THURSDAY, MAY 26, 1892.

MATHEMATICS USED IN PHYSICS.

Einleitung in die Theoretische Physik. Von Victor von Lange. Second Edition, Enlarged and Revised. (Braunschweig: Vieweg, 1891.)

THIS work is intended to give an account of the mathematical processes employed in physical investigations. It is divided into chapters dealing with the various branches of physics, mechanics, gravitation, magnetism, electricity, solids, fluids, gases, light, and heat. It is very difficult in such a book to decide how far to go in mathematical processes, and Herr von Lange has exercised his discretion wisely in this matter. At the other limit of how little to assume known he has certainly not erred in the direction of assuming too much, for he introduces proofs of simple differentiations and integrations when he requires them, which had much better be learnt continuously in an elementary treatise on the calculus. No English student would use a book of this advanced character without some preliminary mathematical training, and it is very doubtful whether anybody picking up the calculus in this haphazard fashion could ever use it in his own investigations; and if it is no use to him for this, would it not be a great saving of time and energy for him to depend on the investigations of others without going through all their work, just as an investigator of magnetic declination need hardly expect to have time to work through the lunar and planetary theories that help in the calculations of the *Nautical Almanac* he uses? A work of this kind is of great service as a concentrated store of information for those who want to study physics, and who have sufficient mathematical ability and training to be able to use the mathematical processes involved; but it cannot successfully compete with special treatises on the elements of solid geometry, differential calculus, &c., as a means of supplying the mathematical training required in order to use these processes.

Some readers may be disposed to doubt whether it is worth while introducing into a work of the scope of this book any elementary dynamics. The subject, however, wastes only a few pages, and it may very well be worth while introducing it in order to avoid references and explanations that might be quite as long. His discussion of the nature of mass is hardly satisfactory without a description of apparatus and methods of experimenting, but, so far as it goes, is fairly sound. He does not point out with sufficient clearness where definition ends and observation comes in. These are, however, really physical questions, with which a mathematical work might very well dispense. In discussing the rotation of a solid subject to forces, he bases his investigation on Airy's mathematical tracts, but he does not safeguard himself with all the provisos Airy so carefully introduces; and in consequence there are many pitfalls, carefully hidden. The method is based upon supposing the body given a series of blows, and appears on the face of it to be purely kinematical. It is on the other hand evident that, in general, dynamical questions, such as the centrifugal acceleration introduced when the axis of rotation is not a principal one, must come into consideration when discussing the forces that must be applied to a real body in order to make it move in a given way. A student of this investigation would be puzzled to understand how it happens that a solid sphere, when rotating round an axis and given a blow, begins to rotate round a new axis, new both inside the sphere, and in space, while a gyroscope takes up a wobble. It is possible by a series of blows given to a sphere to cause its axis of rotation to move round in space while preserving its position in the sphere, but a series of blows in general would not produce this result. The kinematic investigation of rotation of a solid round an axis accompanied by an angular acceleration round a rectangular axis is an interesting geometrical question, but must be carefully distinguished from the dynamical question of what forces must be applied to a real solid in order to produce this motion, and these two different questions not being sufficiently clearly distinguished make the investigation unsatisfactory. In connection with the motion of a solid, it is to be regretted that a short account of the theory of screws was not included.

Under gravitation at one place, there is a full account of free fall, pendulums, balances, bifilar suspensions, torsion balance, &c. Then he proceeds to questions depending on gravitation at different places, the figure of the earth, the constant of gravitation. Here he mentions Foucault's pendulum, and notices that the elementary investigation is insufficient, without, however, giving more than the result of the complete investigation, not even explaining why the elementary investigation fails, owing to the precessional motion of the axes of the ellipse in which the bob of the pendulum necessarily moves, and which becomes comparable with the motion looked for, unless the amplitude be very small and the suspending thread very long. This chapter concludes with an account of the theorems connected with forces varying inversely as the square of the distance. It is doubtful whether it would not have been better to deal with this subject in the first place from the hydrodynamical point of view. Such theorems as that the flow is equal across every section of a tube of flow, and its numerous consequences, such as that equal quantities of electricity exist at the ends of a tube of force, that the total normal force over any surface is equal to 4π times the quantity of electricity within, &c., are all intuitively evident in hydrodynamics, and it is well to call a student's attention to the way in which he can safely argue from the familiar to the unfamiliar.

The chapter on magnetism is very complete, though the action of two magnets on one another is done in a fearfully long-winded way; and in the account of the determination of magnetic declination the spherical trigonometry required in order to calculate the azimuth of the terrestrial meridian from the astronomical observations is not given. It would also appear as if the determination of variations of dip by means of an induction vertical force magnetometer were quite a different thing from determinations of the variation of vertical force by means of a balance magnetometer. Magnetic induction is the usual mathematical investigation of simple cases where the permeability is assumed constant. An

edition dated 1891 might have included some of the mathematics of hysteresis.

Electrostatics is treated as fully as it should be, though perhaps a single chapter on the law of the inverse square, containing most of the theorems required in magnetism and electricity, would have given a sounder view of the mathematics involved. It was hardly to be expected that a mathematician should avoid the temptation of describing Mossotti's theory of dielectrics without a warning that it can hardly be complete, and in consequence gives the electrical displacement as

$$\frac{K-1}{4\pi}$$

instead of $\frac{K}{4\pi}$ times the electrical force, thus making the displacement zero in a vacuum, and justifying this by saying that the results differ very little, while it would really overturn the whole electro-magnetic theory of light. This same overturning is calmly got over when the electromagnetic theory of light is considered further on by a reference to this place, and this very remarkable statement that $K-1$ differs but little from K. There seems to be some confusion, arising from the fact that in electromagnetic measure K is nearly 10^{21}, but such a muddle is inexcusable. He further on gives the theory of penetration of electric force into conductors, without referring back to an investigation he has previously given of the concentration of alternating currents on the surface of a wire, not appearing to appreciate that they are the same. He also actually explains wave propagation in dielectrics by induction from layer to layer because the inducing force is *very small* initially at a distance. He has not learnt the A B C of action by means of a medium, but is still hampered by the dry bones of theories of action at a distance. In consequence of this, his investigation of the magnetic action of electric currents is all bristling with the action of elements upon one another, and little or no attention given to the energy stored in the medium, or how it goes from place to place.

The chapter on solids begins with some rather doubtful physical paragraphs that are out of place in a mathematical work. Is it sound to call heat a force (*Kraft*) that holds the particles of bodies asunder? Is it sound to say that the difference between solids and liquids is the difficulty of separating the parts of the former, when it is known that it often takes hundreds of pounds per square inch to separate the parts of a liquid from one another, and when it is the resistance of the material to shear that he really uses as the characteristic of solids? That mistake of making the difficulty of separation and not the difficulty of shearing the characteristic of solids seems quite common: it occurs in many books. The mathematical theory of elasticity is given in the usual analytical way, and applied to some of the simpler cases of bending, &c. Periodic motion is then introduced, and the more important cases of wave motion and vibrations of solids considered. In the consideration of torsion he omits to give any warning as to difficulties arising in the case of non-cylindrical prisms. The chapter concludes with an investigation of the impacts of solid spheres in a manner that brings it into connection with the kinetic theory of gases.

The chapters on liquids and gases are fairly complete. There is an interesting numerical calculation of the height of a statical tide: this is an example of how complete and varied are the physical questions of which the mathematics is given by Herr von Lange. The elementary kinetic theory of gases is given, but without any discussion of the distribution of velocities amongst the molecules. Van der Waals's modification of the simple gaseous laws is discussed, and along with it the theory of cubic equations is given in a rather skimpy form—an example of how difficult it is to teach the higher physical mathematics in a way that applies to the particular case in hand, except by teaching the part of the higher mathematics involved from a wider point of view than the particular solution requires.

The chapter on light is hardly so full as such an important subject demands. Diffraction is run through, but the absence of bands inside a shadow is not discussed, and the theory of definition in telescopes is separated from the same question in microscopes in a very unscientific way. There is a lot of reflection theory, and a paragraph on the direction of the vibration relative to the plane of polarization; but no notice is taken of the theory of the blue sky, nor of the electro-magnetic method of determination, nor of Wiener's proof that it is the electric force which acts on silver salts, and is consequently the one probably effective in most chemical actions, and therefore in irritating the retina. It is possible, however that iron salts may be acted on by the magnetic force.

The last chapter is on conduction of heat and on the mechanical theory of heat. The first part is an account of the simpler parts of Fourier, as any book on conduction of heat must be, and the latter is a good account of thermodynamics. It is to be regretted that he does not give some mechanical illustrations of temperature, though a discussion of the nature of temperature would have been out of place. The chapter concludes with a variety of applications of thermodynamics to such questions as the relations of electromotive force, compressibility, and surface tension, to temperature, as well as the usual one, vapour pressure. It is much easier to point out defects than adequately to describe excellences. It must not therefore be concluded from the fact that much of this review is concerned with the former that the defects preponderate over the excellences of Herr von Lange's work. On the contrary, the work is full of excellences. The way in which physics and mathematics are tending to grow each purer—one in the direction of mathematical abstractions, complexes, matrices, and such like; the other in the direction of experimental methods, accuracy, phenomena, and such like—makes it daily more important for physical investigators especially to have by them a convenient *résumé* of those parts of mathematics that are most often useful to them in their investigations, and this has been ably supplied by Herr von Lange.

PHASES OF ANIMAL LIFE.

Phases of Animal Life, Past and Present. By R. Lydekker, B.A. (Cantab.). (London: Longmans and Co., 1892.)

THE sixteen essays which make up the volume are reprints, with a few alterations, of articles originally published in *Knowledge*. "They are intended," the

author tells us, "to illustrate in a popular manner a few of the various modes in which animals—especially vertebrates—are adapted to similar conditions; and also to demonstrate some of the more remarkable types of structure obtaining among the higher vertebrates."

