," 4th edition; "England and Russia in the East," by Sir Henry Rawlinson, K.C.B., F.R.S.; "Human Longevity: its Facts and Fictions," by W. J. Thoms; "Personal Recollections from Early Life to Old Age," by Mary Somerville.

THE Perthshire Society of Natural Sciences has recently done a very proper thing. On the suggestion of the council, the Hon. Secretary was instructed to communicate with such members of the Society as might be elected to serve on the Perth School Board and other School Boards in Perthshire, and ask them to keep in view the importance of introducing into the course of instruction in schools the elements of natural science.

SOME time since a paragraph appeared in NATURE relating to a supposed power of a preparation of boxwood over the growth of the human hair. A correspondent would be glad if any of our readers could inform him in what way the preparation is made, and what part of the plant is used.

MR. F. W. PUTNAM has sent us a few archæological notes on an ancient fortification surrounded by a great number of mounds, at Merom and Hutsonsville, Sullivan Co., Ind., U.S. The fort is situated on a plateau of loess, about 170 feet above the Wabash, on the east bank of the river. The position of the fort would be one of great advantage even at the present day. One of the mounds outside was dug into, and at the bottom of the pit thus made were found remains of a fire, bones of animals, pottery, and an arrow head. Mr. Putnam concludes that the pits now filled up so as to form mounds, were the houses of the inhabitants or defenders of the fort.

THE additions to the Zoological Society's Gardens during the last week include an Ocelot (*Felis pardalis*), from Honduras, presented by Miss E. E. Brooks; two vinaceous Turtle Doves (*Turtur vinaceus*) from W. Africa, presented by T. P. Tindale; a Leopard (*Felis pardus*) and a Civet Cat (*Viverra civetta*) from W. Africa, presented by L. Hart; two Goldfinch (*Carduelis elegans*) and two Canary Finches (*Serinus canarius*) from Madeira, and a Paradise Whydah Bird (*Vidua paradisea*) from W. Africa, presented by Lieut. F. L. C. Hearne; a Philantomba Antelope (*Cephalopus maxwellii*), born in the Gardens; three Indian Tree Ducks (*Dendrocygna arcuata*); three Summer Ducks (*Aix sponsa*) from N. America; two Hooded Cranes (*Grus monachus*) from Japan, purchased; two Malayan Tapirs (*Tapirus indicus*), a Rhinoceros Hornbill (*Buceros rhinoceros*), from the Malay peninsula; a Derbian Wallaby (*Halmaturus derbianus*) from Australia; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama; and a Greater Sulphur Crested Cockatoo (*Cacatua galerita*) from Australia, deposited.

THE BIRTH OF CHEMISTRY

IX.

Early Ideas concerning the Process of Combustion.—Association of Nitre with the Air, so far as the part they play in Combustion is concerned.—Hooke's Theory of Combustion. —Mayow's Experiments.—Early Pneumatic Chemistry.—Proof of the Analogy existing between Combustion and Respiration.

AS in the history of matter we find molecules grouping themselves around a common centre or a common line, thus constituting crystalline bodies, so in the history of sciences and of nations we may often observe well-defined axes, about which the facts of particular epochs congregate. Such axes are to be found in the history of chemistry. At the particular period of which we now write, the facts of the science mainly grouped themselves around theories connected with combustion, which involved as collateral matters conceptions regarding the nature of calcination, and of the air.

Combustion was, and still is, the most prominent exhibition of chemical force, with which man ordinarily comes into contact. It is a purely chemical action—the union of dissimilar bodies under the influence of chemical affinity, attended by the evolution of light and heat. Many attempts were made to explain its cause. Fire, in common with earth, air, and water, as we have before seen, was regarded as an element, till almost within our own memory. Epicurus regarded heat as a congeries of minute spherical particles possessing rapid motion, and readily insinuating themselves into the densest bodies. Fire was simply an intense form of heat. Cardanus speaks of flame as *aer accensus*, and of fire as heat immensely augmented. During the Middle Ages the existence of two kinds of fire was admitted—the one pure celestial fire "*subtilis ignis*," "*cœlestis ignis*," the principle or essence of fire; the other "gross earthly fire," or "mundane fire." The latter was the *materia*, the former the *forma*. Celestial fire became mundane fire when it was associated with combustible bodies, that is, in ordinary combustion. Seneca tells us that the Egyptians divided each element into an active and a passive form; fire became active flame which burns, and comparatively passive warmth and light. The elemental nature of fire was not universally admitted during the Middle Ages; thus Francis Bacon asserts, in the *Novum Organum*, that fire is "merely compounded of the conjunction of light and heat in any substance," and he defines heat as a rapid motion of material particles. Athanasius Kircher, in his ponderous treatise, "*Ars Magna Lucis et Umbræ*," affirms that fire is air which is caused to glow by the violent collision of bodies, by which means combustible bodies become flame. At an early date it was observed that fire cannot exist without air; the experiment of burning a candle in a closed vessel was well known. Some affirmed that "air is the food of fire," some that "air nourishes fire." The influence of a blast of air upon fire was well recognised; we have seen that bellows were known at a very early date. When nitre—which for many centuries was one of the most important bodies in chemistry—came to be known, it was soon noticed that it produces intense ignition; that, in fact, to direct a blast of air upon a red-hot coal, or to throw some nitre upon it, produced the same result, viz. greatly augmented combustion. Hence arose the idea that nitre and the air are in some way connected, for "things which are equal to the same are equal to each other." This association of ideas may seem crude to us now, yet we must remember that nitre produces rapid combustion simply because it contains a great quantity of that constituent of the air, oxygen gas, which ordinarily produces combustion. Thus the old natural philosophers, wandering in the dim twilight of experimental knowledge, were not so far wrong in their supposition. The idea mentioned above was very prevalent two centuries ago: Robert Boyle speaks of the presence of a "volatile nitre" in the air; Lord Bacon says that nitre contains a "volatile, crude, and windy spirit"; Clark attributed thunder and lightning to the presence of nitre in the air; Gassendi imagined that minute particles of nitre are diffused throughout the atmosphere. When we heat lead or tin in a current of air, these metals are respectively converted into a powder, or *calx*, and calcination was one of the most important processes in old chemistry. Calcination seemed to be due more or less directly to the air; and metals could also be calcined by heating them with nitre, or with the spirit of nitre—nitric acid; hence arose another bond of connection between nitre and the air; at least, they had something in common. Lemery in his "Cour de Chimie," published in 1675, affirms that the acid of nitre contains a number of "*corpuscules ignées*" locked up in it, and he defines these latter as "a subtle matter, which having been thrown into a very rapid motion, still retains the power of moving with impetuosity, even when it is enclosed in grosser matter; and when it finds some bodies which by their texture or figure are apt to be put into motion, it drives them about so strongly that, their parts rubbing violently against each other, heat is thereby produced."