The subject is one upon which Mr. Lydekker is well qualified to write; this is alone a decided recommendation to the book. As a rule, the writing of "popular" books and magazine articles is done by persons who have no special knowledge of the matters of which they treat, and the result of this is not at all gratifying to instructed readers. Mr. Lydekker recognizes the fact that it is impossible to write upon zoology without using plenty of technical terms. When such terms are used they are introduced without any apologies. There are some authors who have the habit of invariably interpolating an apologetic remark in brackets whenever an unusually lengthy word is used. This practice is not at all humorous; and, besides, it is insulting to the intelligence of the reader. Anyone who is likely to read an article upon zoology is perfectly well able to take care of himself when he meets with a strictly technical explanation of some fact. Mr. Lydekker is therefore, in our opinion, quite right in speaking of "Condyles," "Dinosaurs," "Iguanodons," &c., with perfect freedom. Sometimes, however, he goes out of his way to invent or borrow an English equivalent for a scientific name; thus the Ichthyosaurus is always referred to as a "fish-lizard." It seems to us that if there be any fossil creature whose name is absolutely without need of translation it is the Ichthyosaurus; we cannot remember the time when this name was unfamiliar to us; besides, to speak of these reptiles as "fish-lizards" implies that they are intermediate between fishes and lizards, which is by no means the case. It would have been in every way much more reasonable if Mr. Lydekker had spoken of the Dinosaurs as "bird-lizards."

The chapter dealing with these same Dinosaurs is perhaps the most interesting. The information which is given must be newer to the general reader. There is a figure of one of the splendid skeletons of the Iguanodon recently unearthed in Belgium, and now on view in the Brussels Museum; the reproduction of the plate illustrating M. Dollo's memoir upon these remains is not, however, very good; it is difficult to distinguish the numerous small bones which lie along the vertebral column, and which are an indication of the immense development of the tendons of the muscles used to move the powerful tail of the reptile. M. Dollo thought that the Iguanodon lived principally in marshes swimming with the aid of the tail, and only occasionally coming forth to browse upon shrubs on the dry land.

There is naturally a chapter upon the Monotremes. Quite close to the beginning of the chapter it is stated that "within the last few years" these Mammals have been discovered to be oviparous, like reptiles and birds. Mr. Lydekker's book deals mainly with extinct forms of life, and he must have forgotten that in this chapter he was dealing with historical and not with geological time. It is surely unnecessary to remind the author that the oviparity of the Monotremata is not a discovery of the last few years; the *re*-discovery by Mr. Caldwell of this remarkable fact strikingly shows how an important point of this kind may be utterly forgotten. The history of the whole question has been the subject of an interesting article in this journal by Prof. Baldwin Spencer, which appeared two or three years ago.

F. E. B.

OUR BOOK SHELF.

Silk Dyeing, Printing, and Finishing. By George H. Hurst, F.C.S. (London: George Bell and Sons, 1892.)

PUBLISHED information connected with the application of colouring matters to silk is somewhat limited, and for the most part scattered throughout the various pamphlets issued by coal-tar colour manufacturers, the periodicals devoted to dyeing, &c.

The present publication is therefore very acceptable, since it brings together, in a convenient and useful form, much of this diffused information, and constitutes one of the well-known series of technological hand-books edited by Sir H. Trueman Wood, Secretary of the Society of Arts.

The author, Mr. Hurst, has here rewritten and brought up to date his articles on the subject of silk-dyeing which appeared during 1889 in the pages of the *Dyer and Calico Printer*, and has added chapters on silk printing and finishing, and on the testing of dyed silks.

The language and style of the book are clear and explicit, and it has evidently been written with distinctly practical aims, so numerous are the working details given throughout the work.

The opening chapter contains an account of the origin, structure, composition, and properties of the most important varieties of silk, followed by one on the preliminary operations of "boiling-off" and bleaching. Special chapters are devoted to the dyeing of blacks, fancy colours, and mixed fabrics. The concluding chapters deal with silk printing, the machinery used in dyeing and finishing, and the examination and assaying of raw and dyed silk.

Some 170 selected and also original recipes, together with 66 dyed patterns of yarn and cloth, appear as an appendix. Altogether the author has succeeded in compressing into a somewhat limited space of about 230 pages, a considerable amount of useful practical information.

In the body of the work, containing numerous technical details of dyeing, explanations of the principles underlying the different processes involved are here and there interspersed, so that the volume may be recommended as a handy book of reference not only for the practical dyer and his apprentice, but also for the student and teacher in technical schools where silk dyeing is taught.

Phycological Memoirs. Edited by Geo. Murray, F.R.S.E., F.L.S. Part I. (London: Dulau and Co., 1892.)

THE establishment of this new serial is an indication of the increased attention given in this country during recent years to the study of Algæ, whether marine or fresh-water. It is intended to form a medium for the publication of the results of researches on Algæ carried on in the Department of Botany at the British Museum, and for making known the treasures of the Museum; and the present number is full of promise of valuable additions to our phycological literature. The place of honour is given to a paper by Miss Margaret O. Mitchell and Miss Frances G. Whitting on *Splachnidium rugosum*, a well-known seaweed of the Southern Seas, hitherto included under the *Fucaceæ*, but which the authors regard as a new type of Algæ occupying possibly an intermediate position between the *Fucaceæ* and the *Laminariaceæ*. For reasons which certainly seem cogent, they are of opinion that the reproductive organs contained in the conceptacles are not sexual oogones and antherids homologous to those of

the Fucaceæ, but non-sexual sporanges containing zoospores similar to those of the *Laminariaceæ*. Mr. E. A. L. Batters describes an interesting new genus of perforating marine Algæ, *Conchocelis*, belonging to the order *Porphyraceæ*, which forms pink stains on empty shells, especially those of *Mya truncata* and *Solen vagina*. Miss Ethel S. Barton describes malformations produced in two seaweeds, *Ascophyllum nodosum* and *Desmarestia aculeata*, by the attacks respectively of a new species of Nematode, *Tylenchus fucicolus*, somewhat similar to that which produces the well-known "galls" of *Vaucheria*, and of an undetermined Copepod. The editor himself has two papers, one on a fossil Alga belonging to the genus *Caulerpa*, from the Oolite (Kimmeridge clay of Dorsetshire), a new species, which he names *C. Carruthersii*; and one on the genus of marine Algæ, *Dictyosphæria*, the position of which he retains among the *Valoniaceæ*, near to *Valonia* and *Anadyomene*. The present number is illustrated by eight well-executed plates, most of them coloured. A. W. B.

Live Stock. By Prof. Wrightson. (London: Cassell, 1892.)

THIS is the third of Cassell's series of agricultural textbooks, and though hardly equal to other writings of Prof. Wrightson, will be found useful as a reader in elementary classes.

The illustrations are well done, and the text is pretty clear, except perhaps on pp. 52–53, in a paragraph upon the "effect of food on milk." Here it is said that

"The quantity of milk is therefore in some degree dependent on liberal feeding. The quality of the milk is much less easily controlled, and it is doubtful if any special feeding will materially alter the percentage of butter-fats or cream in milk."

Then, at the end of the paragraph we have—

"Watery foods, such as silage, grass, grains, and distillery wash, increase the quantity of milk, but lower the quality, and in town dairies, where a large amount of milk is the principal object, they are much employed."

This paragraph is contradictory and confusing, for Prof. Wrightson himself admits that the quality of milk may be lowered by using watery foods, and we are decidedly of opinion that it may be increased by means of rich, oily foods.

LETTERS TO THE EDITOR

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

Lord Kelvin's Test Case on the Maxwell-Boltzmann Law.

IN his recent communication to the Royal Society, of a case disproving the Boltzmann law, Lord Kelvin seems to have overlooked an important consideration.

It is well known that in an atmosphere near the earth, under conductive (not convective) equilibrium of temperature, the mean kinetic energy (*i.e.*, the temperature) would be uniform notwithstanding the attraction of the earth, which causes each molecule to move more rapidly at the lower end of its path than at the upper end. This is due to the effect of gravity in sifting out the less rapidly moving particles, preventing them from reaching the upper layers, so that, of the particles in any one layer which reach a higher layer, the great proportion are those which move rapidly in the lower layer. Thus there will be fewer particles in the upper layer, but the mean kinetic energy of a particle will be the same in both.

Applying these considerations to Lord Kelvin's example, it appears that the C particle, when going rapidly, will penetrate a considerable distance into the region of the repulsive force, while, when going slowly, it will only penetrate a short distance. Thus the *duration* of a slow flight might be much shorter than that of a quick one (with a force varying directly as the distance, the durations would be equal). It is quite different with the A particle, which moves uniformly to the end of the tube and back again. The duration of a slow flight will be long and of a quick flight short, being always inversely proportional to the velocity. Again, it appears evident that the chances for C having a great or small initial velocity at B are exactly the same as those for A. Hence, if we compare the velocities of A and C at an instant arbitrarily chosen, the probability of our happening on a time when A is moving slowly may be less than that of our happening on a time when C is moving slowly, and we cannot conclude that the mean kinetic energy of A is greater than that of C; indeed, a comparison of this case with that of the atmosphere, would lead us to expect that the mean kinetic energies of A and C would be equal.

There are cases in which the Boltzmann-Maxwell distribution does not hold. For instance, the case of a large particle confined at the end of a tube, with numerous small particles bombarding it. The mean kinetic energy of the large particle will depend on the range of its motion in the tube. This example would suggest the conclusion that in such cases as gases in contact with solids and liquids, where the molecules of the latter are so confined by molecular forces as to approximate to the condition of the large particle at the end of the tube, the conditions of temperature equilibrium can hardly be determined by the Boltzmann-Maxwell law.

40 Trinity College, Dublin. EDW. P. CULVERWELL.

Poincaré's Thermodynamics.

RENTRANT à Paris après une assez longue absence, je prends seulement connaissance de la dernière lettre de M. Tait. Je ne veux pas continuer une discussion qui ne saurait se prolonger sans dégénérer en une simple logomachie. Il résulte en effet des débats que M. Tait n'attribue pas le même sens que moi à certaines expressions, et en particulier au mot force électromotrice. Il me semble seulement, puisque c'était mon livre qu'il critiquait, que c'était à lui d'adopter mon langage, qui est d'ailleurs celui de tout le monde. Je m'arrêterai donc là, quoiqu'il arrive.

Je suis pourtant obligé d'insister sur un point, parce que je ne veux pas laisser suspecter ma bonne foi. M. Tait a écrit: "Nothing is said, in this connection, about Joule's experiments." En ne tenant pas compte de ces mots "in this connection," j'aurais dénaturé sa pensée. Ces mots ne m'avaient pas échappé. Ils signifient, si je ne me trompe: "dans ses rapports avec la détermination de la température absolue." Et c'est pourquoi, après avoir rappelé que j'avais décrit ces expériences à la page 164, j'ai ajouté que j'avais expliqué à la page 169 comment elles permettent de déterminer la température absolue.

POINCARÉ.

[I need scarcely say that I never dreamt of doubting the good faith of M. Poincaré. What I did (and still do) doubt is my having made my meaning clear to him. For I cannot see how such a discussion could degenerate into a mere war of words. So far as I understand myself, I have been dealing mainly with the validity of certain modes of establishing physical laws, *not* with the mere terms employed in describing the experimental facts on which they are founded.—P. G. T.]

Land and Freshwater Shells Peculiar to the British Isles.

THERE cannot be any reasonable doubt that the inland Mollusca of Britain present some peculiar features, but it is surprising, considering the amount of attention that has been devoted to them, how little exact knowledge we have of this subject. This want of knowledge is doubtless due to two principal causes—first, that so many conchologists consider varieties, and especially slight varieties, to be of little or no importance; and secondly, because those who study our native shells are, as a rule, but ill acquainted with foreign species and varieties. The publication of a list of supposed peculiar forms in the new edition of Dr. Wallace's "Island Life," will, it is hoped, direct attention to this matter. Although this list is more or less provisional, and will doubtless require much alteration as time goes on, I anticipate that the number of forms actually peculiar to our islands, when fully ascertained, will considerably exceed eighty-three, the number at present listed. On the other hand, no doubt, several at present in the list will have to be eventually struck out.

With regard to the peculiar species: *Limnæa involuta* is doubtless an isolated derivative of the *peregra*-type, to which the curious and distinct var. *burnetti* of Scotland may be said to lead. *Assiminea grayana* and *Hydrobia jenkinsi* belong to the brackish-water and salt-marsh fauna, which, as has been well observed, formerly extended far beyond its present limits. To this now-restricted fauna belong many of our peculiar Lepidoptera (see the list in "Island Life," pp. 347-350), and the probability is that most of these are destined shortly to become extinct, as the large copper butterfly (*Chrysophanus dispar*) already is. The fourth species, *Geomalacus maculosus*, is not strictly peculiar, being also found in Portugal; but it is a survival of the Lusitanian fauna, to be classed with numerous plants of similar range, recorded in "Island Life," p. 364. Thus, of the four species given as peculiar, one only is strictly endemic, having regard to its whole history; and the three others are apparently best regarded as survivals of faunæ which were formerly more widely spread.

Turning now to the varieties, we meet with a much larger proportion of truly endemic forms, though from our want of knowledge there is much uncertainty. *Limax marginatus* var. *maculatus* is quite common in parts of Ireland, and as it is a very striking form, it could not easily have been overlooked had it occurred on the Continent. The same applies with perhaps greater force to the beautiful var. *albolateralis* of *Arion ater*, which abounds in parts of Wales. The black variety of *Agriolimax agrestis* is frequent in some places in Yorkshire, and has never been detected on the Continent. But Simroth found it recently on mountains in the Azores, above the zone of cultivation; and in Sicily and Crete there is a melanic form (*panormitanus*), still more differentiated. The var. *griseus* of *A. agrestis*, found in England, and lately by Scharff in Ireland, is grey instead of black, but I am not aware that even this degree of melanism exists on the Continent, though, it is true, they have the dark brown var. *tristis*.

This melanism is well illustrated by other British slugs—namely, two forms of *Limax flavus*, and two of *Amalia sowerbyi*, and may be compared with the well-known cases of melanism so frequent among our Lepidoptera. That there is a strong tendency to the formation of melanic races in these islands cannot, I think, be doubted; and insular melanism elsewhere has been well established as a fact.

There is another class of varieties, noticed especially in the shells, characterized by a slight and yet real difference from the continental type. This sort of variation is as yet very little worked out, but most conchologists who have received common species in numbers from abroad, must have noticed how frequently they have a different *facies* from those familiar to us in Britain, though the actual difference may be so slight that we should hesitate to separate them as varieties. Quite recently, M. Bourguignat has regarded certain British specimens of *Clausilia* and *Unio* as constituting new species. Probably hardly anyone will be found to follow him in this decision, but we know how thoroughly he and his colleagues have ransacked Europe, and especially France, for novelties, so we may rest assured that in all probability these shells represent variations not existing on the Continent.

Another class consists of forms which might be set down by some as mere monstrosities, but which, nevertheless, are local in their distribution. Such are sinistral forms, which occur rarely in many species, but in many instances frequently in certain places. This form of variation is certainly inherited, and in fact has become the character of species and genera. White shells of coloured species are apt to be scoffed at as mere albinos, but the character is undoubtedly an important one, since in *Hyalinia* we have every gradation of species from those which rarely present white varieties, to those which are normally and indeed invariably white. The colourless variety of *Cochlicopa lubrica* is frequent in one or two British localities, at least, but I never heard of its occurrence on the Continent, nor in North America, where the species is abundant.

The sources of possible error, in estimating the number of peculiar forms, are obviously many, and hence the need for prolonged and careful research in the future. *Helix virgata* var. *subdeleta* is very common in England, and I formerly supposed it endemic; but recently Mr. J. T. Carrington found it at Toulon; and *Helix dautezi*, Kobelt, a supposed species from near Algesiras and Gibraltar, is almost precisely identical with it, so far as I can judge from specimens collected by the Rev. J. W. Horsley. The variety *leucozona* of the same species also seemed characteristic of the British fauna, but a form from Toulon differs but slightly from it. *Arion hortensis* var. *fallax*, with orange slime, is given as peculiar. It may, however, be the same as var. *subfuscus*, C. Pfr., which is of a brownish colour, or var. *rufescens*, which is described as reddish or orange. These would look extremely like *fallax* when the latter was covered with slime; but there is an element of uncertainty, since Dr. Scharff has shown that in *A. subfuscus*, Drap., there are two forms, one coloured reddish only by its slime, as in *fallax*, and the other with a yellow pigment in the skin. Similarly, we remain doubtful about *Helix aspersa* var. *lutescens*, a form not rare in some English localities. I know nothing described from the Continent that would agree with it, but when it loses its epidermis it agrees with the description of a French variety, and if we suppose the type of the latter to have been a weathered specimen, the two must be identical.

T. D. A. COCKERELL.

Institute of Jamaica, Kingston, Jamaica, May 3.

The Former Connection of Southern Continents.

I READ Mr. Lydekker's article on "The Discovery of Australian-like Mammals in South America," in NATURE of May 5 (p. 11), with the greatest interest. It is worth while calling attention to a physiographic fact pointing towards a former connection between South America and Southern Africa, such as appears to be required on biological grounds, as pointed out by Mr. Lydekker.

The island of South Georgia in the Antarctic Ocean lat. 54° S., long. 37° W., is composed of clay-slate, the mountains, rising precipitately from the ocean, attaining to altitudes of from 2000 to 3000 metres (NATURE, March 27, 1884, p. 509). It is about 1200 miles due east of Cape Horn, and almost exactly one-third of the way between that cape and the Cape of Good Hope.

The full significance of these facts seems hardly to have been realized, especially from a geological point of view. The existence of clay-slate rock forming mountains of an Alpine character indicates with certainty that the island is a portion of a submerged land of great extent. In "The Origin of Mountain Ranges" I have dwelt upon and developed the law that all great mountain ranges (not volcanoes) are thrown up only in areas of great sedimentation. This is true of every mountain range that has been geologically examined, and I do not know of a single exception. Keeping this law well in view, clay-slate mountains of an Alpine character protruding directly from the ocean become invested with deep meaning. They indicate vast horizontal extensions of thick sedimentary deposits which have been subjected to great lateral pressure, and have become ridged up along lines of least resistance. That such sedimentary rocks exist far and wide, forming the ocean bottom about the island of South Georgia, I have not the least doubt. A continental stepping-stone one-third of the way is a somewhat important independent support towards the land connections required by biologists between two great continents.

Park Corner, May 9. T. MELLARD READE.

The Lesser Spotted Woodpecker.

THE lesser spotted woodpecker is rather a rare bird, and perhaps the following notes may be worth recording.

This house is in the fields, at the foot of the Cotswolds. Opposite my bedroom window, and only four yards distant, there is a very tall old Lombardy poplar, with a stem two feet thick. One of these birds visited this tree almost every day from the latter part of March till the 12th of this month, coming every morning between 6 and 8, and sometimes also at other hours. He fixed himself always on the same part of the stem, opposite my window, and about 25 feet from the ground; and as there are only a few small branches there, he was very plainly seen He made a remarkable sound, very loud, like the boring of a large auger, continued for one or two seconds, and repeated again and again at short intervals. While the sound continued his whole body seemed in rapid vibration, and he was tapping the tree with extreme rapidity with the point of his beak. During the intervals his head was generally moving quickly from side to side, and his beak was often turned over to plume himself. At this time the crest on his head became often a splendid object. When the sun shone on it, it was like a flash of flame, or the glitter of polished copper foil. The bird was about six inches long, with a rather thick, fluffy-looking body, the tail and back striped black and white, the stripes broadest at the tail. What he was really doing I could not determine. The

stem of the tree at that place seems to be hollow, and the bark is cracked, but no hole has been bored, and no insects are seen there. I have had it examined with a long ladder. The bird has now disappeared. I think his nest has been in the stem of an ash-tree in a field not far off. There is a hole in it about the size of a tea-cup, but out of reach. I have not seen his mate, or heard any answering cry.

ALBERT C. MOTT.

Detmore, near Cheltenham, May 21.

The God of the Ethiopians.

IF we were to classify the various African tribes which speak dialects of the Bantu language-branch (the Ethiopians of Herodotus and Pomponius Mela, of Dos Santos and Merolla) according to the names by which they designate the Deity, the greater number of them would be found to fall into two great groups.

Those on the eastern coast worship a god who is known under some form of the word Unkulunkulu.

Tribe.	Name for God.	Root, meaning "great" or "old."	Derivative.
ama Mpondo	Ukulukulu	... ...	inkulu = great, old ubukulu = greatness ukukulwa = to make great ekholo = great
ama Xosa, ama Zulu	Unkulunkulu	Kulu	
be Chuana	(Mokholokholo)[1] ...	Kholo	
Inhambane tribe	Mulungulu		
Tribe at L. Moero	Mulungu		
,, ,, L. Tanganika	Mulungu		
wa Yao	Mulungu	... ...	ukulungwa = greatness.
a Nyika	Mulungu	Kulu	
wa Kamba	Mulungu		
ma Konde	Mlungu		
ma Koa, Moçambique	Moloko (Muluku)		
,, Quillimane	Mulugo		
,, Rovumah	Mlugu		
Sofala tribes	Murungu...	guru	
,, ,, of Dos Santos	Molungo		
Sena tribes	Murungu...	Kuru	ikuru = great
Tete tribes	Muungu	Kuru	
L. Bangweolo tribe	Mungu		
wa Swahili, Zanzibar	Muungu	Ku	Kukuu = old Kwanza = old Kuu = morally Kubwa = physically } great ukuu ukubwa } greatness
,, C. Delgado	Mlungu		
wa Pokomo	Mungo	Ku	
ba Yanzi (Central Africa)	Molongo		
ova Hererò (South-West Africa)	Mukuru	Kuru	ou kuru = antiquity ova kuru = ancestors ova kurupa = old age

[1] This term means simply a very old person, and is not applied to God.