Thus recognising the causes which had led to the association of the air with nitre, at least so far as they are both concerned in the production of combustion, we are prepared to examine Robert Hooke's theory of combustion. The announcement of this theory marks an important history in the theory of chemistry; it was the first chemical theory worthy of the name, and it gave a far more just and accurate explanation of combustion than the crude and over-belauded theory of Phlogiston, of Beccher and Stahl. Hooke's theory was, moreover, founded upon experiment, and although unfortunately he does not describe the experiments, we see at a glance that it could not have been constructed without such means. "This hypothesis," he writes, "I have endeavoured to raise from an infinity of observations and experiments," and all who know Hooke's writings, are well aware how good an experimenter he was. The theory was published in 1665 in Hooke's "*Micrographia*;" it is there found (Observation 16) buried in a mass of irrelevant matter, and to this cause may, perhaps, to some extent be attributed the fact that it has been so little recognised and known. The theory is stated in twelve propositions, the principal of which are as follows:—

1. That the air is the "universal dissolvent of all sulphureous bodies."

Sulphur was long regarded as the type of combustible bodies, on account of its ready inflammability; some even derive the name from *sal*, πῦρ, the salt of fire. By sulphureous bodies, Hooke simply meant combustible bodies, viz. bodies that can burn in a supporter of combustion. By air being the "universal dissolvent," he meant that through the agency of air combustible bodies are caused to become transformed into similarly invisible substances. For instance, we burn a pound of wood, and a few grains of ash remain, the rest has disappeared into air; as we say now, it has been converted into carbonic anhydride gas; as Hooke said then, it has been dissolved by the air.

2. "That this action it (the air) performs not until the body be sufficiently heated."

In more modern phraseology, every combustible possesses its special igniting point, phosphorus 92° F., sulphur 482° F., and so on.

3. "That this action of dissolution produces or generates a very great heat, and that which we call *Fire*."

4. "That this action is performed with so great a violence, and does so minutely act, and rapidly agitate the smallest parts of the combustible matter, that it produces in the diaphanous medium of the air the action, or pulse, of *Light*.

This would seem to indicate that Hooke considered light to be an intensified form of heat, and to be generated in the same manner, and to be a kind of very rapid motion.

5. "That the dissolution of sulphurous bodies is made by a substance inherent and mixed with the air, that is like, if not the very same with, that which is fixed in saltpetre."

Hooke had evidently traced the connection between certain actions produced by the air and by saltpetre or nitre; and he says it may be readily demonstrated that combustion is effected by that constituent of the air which is fixed in saltpetre. This is a remarkable assertion, because oxygen gas was not discovered until more than a century after the proposition of Hooke's theory; and we now know that nitre contains "fixed" in it the same substance—oxygen gas—which causes air to "dissolve" combustible bodies. It is probable that the connection between air and nitre may have been rendered the more probable in the minds of Hooke and his contemporaries by the knowledge that gunpowder will burn in a space devoid of air; thus, if sulphur and charcoal burn in air, and consume air in burning, and if nitre will cause them to burn out of contact with air it would surely appear that nitre must contain air, or one of its components.

10. "That the dissolving parts of the air are but few, ... whereas saltpetre is a menstruum, when melted and red hot, that abounds more with these dissolvent particles, and therefore as a small quantity of it will dissolve a great sulphureous body, so will the dissolution be very quick and violent."