It will be seen that the least corrupted form of the word Unkulunkulu, or Ukulukulu, is found in the Zulu, Xosa, and Pondo dialects of the Kaffir language.

The word itself is formed from the Zulu or Xosa adjective nkulu (root kulu) "great," "grown," hence "adult," "old." Unkulunkulu therefore means primarily "the great (or old) one of the great (or old) one."

The cult paid to Unkulunkulu is a typical instance of that form of monotheism which takes its origin from ancestor worship. The Kaffirs call him their progenitor. Unkulunkulu ukobu wetu.

The above table appears to show that, in Molungo, Mulungulu, Mlugu, or Mungu, the term thus variously modified is derived directly from the full form Unkulunkulu (perhaps originally Munkulunkulu), and thereafter corrupted by phonetic decay, instead of being in each case derived independently, like the archaic form, from the adjective signifying "great" in the language to which it belongs.

The inference, therefore, seems to be that the word Munkulunkulu was used (not necessarily in its present sense) by the common ancestors of all the Eastern Bantu tribes from the River Dana to the Great Fish River, whose descendants still retain the name in their vocabularies, and still hold it in veneration.

On the western coast this name seems replaced by a word which may be most conveniently referred to under its most common form Nzambi.

Tribe.	Name of God.
di Wala, i Subu	Nyambi
n Halemoe	Nyama
be Nga, ba Seke	Nyambi
o Rungu	Anyambi
m Pongwe	Njambi
m Bete	Ndshambi
a Shira	Aniembie, Njambe
ba Kele	Nshambi
ba Nyombe...	Ndzambi
Loango tribes	Zambi
Kabinda tribes	Nzambi Pongo
Ka Kongo tribes, Angoy tribes	Zumbi
ba Sundi	Ndzambi à pungo
ba Teke	Ndshambe, Nshami, &c.
ba Yansi	Nzambi, Nyambi
ba Buma	Ndshambi
eshi Kongo	Nzambi, Nzambi ampungo
ba Lunda	Zambi
ba Bunda	Onzambi
ma Ngala	Nsambi
ba Bihe	Nzambi
ba Rotse	Nyampe
ova Herero	Ndyambi

The worship of Nzambi is inextricably commingled with that of fetishes and idols, and has doubtless been still further corrupted by contact with the Portuguese missionaries who were so active in the work of conversion in the Congo Empire in the seventeenth century. But there is reason to believe that in its

primitive conception Nzambi was a celestial being or force, a Nature spirit like Zeus or Indra, who ruled the sky or controlled the tempest.

Among the Isubu, *e.g.*, a cognate form signifies "heaven," and such is the case also at Cape Lopez. Winwood Read's Mpongwe raised their hands to heaven when they appealed to Njambi to save them from the hurricane; and his Ashira slave pointed in the same direction when questioned on the subject of the deity. The Manyombe regard Nyambi as heaven, and the Basundi call him the "spirit on high"; and according to Kólbe the otyi Herero term Karunga Ondyambi = "heavenly bestower," "who gives and withholds rain."

The word bears little evidence of change, and is perhaps of comparatively modern origin.

It appears, therefore, that while the Eastern Bantus, who worship Unkulunkulu, indulge in *ahnen-cult*, the western adherents of Nzambi are more or less Nature worshippers. In this respect they appear to approach the Negroes of the Gold, Slave, and Oil Coasts.

A third and smaller, but very distinct group apply the term Morimo or Molimo to their conception of the deity. I refer to the Barolong, the Basuto, the Batlapin, and other clans, which are generally classed together as the Bechuana tribes. "Morimo" is the singular form of a word the plural of which, barimo, balimo, bedimo, bazimo, is found almost universally among the Bantu tribes to denote the spirits of the dead.

The application of the singular form, Morimo, Molimo, in a specialized and restricted sense to the Supreme Being is confined almost entirely to the Bechuana tribes, and has perhaps been only recently used in this monotheistic sense; although John Pory mentions (in his edition of Leo Africanus, A.D. 1600) Muzimo as the one god of the Monomotápa tribes, and Gravenbroek (A.D. 1695) says of the Kaffirs of Zimboe, "Divinitatem aliquem Messimo dictam in lucis summo cultu venerantur."

One other tribe, the Lomwe, who live east of Lake Kilwa among the Namuli Hills, use the word Murimu for God; in this respect differing from their Makoa foes, who worship Mlugu; but this rather leads one to conclude that this tribe is an outlying Bechuana clan. Mr. O'Neill has pointed out the peculiarities of language and architecture which distinguish the Lomwe from their neighbours. W. HAMMOND TOOKE.

Cape Town.

Aurora Borealis.

HAVE any of your readers observed the display of aurora borealis to-night (Wednesday)? I regret that insufficient knowledge of astronomical technicalities does not permit me to describe more exactly the size and position of the display. It appeared between 11 and 11.30 p.m., as white streaks or bands of light, varying in width and intensity, now shooting up a considerable distance, now dying away. It was especially brilliant just to the right of the constellation of Cassiopeia, and this was its furthest eastward limit; it extended more or less across the whole northern sky, and at times was bright enough to dim the stars it covered. The rays appeared to shoot up high into the sky above Cassiopeia. It was a very beautiful phenomenon, and was possibly more distinct in more northern latitudes. WARINGTON STOCK.

S. Paul's Vicarage, Derby, May 18.

THE NEW ELEMENT, MASRIUM.

FURTHER details concerning the new element, whose probable existence was announced in a paper communicated to the Chemical Society at their meeting on April 21, are contributed to the number of the *Chemiker Zeitung* dated May 11. The mineral containing the new substance was discovered in 1890 by Johnson Pacha in the bed of an old river in Upper Egypt long since dried up, but of the former existence of which there are records dating back some 6000 years. Indeed, the name by which it is known in the neighbourhood is "Bahr-bela-Mā," or "river without water." Here and there in the track of the old watercourse are small lakes whose water is of considerable repute for its medicinal value. Specimens of the mineral were sent by Johnson Pacha to the Khedivial Laboratory at Cairo, where it was examined by Messrs. H. Droop Richmond and Hussein Off, the authors of the paper laid before the Chemical Society. The mineral is found to be a fibrous variety of a mixed aluminium and iron alum containing ferrous, manganous, and cobaltous oxides. In addition, however, to these ordinary constituents, a small quantity of the oxide of another element would appear to be present, having properties entirely different from those of any yet known. This element the discoverers have termed *masrium*, from the Arabic name for Egypt, and the mineral has accordingly received the name of *masrite*. The symbol adopted for masrium is Ms.

The composition of masrite may be expressed by the formula $(Al,Fe)_2O_3 . (Ms, Mn, Co, Fe)O . 4SO_3 . 20H_2O$. The amount of masrium present is very small, averaging only about 0·2 per cent., but by working upon fifteen kilograms of the mineral a considerable quantity of the element in the form of various salts has been accumulated. A typical analysis of masrite published in the Proceedings of the Chemical Society is as follows:—

Water	40·35
Insoluble matter	2·61
Alumina	10·62
Ferric oxide	1·63
Masrium oxide	0·20
Manganous oxide	2·56
Cobaltous oxide	1·02
Ferrous oxide	4·23
Sulphuric oxide	36·78
	100·00

Suspicions that the mineral contained some hitherto unknown constituent were first aroused by the fact that when it was dissolved in water, and sulphuretted hydrogen was passed slowly through the solution in presence of acetic acid, instead of the expected black precipitate of sulphide of cobalt a white insoluble substance was first precipitated. This white precipitate continued to form until the new substance in the solution was all used up, when black sulphide of cobalt began to be thrown down. By decantation before the formation of the latter, and subsequent washing with dilute hydrochloric acid, the white substance was isolated in a state of tolerable purity. It was found to dissolve in boiling nitrohydrochloric acid. The solution in *aqua regia* was evaporated in order to remove the excess of acid, and ammonium hydrate added, when a voluminous white precipitate of the hydrate of the new metal was thrown down. The hydrate was washed by decantation, and subsequently dissolved in the minimum excess of sulphuric acid. The solution of the sulphate of the new metal was next evaporated to syrupy consistency, water was added until complete solution was just effected, and the solution mixed with an equal bulk of alcohol. The effect of this addition of alcohol was to cause immediate precipitation of crystals of the sulphate of the new metal, a further crop of which was also obtained upon evaporation. By repeated recrystallization most of the small quantity of iron present was removed. In order to eliminate the last traces of admixed ferrous sulphate, the crystals were redissolved in water, and excess of sodium hydrate added. As the hydrate of the new metal is soluble in excess of soda, the hydrated oxide of iron was readily removed by filtration. Upon the addition of ammonium chloride the white hydrate was precipitated in a gelatinous form; the hydrate was redissolved in hydrochloric acid, and again precipitated and washed. The almost perfectly pure hydrate so obtained was then finally converted to chloride by solution in hydrochloric acid.

In order to obtain data as to the atomic weight of masrium the following determinations were made. A known quantity of the chloride solution was precipitated by ammonia, and the hydrate thus obtained was ignited, and the remaining oxide weighed. A second portion was precipitated by a solution of microcosmic salt in presence of ammonia, and the phosphate obtained ignited

and weighed. The chlorine contained in a third portion was determined by means of silver nitrate in the ordinary manner. From the numbers so obtained the equivalent of masrium was calculated. A pure preparation of masrium oxalate was also obtained by precipitating the neutral solution of the chloride with ammonium oxalate, masrium oxalate resembling the oxalate of calcium in being insoluble under such conditions. The precipitated oxalate was washed, dried, and ignited in a combustion tube whose forward end was filled with copper oxide, when the salt was decomposed with elimination of its water of crystallization, which was absorbed and weighed in the usual manner. The residual oxide was also weighed, and the oxalic acid, in another quantity of the salt, was determined by means of a standard solution of potassium permanganate. The crystals of the oxalate were thus found to contain 52·70 per cent. of masrium oxide, 15·85 per cent. of oxalic anhydride, and 31·27 per cent. of water.