It was well known that if a piece of red-hot charcoal be thrown into melted nitre, it is consumed with great rapidity, while in the air it burns with far less readiness; hence Hooke infers that that particular component of air which causes it to support combustion exists in a condensed form in saltpetre. He also remarks that if air be violently forced upon a piece of ignited charcoal by bellows it may be made to burn almost as rapidly as in melted nitre.

12. "It seems reasonable to think that there is no such thing as an *element of fire* . . . . but that that shining transient body called *flame* is nothing else but a mixture of air and volatile sulphureous parts of dissoluble or combustible bodies."

Hooke asserts that this theory had been worked out by him several years earlier, and had been well supported by experimental means; he says, moreover, that he has here "only time to hint an hypothesis, which, if God permit me life and opportunity, I may elsewhere prosecute, improve and publish." This he never did; but a young Oxford physician named John Mayow (b. 1645 d. 1679) eagerly accepted the theory, and adduced many experiments in support of it. Perhaps Mayow may have worked with Hooke, during his residence in Oxford, and may have helped to adduce verifications of the then half-formed theory. Mayow's experiments are contained in a treatise entitled—"*Tractatus Quinque Medico-Physici quorum primus*

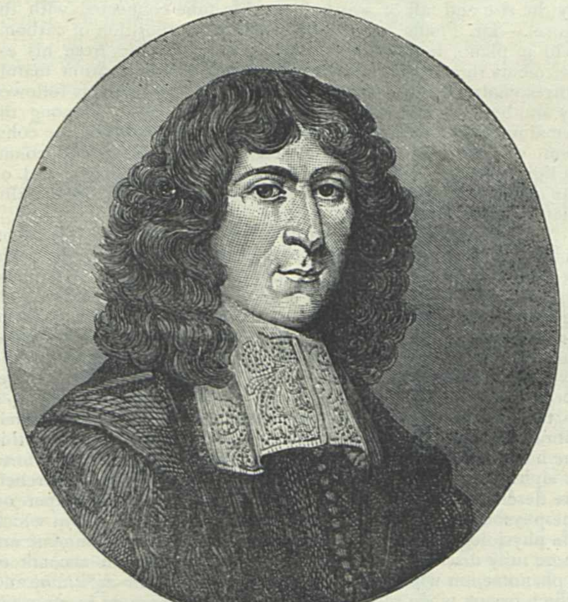


Fig. 18.—John Mayow.
(From his "Tractatus Quinque Medico-Physici, 1674.")

agit de Sal-nitro et Spiritu Nitro-aëreo, Secundus de Respiratione . . . . Oxonii, 1674." The book is altogether important, because the experiments which it contains form the basis of pneumatic chemistry, that is the chemistry of gaseous bodies; it is also distinguished by accurate reasoning and well-founded generalisations. Had it been better known, it can scarcely be doubted that the discovery of oxygen and of various gases made a century ago, would have been forestalled by many years.

Mayow calls the "dissolving parts" of the air and of nitre, which we now call oxygen gas, by the several names of *nitre air*, *fire-air*, and *nitro aërial spirit*. Air does not consist wholly of nitre-air, because when a candle is burnt in a closed vessel only a portion of the contained air is consumed. Nitre-air exists in large quantities in a condensed form in nitre; hence combustible bodies mixed with nitre will burn under water, or in a vacuum. The acid of nitre contains all the nitre-air in nitre, but it does not inflame bodies so readily as nitre because in it the nitre-air is surrounded by particles of water which tend to quench the burning body. Nitre-air is not combustible itself, neither does nitre contain any combustible substance, because it may be fused in a red-hot crucible, but no ignition will be observed to take place, until a combustible body has been added. All acids contain nitre-air:—how curiously this contrasts with Lavoisier's name *oxygen*, from *οξυς γενναω*, which he gave to the gas, because he believed it to be an essential constituent of all acids. Sulphuric acid, according to Mayow, consists of nitre-air united with sulphur; wines become sour and are changed into vinegar by the absorption of nitre-air from the atmosphere. It is the cause also of fermentation and putrefaction, and for this reason, substances when covered with fat or oil do not putrefy. During calcination metals increase in weight, and this increase is attributed by Mayow to absorption of nitric air; thus calx of antimony is antimony *plus* nitre-air, and this is borne out by the fact that a substance absolutely similar to calx of antimony may be procured by treating the metal with the acid of nitre and evaporating. Again, rust of iron is iron united with nitre-air.

We come now to some of the first experiments in Pneumatic Chemistry. In one of his experiments Mayow supported a kind of ledge within a bell-jar full of air (see Fig. 19); upon the ledge he placed a piece of camphor, and fired it by concentrating the rays of the sun by a lens upon it. The camphor ignited and burnt for some time, water then rose in the jar; and on again attempting to ignite the camphor he was unsuccessful. A lighted candle was also burned in the jar with the same result. Thus a part only of the air had been consumed, and the remainder was unable to support combustion. The siphon tube (shown on the right-hand side of the figure) was inserted at the commencement in order to render the height of the water the same, inside and outside the tube, as stoppered air jars were then unknown.

Thus it was clearly proved that air is diminished in bulk by combustion. In order to prove that respiration produces a

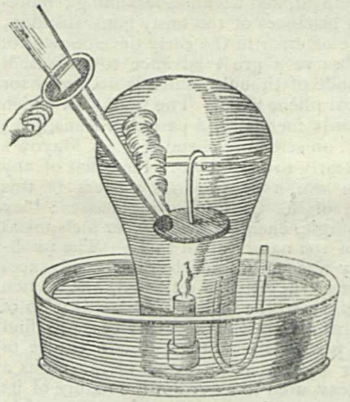


Fig. 19.

Fig. 20.

Fig. 19.—Early experiment in pneumatic chemistry. Fig. 20.—Early experiment in physiological chemistry.

similar result, Mayow tied a piece of moist bladder over the mouth of a jar (Fig. 20). and upon this he pressed a cupping-glass, so that the edges fitted air tight Within the cupping-glass he placed a mouse, and as the animal continued to breathe he noticed that the bladder was forced up, more and more into the cupping-glass, proving that the air within it had been diminished by the respiration Thus Mayow endeavoured to establish a connection between combustion and respiration. He also placed a mouse in a vessel standing over water, and noticed that the water rose in the jar as the respiration continued; and he found it impossible to ignite a combustible body in a jar of air in which a mouse had died. Again, he placed a mouse and a lighted candle together in a jar of air, and he noticed that the mouse only lived half as long as a mouse lived in the same bulk of air without the candle. Air deprived of its nitre-air was assumed to be lighter than nitre-air, because if a mouse is placed near the top of a closed vessel, it dies sooner than if placed near the bottom.

In 1672 Robert Boyle procured hydrogen gas by acting upon iron filings with an acid, and proved its inflammability; but he does not appear to have further studied its properties, and its discovery is always attributed to Cavendish, a century later. Boyle suggests that it probably consists of "the volatile, sulphur of Mars, or of metalline steams participating in a sulphurous nature." Mayow also procured some of this gas by acting upon iron with dilute sulphuric acid, and he proves that it is not a supporter of life.

Mayow's second treatise is on respiration, and he herein expresses views far in advance of any of his predecessors. He proved that the nitre-air is alone concerned in respiration, and he asserts that this is absorbed by the blood, while the rest is rejected. It unites with combustible particles in the lungs, and thus produces animal heat. The lungs consist of a number of minute sack-shaped membranes through which the nitre-air passes to the blood.

We add the following *résumé* of Mayow's treatise, and of the position which it ought to occupy in the history of chemistry, from an article which we wrote on the subject a few years ago.

Mayow's work is remarkable in several respects. In it he conclusively proved that respiration and combustion are analogous processes; he upset the four-element theory by demonstrating the compound nature of air; and he recognised oxygen and nitrogen as clearly and almost as notably as they were recognised a hundred years later—the one the supporter of life and combustion, the principle of acidity, and the cause of fermentation and putrefaction, heavier than atmospheric air; the other incapable of supporting life or combustion, and lighter than atmospheric air. We find, moreover, in this work the dawn of the idea of chemical affinity in the *fermentation*, which he speaks of as taking place between nitre-air and combustible particles, and extending to the production or destruction of things. Mayow even employs some of the terms in general use in the present day; thus he speaks of *affinitas*, existing between acids, and earthy substances, and uses the words *combinetur* and *combinentur* in speaking of the *congressus* of different substances.

The treatise is characterised by much clear and condensed thought, well-sustained argument, and accurate reasoning; moreover, we seldom meet with instances of too hasty generalisation, always the dominant source of error in the early development of a science. We further observe a great advance towards that exact and discriminative mode of thought which is necessary for the investigation of chemical phenomena. The period in which Mayow wrote, was, as regards chemistry, a period of transition; there was as yet no work on scientific chemistry, yet Mayow's treatise approached more nearly to such a work than that of any of his predecessors. The works of previous writers in this direction belonged to one of the three following classes: they were either chemico-metallurgic, chemico-medical, or alchemical treatises, or they partook of the nature of all three. The publication of works on alchemy was fast waning before the advances of the new philosophy; for as superstition retreated, and as men began to devote their energies to the legitimate investigation of nature, a false and chimerical art must of necessity cease to find votaries. Mayow was the first to discuss the intimate nature of an intangible body; other writers had treated of the air as a whole, but no one had endeavoured to ascertain the nature of its internal constitution, or to determine why it produces certain changes in surrounding bodies, upon what these changes depend, and the nature of the constituent or constituents of the air producing them. The old dogma of the elemental nature of the air was received as an absolute truth, although entirely unproven; it was thought that a theory which had been received since the earliest ages must of necessity be correct, and no attempt was made to disprove it.