From the whole of the analytical data yet obtained, assuming, as the reactions of the salts would indicate, that masrium is a divalent element, the atomic weight would appear to be 228. An element of atomic weight about 225 is, indeed, required to occupy a vacant place in the periodic system in the beryllium-calcium group, and masrium appears likely to be the element in question.

Masrium has only yet been observed to combine with oxygen in one proportion, to form the oxide MsO. Masrium oxide is a white substance much resembling the oxides of the lime group. The chloride, $MsCl_2$, is obtained upon evaporation of a solution of the oxide or hydrate in hydrochloric acid. The nitrate, $Ms(NO_3)_2$, crystallizes from 50 per cent. alcohol, and the crystals contain water, the amount of which has not been determined. The sulphate, $MsSO_4 . 8H_2O$, is a white salt which crystallizes badly from water, but which separates in well-developed crystals from 50 per cent. alcohol. It combines with sulphate of alumina to form an alum, also with potassium sulphate to form a double sulphate. The oxalate above referred to, $MsC_2O_4 . 8H_2O$, is a white salt, soluble in acetic acid, and also in excess of masrium chloride.

The most important reactions of the salts of masrium, as far as they have yet been studied, are the following. Sulphuretted hydrogen produces no precipitate in presence of hydrochloric acid, but yields a white precipitate in presence of acetic acid. Ammonia precipitates the white hydrate of masrium from solutions of the salts; the hydrate is insoluble in excess of ammonia. Ammonium sulphide and carbonate produce white gelatinous precipitates, likewise insoluble in excess of the reagents. Ammonium phosphate yields a white precipitate of phosphate. Caustic alkalies precipitate the hydrate, but the precipitate is readily soluble in excess of the alkaline hydrate. Potassium ferrocyanide produces a white precipitate which is soluble in excess of masrium chloride, but not in dilute hydrochloric acid. Potassium ferricyanide yields no precipitate. Potassium chromate precipitates yellow chromate of masrium, which is soluble in a further quantity of masrium chloride. Potassium tartrate yields a white tartrate precipitate which dissolves in excess of the reagent, but the solution is not reprecipitated by the addition of ammonia.

Metallic masrium has not yet been obtained. Attempts to isolate it by heating the chloride with sodium under a layer of common salt, and by the electrolysis of a solution of the cyanide proved unsuccessful. The chloride, moreover, is not sufficiently volatile to permit of its vapour density being determined.

From the above interesting reactions, however, it will be evident that masrium possesses a strong individuality, although on the whole behaving somewhat like the metals of the alkaline earths and those of the zinc group. Further work will doubtless afford more definite information concerning its nature and properties. A. E. TUTTON.

ON A NEW METHOD OF VIEWING NEWTON'S RINGS.

IF we observe the reflection of a rectangular strip of any opaque substance (A) about ¼ inch wide in a piece of plate glass *of about the same thickness*, it appears thus:—

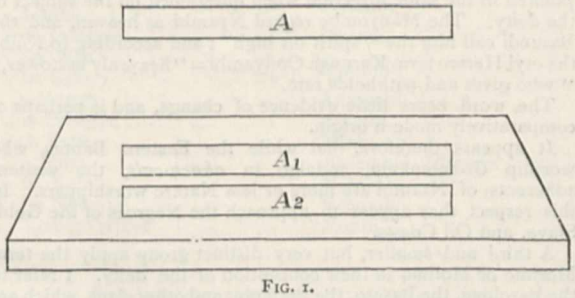


FIG. 1.

A_1 A_2 being the reflections caused by the upper and lower surfaces of the glass respectively.

If a second glass plate, of the same thickness, be added beneath the first, there is a third reflection (A_4) added below A_2 thus, drawing only the reflections for simplicity's sake:—

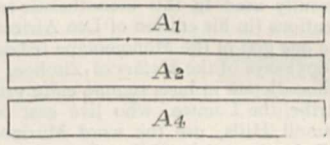


FIG. 2.

Now if the upper slab of glass be *gradually* raised above the lower, the opaque strip remaining in position, the reflection A_2 (Fig. 2), which generally exhibits traces of colour when plate glass is used, splits up into two (A_2 A_3), thus:—

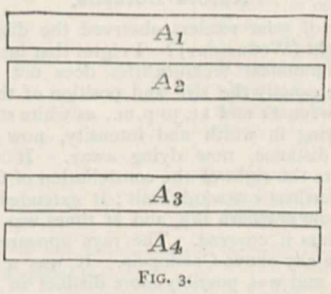


FIG. 3.

Thus it is proved that A_2 (Fig. 2) is the resultant of the reflections of the strip by the lower surface of the upper plate, and the upper surface of the lower plate (A_2 and A_3, Fig. 3, respectively).

In saying that A_1 is the reflection of A caused by the top surface, we mean that light which would fall on that surface and be reflected to the eye is prevented from so doing by the presence of A; and so with respect to the other reflections: thus, if any one of the reflections is not perfectly dark, we can assert that the light seen in it is at any rate not due to reflection (for the first time) at the corresponding surface; *e.g.* A_4 (Fig. 2) appears anything but dark, and we may assert that the light seen in it is not reflected from the bottom surface of the lower plate (at all events for the first time).

Now by means of two similar rectangular strips A and B, placed with their long sides parallel to the surface of the glass, B being further from the observer and from the top plate, it is very easy to arrange them so that B_4—the reflection of B in the lower surface of the lower plate—

apparently coincides with A_1—the reflection of A in the upper surface of the upper plate; and thus, neglecting for the time light which has undergone more than one reflection, we see this A_1B_1 combination of reflections illuminated by light which has undergone reflection at the two inner surfaces only.

It is clear that if we substitute for the two glass plates the apparatus generally sold for exhibiting Newton's rings, we can by this simple method view the rings by the light proceeding from the two inner surfaces only. Thus viewed, the central dark spot appears of a rich velvety black, and the coloured rings very brilliant. The experiment can easily be projected, and the difference in the appearance of the rings on the screen, with and without the opaque screens, is very striking.

The effect of the two screens can be still more simply given by cutting a slit in a piece of blackened cardboard of about the same width as the thickness of one of the glass plates in the rings apparatus; it is almost needless to state that the cardboard in the region of the upper and lower edges of the slit performs the functions of the screens B and A respectively. In this way the backing of the lower glass plate (to get rid of the reflection from its lower surface) may be avoided; an obvious advantage when it is desirable to show the interference in the transmitted as well as in the reflected light.

But the interest of the method does not only lie in its simplicity. Besides affording an easy proof that the rings are caused by light reflected at the inner surfaces of the plates, it also gives a method of seeing and possibly differentiating the interference curves produced by light which has undergone only one reflection, *i.e.* the rings commonly known as Newton's, from the curves produced by the interferences of waves which have undergone two reflections or more (and these last, so far as I know, can only be shown by this method); for if, using the ring apparatus and a single opaque screen, say 3 inches × $\frac{1}{8}$ inch, we look into the central reflection (A_2) carefully, two sets of rings, intersecting, can be seen. These cannot be due to light reflected at the points whence the rays which form the primary rings are reflected—by what has gone before.

To indicate, without attempting for the present any further analysis, how some of the other interference systems may be rendered visible:—Take a strip of blackened cardboard, say 8 inches × $2\frac{1}{2}$ inches, and view its reflections in the Newton's rings apparatus. C (see Fig. 4) being the lower portion of this new screen, its

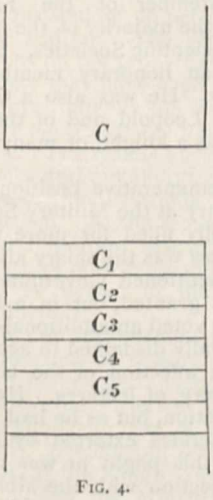


FIG. 4.

reflection will be seen to consist of a number of shaded strips, C_1, C_2, C_3, &c.; and in each of these will be evident different interference curves (plainer, of course, when monochromatic light is used); in C_1 the primary rings; in C_2 two series of rings crossed; in C_3 still more complicated forms, and so on; each set fainter than the last, the light to which it is due having undergone more reflections than its predecessor. The method suggested for the experimental analysis of these interference systems can only be sketched roughly here. It is, by the use of a second screen, possibly a third, so to combine the reflections of the screens with observations of the consequent alteration in the interference curves, as to completely verify the results a mathematical analysis of the problem would predict. T. C. PORTER.

JEAN SERVAIS STAS.

FEW, if any, among the men of science of the present day have at once done such important work and earned so little popular recognition as Jean Servais Stas. The names of Faraday, Liebig, Dumas, Darwin, have become household words beyond the laboratory and the lecture theatre, and are frequently taken in vain by the purveyors of "science for the million." But, whether among the "classes" or the "masses," if we mention Stas we are apt to be asked, Who was he? What has he done? If we mention his determination of the atomic weights, we have to follow this statement up with a popular lecture on stöchiometry, and are then told that there is not much in it.

Stas was born at Louvain, on August 21, 1813. Like many young men of scientific tastes in the earlier part of the century, he entered upon the study of medicine, and graduated as M.D. But, feeling himself strongly drawn to chemical research, he came to the conclusion that the life of a practising physician was not his true sphere. So early as 1835 he undertook, in conjunction with his friend De Koninck, an investigation of the root-bark of the apple-tree, and discovered phloridzine, an interesting crystalline body. However, at the outset he merely succeeded in obtaining this body in its pure state and in ascertaining its behaviour with reagents. He decided to go further, and to study the constitution and transformations of phloridzine. To this end he stood in need of further instruction. But the methods of organic investigation were at that time little advanced. The art of research was taught only by Liebig at Giessen, and by Dumas at Paris. Stas made choice of Dumas, and after overcoming endless difficulties, was admitted as a pupil in the laboratory of that distinguished Academician.

Here, he resumed the study of phloridzine, and soon succeeded in determining its formula, and those of its principal derivatives. He ascertained that in contact with acids, phloridzine was split into glucose and phloretin, thus belonging to the class of glucosides, bodies the prototype of which had been discovered by Liebig and Wöhler in amygdaline. Berzelius, a man by no means lavish of praise, declared that "from an investigator who has carried out such a research much may be expected."