We see from the above that it was the investigation of the nature of nitre which led to the knowledge of the constitution of the air, and to the first experiments in pneumatic chemistry. Mayow remarks at the commencement of his treatise, that so much had been written about nitre, that it would appear "*ut sal hoc admirabile non minus in philosophia, quam bello strepitus ederet; omniaque sonitu suo impleret;*" and when he remembers its connection with the foregoing results we are almost inclined to agree with him. G. F. RODWELL

SCIENTIFIC SERIALS

THE *Journal of Botany* for April commences with two useful papers on Cornish botany: Supplementary Contributions to the Flora of North Cornwall, a very little known district, by Mr. J. G. Baker, and another by Mr. T. Archer Briggs.—Mr. F. E. Kitchener contributes a very interesting note on Cross-fertilisation, as aided by sensitive motion, in Musk and Achimenes, the former from observations of his own, the latter from those of Miss Dowson. The structure and motion of the sexual organs, which have long been known in both these flowers, are clearly shown to be contrivances for ensuring cross-fertilisation by insect-agency.—Dr. M'Nab, in a short paper, suggests the employment of the term "pseudocarp," to distinguish fruit-like structures from true fruits, such, for instance, as the apple, the strawberry, the rose-hip, the mulberry, and the fig, into the composition of which other organs besides the true fruit enter. Among the short notes, the most interesting is one of the discovery of *Echium plantagineum* in Cornwall, by M. Ralfs, the plant having been hitherto confined, as far as British botany is concerned, to the Channel Islands. There is a coloured illustration of four new Hymenomycetous fungi, by Mr. W. G. Smith.

Poggendorff's Annalen, No. 1, 1873.—This number opens with the fourth of a series of papers, by Oscar Emil Meyer, on the internal friction of gases; he shows that Poiseuille's law for droppable fluids is verified for gaseous transpiration through narrow pipes.—Dr. Hermann Herwig communicates an account of experiments made on the action of the induction spark in explosion of gaseous mixtures; this action varying with pressure and concentration in the mixture, and with the quantity of electricity passed.—An apparatus of physiological interest, termed the Physometer, is described by P. Hartwig. It is a refinement on Robert Boyle's idea for examining the action of the swimming bladder in fish. The fish, enclosed in a wire cage, is elevated or depressed at will in a vessel filled with water, while the changes of volume in the animal are indicated by the rise and fall of water in a thin tube connected with the vessel.—Dr. Pfeffer, in a paper on the decomposition of carbonic acid in plants by the different spectral rays, infers from his experiments that the curve representing the decomposition mainly corresponds with the curve of brightness.—This paper is followed by another on a similar subject, by E. Gerland. Among the remaining articles may be noted those on the Synaphy (or cohesion) of ethers, by Dr. Scholz, on the polarisation and colour of light reflected in the atmosphere, by E. Hagenbach, and on the electromotive force of very thin gaseous layers on metallic plates, by F. Kohlrausch.

No. 2 contains one of a series of papers, by Julius Thomsen, entitled *Thermo-chemische Untersuchungen*. In the present number he investigates the affinity of hydrogen to the metalloids, chlorine, bromine, and iodine.—Oscar Meyer also continues his series on internal friction of gases; giving a detailed account of two kinds of apparatus for estimating the influence of temperature on friction, and adding some valuable observations on the dynamical theory of gases.—Several new apparatuses are described in this number, Prof. Mayer, of Hoboken, explaining a method of observing the phases and wave-lengths of sound-vibrations in air, and also his acoustic pyrometer based on this method; while an improved deep-sea thermometer, a new form of siphon, and a photometer based on the perception of relief, are described by their several inventors.—A second paper on the physometer is also communicated by P. Hartwig, in which the physiological and other applications of the instrument are more fully discussed.—W. Feddersen contributes an account of a phenomenon which he proposes to call *thermo-diffusion*, and which occurs when two portions of gas are separated by a porous diaphragm, the opposite sides of which have different temperatures. A diffusion is observed which, unlike the ordinary diffusion, takes place when, on both sides of the diaphragm, there is the same gas with the same pressure.—Dr. Morton communicates a note on fluorescence, supplementary to Hagenbach's researches; and there are, in addition, a few notes from English and other sources.

Revue des Sciences Naturelles, Nos. 1-3, 1872.—This new quarterly journal, published at Montpellier, is another proof of the scientific activity which is now reviving in France. Like Lacage Duthier's *Archives de Zoologie*, this provincial-review will we trust exhibit what Prof. Jourdain calls in one of these numbers "ces qualités éminemment françaises: la méthode, la rigueur et la clarté," combined with *Deutscher Fleiss una Unbefangenheit*, which though of late years less common in France may well be reclaimed as no alien virtues by the countrymen of Descartes, and Cuvier, and Laennec. The editor is M. Dubrueil, with whom Dr. Heckel was associated in the first two numbers. Among the contributors are the names of Andouard, Barthélemy, Boyer, Paul Gervais, Joly, Jourdain, Robin, Malinowsky. The first number opens with a paper by Prof. Joly, on the development of the Axolotl, illustrated with some good drawings. There follows a short communication on a new French mollusk (*Pisidia Dubrueui*), an introductory lecture on botany, and an account of the geology of the neighbourhood of Montpellier. Perhaps the most important part of this and the subsequent numbers is a series of careful abstracts of French and foreign publications in zoology, botany and geology. The second number contains a botanical paper on certain Juncaceæ, by Duval-Jouve, with plates; a new classification of Mammalia, by Prof. Contejean (there is nothing very new in it: the chief novelties are definitely uniting the elephant with Rodentia, and separating the Pinnipedia from the other Carnivora to associate them with Sirenia and Cetacea); a description of diatoms found in the mixture of various corallines and algæ which is known in pharmacy as "Mousse de Corse" (*Corallina corsica*, "sea-moss"), by A. de Brébisson; and a short account with a plate of the remarkable Filaria discovered in chylous urine, by Wucherer and T. R. Lewis, and lately found in human blood by the latter observer. Among the abstracts of this number, by Prof. Jourdain, is an interesting review of the affinities of *Amphioxus* and the Tunicata from an anti-Kowelevskian point of view, by Prof. Jourdain, *àpropos* of Giard's *Etude* on the subject in the *Archives de Zoologie*. The third number, published last December, contains, among other articles, an important communication from M. Bavay on the development of a frog (*Hylodes Martinicensis*, Tschudi), observed in the island of Guadaloupe. Though it issues from the egg as a perfect anurous abranchiate Batrachian, it can be seen in the semi-transparent fœtal coverings to go through the tadpole stage, having a well-developed tail and small external gills, both of course functionless. We congratulate M. Dubreuil on his enterprise and success, and hope he will be able to maintain the high character of the first three numbers of his review. P. S.