Impressed with the ability of his pupil, Dumas requested him to undertake a series of investigations in concert with himself. The first of these researches was the examination of the action of potassa-lime on alcohols. They determined that, without exception, alcohols were transformed into corresponding acids. By their powers methylic alcohol yielded formic acid, and ethylic alcohol yielded acetic acid. Fusel-oil gave a valerianic acid exactly agreeing in its properties with the natural valerianic acid—a discovery of great importance considering the paucity of synthetic organic compounds then known. In conjunction with his master, he ascertained the molecular weight of valerianic acid by a determination of its vapour density and by its conversion into tri- and tetra-chlorvalerianic acid, thus justifying their joint belief

as to the alcoholic nature of fusel-oil. This conclusion was experimentally confirmed by the conversion of fusel-oil into valeraldehyde.

Immediately after these experiments, Stas, aided by Dumas, entered on the most important work of his life. It had been already found that on the combustion of the more highly carbonized hydrocarbons the sum of the carbon and hydrogen was decidedly greater than the weight of the substance taken for analysis. Two possible explanations were suggested. The excess might be due to a constant error in the method employed, but on careful and frequent repetition of the experiments no such error could be traced; or there remained the possibility that the composition either of carbon dioxide or that of water had not hitherto been accurately determined. In deciding this question Dumas and Stas developed precautions which had never been equalled, and which certainly have not been since surpassed.

It must be remembered that, like Darwin in another department of science, Stas was his own most acute and formidable critic. He seems never to have wearied in devising possible objections to his methods and results, nor of suggesting loop-holes through which errors might possibly have crept. In redetermining the atomic weight of carbon, graphite (natural and artificial) and diamonds were submitted to combustion in a current of perfectly dry oxygen. After the checking and re-checking of results, the operators were forced to conclude that the true atomic weight of carbon was lower than hitherto had been universally accepted. It had been determined by Berzelius and Dulong as 12·24. Dumas and Stas made it simply 12, and confirmed the result by carefully repeated analyses of many substances of known composition. Hence Dumas was led to accept for the atomic weight of oxygen 16, and for that of nitrogen 14. Whilst Dumas and Boussingault executed their determinations in Paris, Stas carried out the same experiments by the same method at Brussels.

These startling results recalled the attention of chemists to the hypothesis of Prout, *i.e.* that the atomic weights of all the elements must be multiples of that of hydrogen (H = 1), by a series of whole numbers. Into this question Dumas and Stas threw themselves heart and soul. The experimenters came to separate conclusions. Stas entered the investigation in the full conviction that he should find the principle of Prout exactly confirmed. At the conclusion of his arduous labours, he found his expectations to be "pure illusion."

On the other hand, Dumas sought to retain the hypothesis in a modified form.

Neither of these eminent researchers seems to have paid sufficient attention to the fact that the atomic weights of a considerable number of the elements differ but very slightly, in excess or in deficiency, from the values which the hypothesis of Prout would require. It is quite possible we are here in presence of a residual phenomenon which interferes with the exactitude of the law.

In a paper recently read by Prof. W. Spring before the Belgian Academy of Sciences the speaker gave an abstract of the unpublished researches of Stas. In a certain memoir, "On Silver," was discussed a treatise by Dumas on the quantity of gases absorbed by silver, in which Dumas had conceived doubts as to the conclusions of Stas on the hypothesis of Prout. For the critical purpose Stas prepared absolutely pure silver, containing not a trace of gases nor of kindred metals. At the melting-point of iridium the silver was volatilized without revealing by the spectroscope any trace of sodium, a metal which Dumas had suggested as being possibly present. This pure silver gave the same atomic weight as the silver used previously by Stas. Hence the atomic weight of silver must retain the value which Stas, in his earliest determinations, had assigned to it, and consequently the objections of Dumas fall to the ground.

A second Stas memoir, recently brought to light, fully investigates the question whether the elements sodium, potassium, lithium, calcium, strontium, barium, and thallium can be mutually transformed either by intense heat or by electric action. To carry out his experiments, undertaken in consequence of the views lately expressed, that the spectra of the above metals assume a different aspect at very high temperatures, Stas required materials chemically, or rather spectroscopically, pure. This difficult task took him eleven years to accomplish. As a result he found that even at the melting-point of iridium (from 2200° to 2500°) the spectral lines of the metals remained unaltered, and that consequently the transmutation of elements under the special circumstance is devoid of foundation. The error may have arisen, as Stas suggests, from the use of materials not absolutely pure.

In this course of experiments he verified the distinction pointed out by Bunsen between the flame spectra and the electric spark spectra of metals. The flame spectrum of sodium, even at the most intense temperature, shows the well-known double yellow line. But in the complete electric spark spectrum there appear six double lines, lying respectively in the orange red, the yellow, the greenish-yellow, the green, the greenish blue, and the violet. In the solar spectrum all these six double lines are represented by black lines. In the spectrum of the electric arc may be recognized the six double lines, but in the intense white light of the poles merely the flame spectrum with its double yellow line.

The results of his investigation Stas describes in a discourse entitled "De la Nature de la Lumière Solaire," delivered in 1891. From the coincidence of the lines of the metals as recognized in the spark-spectrum with Frauenhofer's dark lines in the solar spectrum, Stas inferred that the heat and light of the chromosphere were produced by disruptive discharges.

The daily life of Stas was by no means devoid of troubles. Posts of honour, indeed, were showered upon him both in his own country and abroad. He was Vice-President of the Belgian Sanitary Council, technical assessor of the National Bank, a perpetual member of the Council of Administrators of the University of Brussels, a member of the Statistical Bureau, President of the Belgian Academy of Sciences, Honorary Fellow of the Royal Society (which conferred on him the Davy Medal), Corresponding Member of the French Academy of Sciences, and of the majority of the more distinguished Academies and scientific Societies. So far back as 1873, he was elected an honorary member of the German Chemical Society. He was also a Grand Officer of the Belgian Order of Leopold and of the French Legion of Honour, as well as a knight of many orders throughout Europe.

His earliest remunerative position was that of Professor of Chemistry at the Military School of Brussels, a post he successfully filled for more than a quarter of a century. So paltry was the salary attached to this office that he finally petitioned Government for an increase. His request was granted, but in a fashion worse than refusal. He was voted an additional salary of 200 francs —a sum he naturally disdained to accept. Soon after he suffered from an affection of the larynx, which put an end to the delivery of lectures. He was compelled to tender his resignation, but as he had not completed the thirty years of service extorted by law he missed his pension. From this plight he was rescued by the offer of a post in connection with the Mint (Commissaire des Monnaies). The respite from trouble was brief. A syndicate of speculative capitalists proposed to the Government to coin an enormous sum of francs. With the full

concurrence of the Minister of Finance, Stas resolutely resisted a scheme he considered dangerous to the interests of the nation. With a change of Ministry the proposed measure was carried. Stas forthwith resigned his post in the Mint, preferring to sacrifice emolument rather than countenance a step which he knew to be detrimental.

Stas not unfrequently engaged in tasks which appeal more directly to the popular mind than the determination of atomic weights. In 1850, Belgium was thrown into excitement by a poisoning case not less sensational than that of Palmer in our own country. It has been said of Belgium that it is less permissible to knock down an *ouvrier* than to murder a nobleman. A Count Bocarme had poisoned his brother-in-law. Had the crime in question been committed by one of the *people*, it might, if not condoned, have been inquired into in a somewhat perfunctory manner. But as the only man to whom suspicion pointed was an aristocrat, a searching investigation was demanded by an indignant public. The chemical investigation conducted by Stas was performed in a masterly manner. The unerring chemist not only detected nicotine poison, but also the exact quantity which had been administered. The guilt of Count Bocarme was much more satisfactorily established than that of Palmer in the Rugeley case.

With characteristic thoroughness Stas was not satisfied with the mere detection and quantitative determination of nicotine. He elaborated a general method for the recognition of organic poisons in chemico-legal investigations. His method of detection, revised and perfected by Julius Otto, is still in general use among toxicologists, under the name of the Stas-Otto process.

At the London International Exhibition of 1862, to Stas was intrusted the report on the industry of oils and fats. The question was discussed whether the old method of saponification by means of alkalies or the recently invented acid saponification was to be preferred. The experiments of Stas demonstrated not only the superiority of the acid process from an economical point of view, but supplied the industrial world with the working details of a method still followed by the manufacturers of stearine candles.

At the initial meeting of the International Committee of Weights and Measures held at Paris in 1875, Stas appeared as the Belgian representative, and took a very active part in its labours. From 1877 to 1879 he was associated partly with H. Ste. Claire Deville, and partly with C. J. Broch in the selection of the metals to be used as standards or prototypes for weights and measures. The alloy selected consisted of 90 per cent. of platinum, and 10 per cent. of iridium. The reports are rich in important observations on the properties of the platinum metals. Unfortunately they have been published, so far as the writer is aware, only in the *Procès-Verbaux du Comité International des Poids et Mesures*, documents not readily accessible. The results have still to find their way into the text-books and metallurgical manuals.

But other labours of the illustrious Belgian chemist have still to be unearthed. At the request of his Government he carried out important researches on metallic alloys for the manufacture of heavy artillery. His copious reports are said to be buried in the archives of the Belgian War Department.

In one quarter only did Stas encounter ill will. He was a champion of the freedom of research and of the independence of the Universities. Hence he came into frequent collision with the "clerical party," which in Belgium plays a *rôle* similar to that of the ethicists and self-constituted "anti-" Societies in Britain.

On January 1, 1891, at the King's New Year reception he courageously reminded the Ministry of the respect which a Government owes to science. We regret we have not met with the text of this discourse, which would be worth reproduction in England. The insulting replies to the bold utterance of Stas were drowned in the loud and general approval of the country.

It is pleasant to add that the personal character of Stas was in harmony with his scientific pre-eminence. He was a man of whom it could be said, "Nihil tetigit quod non ornavit." It was one of his great distinctions that, unlike many illustrious men of science, he was not followed to the grave by the ghosts of dead theories.

NOTES.

MEN of science were glad to see that the list of those on whom birthday honours were conferred included Dr. John Evans, who has become a K.C.B.; Mr. W. T. Thiselton Dyer, who has been made a C.I.E.; and Mr. H. H. Howorth, who has been made a K.C.I.E.

THE annual visitation of the Royal Observatory at Greenwich will take place on Saturday, June 4.

THE Secretary of the British Association Committee for arranging for the occupation of a table at the laboratory of the Marine Biological Association, at Plymouth, requests us to announce that applications for the use of the table during the present summer should be addressed to him (Mr. S. F. Harmer, King's College, Cambridge) not later than Friday, June 10.