SOCIETIES AND ACADEMIES

London

Chemical Society, April 17.—Dr. Odling, F.R.S., president, in the chair.—Dr. Debus, F.R.S., delivered a lecture "On the Heat produced by Chemical Action." The speaker considered the relation existing between the chemical affinity of the metals and the amount of heat they develop during oxidation or combination with chlorine, iodine, &c., and also the various interesting conclusions which may be drawn from the thermic results obtained by the solution of salts, especially noticing that, in double decomposition taking place in solution, those compounds are always produced which develop the greatest amount of heat.

Geologists' Association.—Excursion to Banbury, April 14 and 15.—This, the first excursion of the season, was under the direction of Prof. Morris and Mr. T. Beesley, and was largely attended. After their arrival at Banbury, the members and their friends examined exposures of the Middle Lias Clays (zone of *A. capricornus*) and the marlstone in the immediate vicinity of the town. Subsequently the party proceeded southwards, visiting at Twyford a section of the Lower Middle Lias, and at King's Sutton an extensive exposure of the marlstone which is here worked for ironstone. Fossils, especially Brachiopoda, are numerous at this place, and abundant occupation was found for the hammers of the party. At Newbottle Prof. Morris described the physical geology of the district, and showed how the hills and valleys, the agriculture, the occupations of the people, and even the houses and churches of a district, depended upon its geological structure. In the evening the members were entertained at a conversazione in the Town Hall, Banbury. A very fine collection of the local fossils as well as of antiquities and other objects of interest, had been brought together by the exertions of Mr. Beesley, and a large assembly testified to the interest the visit of the Association had occasioned. During the evening Prof. Morris delivered a lecture in which he described generally the geology of Banbury, and enlarged upon the advantages of a study of the science. The route for the second day was a long one, and the party left Banbury early, and proceeded by Constitution Hill section of Upper Lias, Broughton Castle and Church, Tadmarton quarries of great oolite, and Camp, Bloxham Church, Comb Hill quarry in inferior oolite, and Adderbury ironstone quarries in marlstone and upper lias. The physical and stratigraphical geology was explained at the various stopping places, and many fossils were obtained at some of the sections. At Tadmarton Mr. Beesley had provided luncheon for the members and visitors, who, while assembled in an ancient British camp, were addressed by Prof. Morris, Mr Beesley, and Mr. Lobley. The association has, during the present session, paid visits of inspection to the British Museum, the Museum of the Royal College of Surgeons, and the Museum of Practical Geology, and lectures descriptive of portions of the collections have been delivered by W. Carruthers, F.R.S., Prof. Morris, F.G.S., Prof. Flower, F.R.S., and R. Etheridge, F.R.S.

Dublin

Royal Irish Academy, April 14.—Dr. Stokes, F.R.S., vice-president, in the chair.—Professor R. Ball, LL.D., read some Notes on Applied Mechanics, and the secretary read, for Mr. Donovan, a description of a Comparable Self-registering Hygrometer.

Riga

Naturforscher Verein, Aug. 28, 1872.—Cand. Westermann described his visit to the Ilsingsee, in which is an island that periodically appears and disappears. It generally makes its appearance above water as the warm weather comes on, and the phenomenon is supposed to depend on the development in the peat at the bottom of marsh and coal gas, which is increased by the heat, and causes the masses of peat to float upwards towards the surface.

September 25.—Herr C. Berg gave a detailed report of Dr. Müller's work on the "Application of the Darwinian Theory to Flowers and Flower-frequenting Insects."

October 2.—Dr. Kersting exhibited some living young frogs, which had been from four to six weeks in the tadpole state. While some had already completed their development, others were still at various stages of transformation; one animal had all four legs, but still retained its long tail, while another was as yet only a biped. In proportion as the feet developed, the animal became all the more meagre, and at the same time the faste. the tail disappeared.—Herr Thoms produced some pieces of the so-called sugar boxwood, an inferior kind of South American mahogany, in which a remarkable secretion of a white hard substance had been found. He found it of the following composition:—Ca O 33·24. PO_5 42·30. Organic matter 3·06. Water 21·40, which is expressed in the formula 2 Ca O + PO_5 + 4 HO. This is almost the same composition as that of the substance which gathers round the kidneys of the sturgeon.