MR. WALTER GARSTANG, M.A., Berkeley Fellow of the Owens College, Manchester, and formerly assistant to the Director of the Marine Biological Association, has been appointed to a naturalist's post upon the staff of the Marine Biological Association at Plymouth, and will have charge of the dredging and collecting operations conducted at the station.

IN the fifth Annual Report of the Liverpool Marine Biology Committee (December 1891), Prof. Herdman suggested that the marine biological station might with advantage be changed from Puffin Island to some more easily accessible part of the district, where a fresh area could be investigated. After a careful consideration of several sites, the Committee decided upon Port Erin, at the south end of the Isle of Man, and a suitable building for a marine laboratory, of three rooms, has now been erected, on the beach immediately below the Bellevue Hotel, from plans prepared by Prof. Herdman. This laboratory being ready for workers, and a number of members of the Liverpool Biological and other scientific societies, and also of the Isle of Man Natural History and Antiquarian Society, having expressed an interest in the progress of the undertaking, the Committee have resolved to inaugurate the station by a formal opening on Saturday, June 4. The Lieutenant-Governor of the Island, Mr. Spencer Walpole, has consented to perform the ceremony; and His Excellency, and the Bishop of Sodor and Man, have accepted the invitation of the Committee to be present at a luncheon to be given at the Bellevue Hotel on the occasion.

THE Puffin Island Biological Station has been taken over by several members of the staff of the University College of North Wales, Bangor, and will be worked henceforth in connection with that College. Dr. Philip White, the lecturer on zoology, has been appointed director of the station. The island is in full view of, and within easy reach of, the College. The station, as formerly, will be entirely supported by voluntary contributions.

THE Marine Biological Laboratory at Wood's Holl, Massachusetts, will be open for investigators from June 1 to August 30. The demand for tables at the laboratory has been so great

that the trustees decided some time ago to enlarge the building, and a spacious new wing will be ready for use on July 1. Various courses of instruction in zoology, botany, and microscopical technique will be given, as usual, during the season. Lectures on special subjects will also be delivered by members of the staff.

THE annual *conversazione* of the Society of Arts will take place at the South Kensington Museum on Wednesday evening, June 29.

THE German Anthropological Society will hold its general meeting this year at Ulm, beginning work on July 31. Arrangements have been made for some very pleasant excursions in the neighbourhood.

MAJOR-GENERAL NOBLE, R.A., died on Tuesday, May 17, in his fifty-eighth year. He was well known, not only as the author of books on military subjects, but as the inventor of various scientific instruments connected with the manufacture of guns and gunpowder.

THE University of Heidelberg has conferred the degree of Doctor of Natural Philosophy, *honoris causâ*, on the well-known entomologist, Baron Osten Sacken.

THE beautiful illustrations contained in the *Black and White* Hand-book to the Royal Academy and New Gallery pictures are sure to be welcomed by those who have not already seen them, while to those who have visited these Galleries good reproductions of them will not be amiss. The different coloured tints given to the pictures produce a pleasant variety of impression, while the fidelity to the original details, which is the chief feature of photographic processes, is here thoroughly maintained. Not only the pictures, but the specimens of sculpture, are reproduced in the same way, the results being equally successful. As an introduction to the volume, a brief but interesting account is given of the Royal Academy, together with illustrated biographies of the present Academicians and Associates.

PART I. of Mr. G. J. Romanes's treatise, "Darwin and after Darwin," was published a day or two ago by Messrs. Longmans, Green, and Co. It deals in a critical manner with the distinctively Darwinian theory, or the evidences of evolution as a fact, and of natural selection (with sexual selection) as a method. It is copiously illustrated, for the most part with original woodcuts, and runs to 450 pages. We gather from the preface that Part II. is to treat in a similar spirit of "Post-Darwinian Theories" (heredity, utility, isolation, physiological selection, &c.); and understand that it will probably be ready for publication in the autumn season.

ON April 29, Mauritius was visited by the most terrible hurricane that is known to have ever devastated the island. According to the official telegram from the Acting Governor to the Secretary of State for the Colonies, one-third of Port Louis was destroyed. The Royal College, twenty-four churches and chapels, and many sugar-mills in the country were completely wrecked. There were over 600 deaths in Port Louis; over 300 deaths in the country and over 1000 wounded. "In Port Louis district," the telegram continued, "returns incomplete; probably same amount. No loss among the military. Estimated reduction of crop one-half. Destruction to property enormous. No famine apprehended. All relief measures taken. Relief committee appointed. Panic allayed. Order and quiet reign, but, in presence of thousands of homeless people, pecuniary assistance urgently needed." A public subscription in aid of the sufferers was at once opened by the Lord Mayor. It is to be hoped that the Observatory at Mauritius has been spared. It was thence that Dr. Meldrum announced that at Mauritius the hurricanes and wrecks varied with the sun-spots. We have again a maximum of sun-spots and unprecedented devastation.

THE National Home Reading Society will hold two summer assemblies this year, one at Weston-super-Mare, the other at Bowness. The former will last from June 25 to July 2, the latter from June 27 to July 2. At both meetings science will be well represented among the subjects of study. At Weston-super-Mare, Prof. Lloyd Morgan will lecture on "The Physical History of the Mendip Hills," Sir Robert Ball on "How came the Great Ice Age?", Dr. Dallinger on "Ants: a Study of Sociology and Politics among Insects," Dr. C. W. Kimmins on "Flowers and their Insect Visitors," Mr. A. W. Clayden on "Geological Structure and the Formation of Scenery." At Bowness, Mr. J. E. Marr and Mr. G. Massee will give geological and botanical lectures, but the chief work of the classes in geology and botany will be done in the course of excursions to the places of scientific interest in the Lake District. Both assemblies are likely to be of great service to all who attend them.

MR. GEORGE FORBES arrived on May 6 at the Niagara Falls in company with the executive officers of the Cataract Construction Company. He is acting as the Company's adviser in connection with the plans he submitted to them in 1890 for the transmission of electrical power from the Falls to Buffalo. When the Company appointed a commission of Sir William Thomson, Mascart, Colonel Turrettini, and others to examine the plans, Mr. Forbes gave them as his mature opinion the assurance that they must use alternating currents, and for motors either the ordinary alternator, as first used by Wilde, or the rotating field (Drehstrom), as then used by Tesla, which Mr. Forbes had tested at Pittsburg. These alternating currents to be used with transformers for lighting, and coupled to motors as described for general power, but for electric tramways and some other purposes the alternating motors were to drive continuous current dynamos. These plans were not approved by the commission, and a resolution was nearly passed saying that alternating currents could not be used for the purpose. There was only one dissentient voice, but in the end no resolution was passed. Turrettini and Mascart are now both converted, and Mr. Forbes's plans have been adopted.

MUCH interest has been excited in Philadelphia by a loan collection of objects used in worship, exhibited in the Museum of Archæology of the University of Pennsylvania. Most of the leading religions of the world are represented in the collection. The objects are arranged in accordance with the plan adopted at the Guimet Museum, Paris, and the managers have tried to make up for gaps by notes in the catalogue, which is a closely printed octavo of 174 pages. One result of the exhibition has been that it has brought to light many objects of scientific importance, the significance and value of which were not formerly known by the possessors.

MR. JOHN H. COOKE has made a valuable addition to the Museum of the Malta University. The *Mediterranean Naturalist* describes the gift as a suite of the Maltese fossil Echinoidea, similar to those that have lately been presented by the same gentleman to the British Museum and to the University of Bologna.

A WRITER in the May number of the *Mediterranean Naturalist*, speaking of the colours of the waters of the Medi-

terranean, says they vary considerably at different seasons of the year and in different localities. During storms and boisterous weather the sea assumes a deep green and sometimes a brownish tint, but when calm and undisturbed it is of a bright, deep blue. In the Bosphorus, and among the islands of the Archipelago, the water is of varying tints, in some places being of a liquid blue graduating into a brighter green, and in others assuming a blue so deep in its intensity as to almost approach a purple.

MR. K. SEKIYA AND MR. F. OMORI contribute to the new volume of the Transactions of the Seismological Society of Japan a most careful paper presenting a comparison of earthquake measurements made in a pit and on the surface ground. It is generally thought that the earthquake motion is considerably less in a pit than on the surface. The conclusion of these inquirers is that for small earthquakes there is no practical difference between the surface and underground observations. For the principal undulations of severe earthquakes a difference may exist, but not to any marked degree; but for small quick vibrations the difference is considerable. Though the calculation for the ripples may be only approximate, their maximum velocities and maximum accelerations are found to be very great, and, in fact, many times greater than those for the principal undulations. Thus, if these ripples are really in great part smoothed away in the pit, it is very likely that in the case of very severe earthquakes there might be less destructive action in deep pits than on the free surface.

THE weather during the past week has been less settled generally than for some time past, although for the most part it was fine and dry over the south and east of England. The distribution of atmospheric pressure was favourable to a westerly type of wind, the barometer being highest over the south of our islands, and lowest over Scotland. An anticyclone was situated over France and Spain throughout the period, and the southern portion of England came greatly under its influence. Several depressions reached the northern parts of the kingdom from the Atlantic, and caused strong winds and gales at some places. The rainfall was considerable in the north and west, amounting to one inch at Stornoway on Monday, but slight in other parts. Bright sunshine was less prevalent; the Meteorological Office report for the week ended the 21st shows that it was below the average in all districts except the Channel Islands. A thick fog occurred over the south of England and parts of the Channel on Sunday. Temperatures have been rather high recently, the maxima reaching 70° and upwards, in places, since Sunday.

THE Weather Bureau of Washington, U.S., has issued, under the title of "Meteorological Work for Agricultural Institutions," a pamphlet containing suggestions as to observations and investigations regarding the relations of climate to agriculture which may with advantage be undertaken at stations situated in agricultural districts, as distinct from the work carried on at observatories and stations established in towns. These suggestions are equally useful for observers in any country; we therefore draw attention to some of the points referred to. (1) Problems of temperature; such as the differences that occur in quiescent air, between places that are close together. These differences depend on solar and terrestrial radiation, the covering of the soil, &c. The subject of protection from frosts also deserves further study. (2) Moisture in the air; especially measurements of evaporation, both from a water surface and from different kinds of soil. The transpiration of plants should also be measured, in such a way that the evaporation from a plant can be compared with the precipitation over the surface occupied by the plant. (3) Condensation and precipitation of moisture. An accurate record of the amount of dew is much wanted; at present, no observations are regularly made. A drosometer has, however, been recently constructed by Kappeller, of Vienna; it is described in the *Meteorologische Zeitschrift* of March last, and is said to give good results. Snow presents many features of interest, such as its density, and the relation of the character of the flake to the character of the weather at the time of the fall. The density of fog, also, should be recorded on some uniform plan, such as the distance at which a slender pole can be seen. The average size and usual forms of hail-stones should also be recorded. (4) Local weather predictions, independent of the daily weather charts, should be carefully studied. The special study of thunderstorms and other local disturbances will result in enabling them to be predicted several hours in advance. Systematic observation with the rain-band spectroscope should also be made. These are but a few of the questions raised in Prof. Harrington's interesting memoir.