October 16.—Prof. Kieseritzky gave a list of plants rarely met with in the province around Riga.—Dr. Bienert read a paper on the *Coniferæ*.

Vienna

Geological Institute, March 5.—Dr. R. v. Drasche showed a mineral that was found in the environs of Plaben, near Budweis, in South Bohemia. The specimens show a white nucleus which consists of felspar, and contains in almost equal proportions lime, potass, and soda. This nucleus is surrounded by a perfectly homogeneous, pellucid green mineral, which sometimes enters in small veins into the felspathic substance; the microscopic examination of this green mineral shows not only the polyhedric forms of the metamorphosed feldspar, but even the stripes characterising the feldspar-twins (*Zwillings-streifung*) are clearly visible. There can be no doubt therefore that the green mineral is a real pseudo-morphosis of feldspar; it belongs to the family of the chlorites and in its properties and chemical constitution is most similar to the pennine or to the pseudophite, described by Kenngott from Mount Idiar in Moravia.—T. Posepny on tube-ores (*Kohren Erze*) from Raibl in Corinthia. In the lead mines of Laibl there are to be found stalks, some lines in diameter and some inches in length, consisting in the outer part out of crystalline galena, whilst the axis is either quite hollow, or is filled with earthy matter. These tubes are inclosed in the dolomite which is the bearer of the lead ores of the country. M. Posepny thinks that these tubes are formed by the deposit of the galena on real stalactites.—M. Ch. v. Hauer on the occurrence of different sorts of coal in one and the same bed. By an accurate investigation of the brown coal of different localities in Styria, the author stated that it consists generally of two different sorts of coal which are mechanically mixed in the same bed, and sometimes in every single specimen. The one sort shows a rather slaty fracture, is faint, compact, and of less heating power; the other, on the contrary, has a conchoidal fracture, is shining, more easily friable, of greater heating power, and may be coked. In the same way in some layers of lignite v. Hauer found small parties of shining coal which resembles good brown coal; he is inclined to suppose that such differences of the coal in the same bed may be caused by differences of the vegetables out of which the coal has been formed.

PHILADELPHIA

Academy of Natural Sciences, Oct. 1, 1872.—Prof. Leidy remarked that he had visited a corundum mine recently opened in the city of Unionville, Chester Co., Pa. The accumulation is perhaps the most extraordinary discovered, and its extent yet remains unknown. The corundum, as exposed to view at the bottom of a trench, appears as the crest of a large body or vein lying between a decomposing gneiss and a white talcose schist. The exposed portion averages about six feet in depth and five feet in thickness at bottom, and is estimated to contain about fifty tons. It looks as if it promised to be the most valuable deposit of corundum ever found. The corundum is the pure material, and is not emery.

October 8.—Mr. Thomas Meehan remarked, that as botanists well knew, *Quercus prinoides* seldom grew more than two feet in height. It was one of the smallest of shrubs. In his collections in Kansas, he found oaks in the vicinity of Leavenworth, which made small trees from ten to fifteen feet high, and with stems from one to two feet in circumference. He was entirely satisfied that it is identical in every respect but size with the *Q. prinoides* of the Eastern States. Among trees there are few which produce forms as low shrubs; but the *Pinus Banksiana*, in the East but a bush of five or ten feet, grew often forty feet along the shores of Lake Superior; the *Castanea pumila*, Chinquapin chestnut, when it gets out of the sands of New Jersey into the clayey soils west of the Delaware, often grew as large as many full-grown apple trees; while the *Celtis occidentalis*, which in the East is generally but a straggling bush along fence corners, is in Ohio a large spreading tree with enormous trunk, and in Indiana is as lofty and as graceful as an elm.

PARIS

Academy of Sciences, April 7.—M. Bertrand in the chair. The following papers were read:—On batteries and on electro-capillary actions, by M. Becquerel.—On a new method for the application of the third theorem to the control of geodetic lines and to the determination of the true figure of the earth, by M. Yvon Villarceau.—On the discovery of Lunar variation by Aboul Wefâ, by M. Chasles.—On an accessory reduction in the number of periods produced by juxtaposition at the moment of the formation of a double point, by M. Max Marie.—On Metallic Reflection, by M. Mascart.—On the action of electric currents on atmospheric air, by M. Boillot; a paper dealing with the formation of ozone by tubes coated with carbon powder.—Note on a new series of samples of crystalline or crystallised substances obtained in the dry way, by M. Ch. Feil.—A letter was received from M. Van der Mensbrugghe, stating that he had been completely convinced by the arguments and experiments of M. Gernez and Violette, in the recent controversy on crystallisation, and seeing that the superficial tension of liquids did not play the important part he assigned to it, he requested the Academy to consider his recent papers as not received.—A note on Tempel's comet (1867, II), was received from M. Stephan.—On composite electric sparks, by M. Gazin.—On the Phonoptometer, an instrument for the study of periodic or continued movement, by M. J. Lissajous.—Note on the effects produced by currents of electricity on mercury immersed in different solutions, by M. Th. du Moucel.—On the solvent action of glycerine on metallic oleates, calcic oleates, and calcic sulphate, by M. Asselin—On the action of chloracetylic chloride on aniline and toluidine, by M. D. Tommasi.—On the toxic effects of the iodides tetramethylammonium, and tetramylammonium, by M. Rabuteau; the author has found that so long as an atom of hydrogen remains unreplaced, the amyl and methylammonium compounds are harmless, but that as soon as the last atom of hydrogen is replaced by the radicle, the body becomes excessively poisonous, with an action like that of curara.—On the age of elevation of Mount Lozère, by M. Fabre.—Note on the public fountains of Toulouse, by M. Grimaud de Caux. During the meeting an election to the vacant chair of the late M. Delaunay, in the astronomical section, took place. M. Loewy obtained 31, M. Wolf 24, and M. Stephan 2 votes; M. Loewy was declared elected.

April 14.—M. de Quatrefages, president, in the chair.—Explanation of the text of Aboul Wefâ on the third irregularity of the moon, by M. Chasles.—A long and detailed reply to M. Faye's late criticism on the solar spot theory was received from Father Secchi; this was followed by an answer by M. Faye, who also answered M. Vicaire's attempted revival of Herschel's theory in the same paper.—A correspondent for the astronomical section, in place of the late M. Quoy, was then elected, M. Mulsant obtained 31 votes, M. Baudelot 8, and M. Joly 1; M. Mulsant was therefore declared duly elected.—A report on M. Boussinesq's "Essay on the theory of running waters" was then read.—On the residues relative to Asymptotes, classification of the quadratics of algebraic curves, by M. Max Marie.—New observations on the theory of solar cyclones, by M. Vicaire.—A memoir on substitutions (mathematical), by M. C. Jordan.—On a new determination of the constant of attraction and of the mean density of the earth, by MM. A. Cornu and J. Baille.—On the effects produced by electric currents on mercury immersed in different solution, by M. Th. du Moncel, a continuation of the paper read at the last meeting.—On irradiation, by M. F. P. Le Roux.—On the hybrid reproduction of Echinoderms, by M. A. F. Marion.—On the trunk of a Nemertian hermaphrodite from the coasts of Marseilles, by M. E. Zeller.—A study on the carboniferous formations of the Bas Boulonnais, by MM. Gosselet and Bertaut.

DIARY

THURSDAY, APRIL 24.

ROYAL SOCIETY, at 8.30.—On the Durability and Preservation of Iron Ships, and on Rivetted Joints Sir W. Fairbairn.—On the Employment of Meteorological Statistics in determining the best course for a Ship whose Sailing Qualities are known: F. Galton.
ROYAL INSTITUTION, at 3.—Light: Prof. Tyndall.
GRESHAM LECTURES, at 7.—On Climate: E. S. Thompson.

FRIDAY, APRIL 25.

ROYAL INSTITUTION, at 9.—Palæontological Evidence of Modification of Animal Forms: Prof. Flower.
HORTICULTURAL SOCIETY, at 3.—Lecture.
QUEKETT CLUB, at 8.
GRESHAM LECTURES, at 7.—On Climate in Health and Disease: E. S. Thompson.

SATURDAY, APRIL 26.

GRESHAM LECTURES, at 7.—On Stimulants: E. S. Thompson.
ROYAL INSTITUTION, at 3.—Ozone: Prof Odling.
ROYAL BOTANIC SOCIETY, at 3.45.
GEOLOGISTS' ASSOCIATION, at 8.—Excursion from Charing Cross (2.25) to Charlton.

MONDAY, APRIL 28.

GEOGRAPHICAL SOCIETY, at 8.30.—On the probable existence of unknown Lands within the Arctic Circle: Capt. Sherard Osborn, R.N.
LONDON INSTITUTION, at 4.—Elementary Botany: Prof. Bentley.

TUESDAY, APRIL 29.

ZOOLOGICAL SOCIETY, at 8.30.—Anniversary.
ROYAL INSTITUTION, at 3.—Music of the Drama: Mr. Dannreuther.
SOCIETY OF ARTS, at 8.—On the British Settlements in West Africa: Governor Pope Hennessy.

WEDNESDAY, APRIL 30.

LONDON INSTITUTION, at 12.—Annual Meeting.
SOCIETY OF ARTS, at 8.—On the Condensed Milk Manufacture: L. P. Merriam.
GEOLOGICAL SOCIETY, at 8.—On the Permian Breccias and Boulder-beds of Armagh: Prof. Edward Hull.—Geological Notes upon Griqualand West: G. W. Stow.—On some Bivalve Entomostraca, chiefly Cypridinidæ, of the Carboniferous Formations: Prof. T. Rupert Jones.

THURSDAY, MAY 1.

LINNEAN SOCIETY, at 8.—On Cinchonas: J. E. Howard.
CHEMICAL SOCIETY, at 8.—On Zirconia: J. B. Hannay.—On a new class of Explosives: Dr. Sprengel.
ROYAL INSTITUTION, at 2.—Annual Meeting.

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