WE have received from the Director of the Batavia Observatory (1) rainfall observations in the East Indian Archipelago, and (2) observations made at the Magnetical and Meteorological Observatory, Batavia, both for the year 1890. The daily and monthly rainfall values are given for 193 stations, together with the mean values, calculated from five or more years for 171 stations. The summaries show that the rainfall which accompanied the eastern monsoon was copious over the whole area, and that both in the years 1889 and 1890 he amount during the months of May to September was abnormally high in the eastern parts of the archipelago. In addition to the hourly meteorological observations for 1890, results for twenty-five years, 1866-90, are published in this volume. Dr. Van der Stok considers the fact proved beyond doubt that at Batavia the moon has an appreciable influence on the number of thunderstorms. The cloud curve also shows an increase of cloudiness as the moon rises above the horizon. After the moon has set, the cloudiness does not decrease at a continuous rate, but apparently remains constant.

WE have received the January number of the *Revista do Observatorio*, which is a monthly publication of the Observatory of Rio de Janeiro. This pamphlet, which, by the way, is an index number, contains in tabulated form all the meteorological observations made during that month at the several places from which regular observations can be obtained. The tables show the daily as well as the hourly reduced readings.

THE Technological Museum of Sydney was taken over by the Department of Public Instruction on January 1, 1890. In his first annual report, just received, Mr. J. H. Maiden, the Curator, says the public have shown their appreciation of the usefulness of the Museum by presenting it with a large number of objects, many of which are of great value. The authorities of the Museum have done excellent service by supplying lecturers with specimens, diagrams, and apparatus for illustrative purposes, and by answering questions sent to them by public school teachers—chiefly in country districts—on such matters as the naming of minerals and plants. Technological museums have been, or are being, formed in all those towns in New South Wales which already possess technical colleges. Mr. Maiden says that the matter has been taken up warmly in country districts, and that the formation of local collections is felt to fill up an important gap in the arrangements for technical education in the colony. A flourishing scientific society at West Maitland offered its valuable collection of natural history specimens to the Department of Public Instruction on condition that suitable accommodation should be found for them, and facilities given to the members for access to them. The specimens having been accepted by the Minister on these terms, they form a valuable addition to the West Maitland Technological Museum, constituting a natural history "side" to it. As local scientific societies are always likely to be useful in securing

specimens for local museums, and in concentrating the scientific activity of a district to the advantage of the local technical college, and of the district in general, Messrs. Sach and Ross, the resident science masters at Goulburn and Bathurst respectively, have formed scientific societies in their respective cities. These societies have already a good number of members, who meet regularly for the discussion of scientific questions, and they seem to Mr. Maiden to give promise of much usefulness.

AT the meeting of the Linnean Society of New South Wales on March 30, Mr. R. Etheridge, Jun., read a paper on, and exhibited, a very peculiar form of "womerah." It is from an unknown locality, but its history is partially known, and a clue is furnished by three very similar weapons in the Macleay Collection from Port Darwin. It is lath-like in form, slightly curved in outline, and altogether a remarkable implement, very unlike anything, to the author's knowledge, previously described.

DR. G. T. STEVENS publishes in *Science* of May 6 an interesting preliminary note on the relations of the motor muscles of the eyes to certain facial expressions. He has for some years closely observed the anomalies of the muscles which govern the movements of the eyes, and has been struck by the fact that remarkable changes often follow the modification of the conditions of these muscles. This led him not only to regard such facial changes with greater care, but to bring to the subject the aid of photography, by means of which alone the expressions could be accurately registered. Photographic portraits giving a direct front view of more than two thousand persons have thus been made. In each case a record, as full as he has been able to obtain, of the state of the eye muscles has been made, and in the majority of cases careful observations have been repeated many times during some weeks or months. Photographs have been taken at various stages of modification of these muscles, so that a comparative study of the face under varying conditions of the eye muscles has been rendered possible. The result of the investigation has been to demonstrate that "certain well-defined types of facial expression are not only associated with, but are dependent upon, certain relative tensions of the oculo-motor muscles." The object of his paper is to present the general characteristics of some of the most typical forms of expression which have their origin in efforts to adjust the eyes.

THE first part of a paper on the development of American armour-plate, by Mr. F. Lynwood Garrison, appears in the May number of the Journal of the Franklin Institute. It was the author's original intention to present in the form of a report the results of the recent armour-plate trials at Indian Head. As, however, these trials have been described in an excellent report by the Chief of the Bureau of Ordance of the U.S. Navy, Mr. Garrison has preferred to give a sketch of the development of armour-plate, combining with this the more important details of the official report. He writes from the standpoint of the metallurgist rather than that of the military engineer. At present great interest is centred upon the use of the complex steel alloys and the methods adopted to harden them, and it is to these subjects more particularly that he calls attention. The detailed methods of producing such alloys as well as the several methods for quenching and tempering armour-plate are kept secret by steel manufacturers; but the results are made public at the trials, and "the possible deductions to be made therefrom," says Mr. Garrison, "are patent to every observing and thinking engineer." The fact that he has had exceptionally good opportunities of making such observations is a sufficient reason for the publication of his views.

SOME interesting details as to the production of mercury in Russia have been submitted by Prof. Emile Muller, of Taschkent, to the Paris Geographical Society. A bed of this rare metal, discovered at Ekaterinoslav, is now worked with great energy, and 20,000 pouds (320,000 kilogrammes) of pure mercury are obtained. The entire demand for the metal in Russia is supplied from this source, and a surplus of 14,000 pouds (224,000 kilogrammes) is exported. During the past year mercury was discovered in the district of Daghestan, in the Caucasus, and it is expected that the discovery will lead to the growth of a profitable industry in that region.

THE vine industry in Bashahr, in the Punjab, was formerly of great importance; but of late years it has declined in consequence of the old trees having been attacked by a disease. Mr. Coldstream, the Deputy Commissioner of Simla, proposes to revive the industry, if possible, and has secured a large number of cuttings for the State.

THE *Pioneer Mail* (Allahabad) of May 5 says that locust swarms are reported from the frontier, and that stragglers have been observed again passing over Lahore. It is thought that they have chosen a bad time, as the district is full of the migratory hosts of starlings which come at this season of the year to feed upon wild mulberries, and few of the stragglers are likely to "run the gauntlet" successfully.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. M. McPherson; a Crested Porcupine (*Hystrix cristatus*) from Africa, presented by Mr. J. Bullock; a Common Pea-fowl (*Pavo cristatus*) from India, presented by Colonel Bagot Chester; two Yellow-bellied Toads (*Bombinator bombinus*), European, presented by Mr. A. M. Ansler; two Black Bears (*Ursus americanus*) from North America, deposited; a Japanese Deer (*Cervus sika* ♂); a Bennett's Wallaby (*Halmaturus bennetti* ♀); two Himalayan Monauls (*Lophophorus impeyanus*); two Greater Black-backed Gulls (*Larus marinus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

PARIS OBSERVATORY REPORT.—The annual report on the state of the Paris Observatory for the year 1891, presented by Admiral Mouchez, shows that a considerable amount of work, as in former years, has been accomplished during the past year. After mentioning briefly some of the last reports that have been communicated by those who are undertaking the work of photographically charting the heavens, he gives a *résumé* of the resolutions that have been adopted during the session of 1891. In the table showing the zones allotted to the different Observatories, that given to Greenwich lies between declinations + 90° and + 65°, and that to Oxford between + 31° and + 25°; the number of plates for each zone being 1149 and 1180 respectively. A *résumé* of the meridional observations for the year informs us that no less than 19,458 observations were made, while those of the planets amounted to 570. M. Paul Henry, M. Wolf, and M. Deslandres, have all been busily engaged in their respective sections, their work having been previously mentioned in these columns. The second volume of the catalogue and the second volume of the observed positions (6h. to 12h.) have been completed and published; while Part III. (12h. to 18h.) is still in preparation. The observations for 1884 are now quite finished, and those for 1885 will be ready by the end of this year. The verification of the reduction of the observations made in 1884–86 for the formation of a catalogue of twenty-four stars very near the Pole has already been commenced, and should, when completed, form a most important volume. The individual works that have been published from time to time are also referred to here. The meteorological observations and time service have been continued as usual.

STARS WITH REMARKABLE SPECTRA.—No. 3090 of the *Astronomische Nachrichten* contains a list of stars with remarkable spectra, continued from a former number (3023) of the same periodical, and communicated by T. E. Espin. The num-

ber of spectra described here is no less than 121, and the star places have all been brought up to the year 1900.

COMET 1892 SWIFT (MARCH 6).—The ephemeris of this comet for this week is as follows :—

1892.	R.A.	Decl.	log Δ.	log r.	Br.
	h. m. s.	° ′			
May 27	23 43 17	+35 36·6			
28	45 36	36 2·2			
29	47 54	36 27·4	0·1727	0·1297	0·42
30	50 10	36 52·1			
31	52 24	37 16·2			
1	54 36	37 39·9			
2	56 46	38 3·2	0·1821	0·1429	0·38

The brightness at the time of discovery is taken as unity.

On the 30th the comet will lie in the prolongation of the line joining v and θ Andromedæ, being about twice the distance from θ as is σ.

LIGHT VARIATIONS OF Y CYGNI.—In *Astronomische Nachrichten*, No. 3091, Prof. Dunér discusses the results of his observations, made during the interval April 1891 to April 1892, of Y Cygni, with respect to the cause of the anomalies in the light variations. The number of minima observed amounted to twenty-seven, and on their reduction (together with many others), by grouping the differences between observation and calculation in a particular way, the values for the normal deviations were obtained. These figures showed that the even and odd epochs deviated on the positive and negative sides respectively ; and from subsequent calculation, in which $\pm z$ represented constant deviation of the even from the odd minima, the numerical value of z was found not to be constant, but a slowly-increasing quantity. Mr. Yendell, who has previously considered this question, explained the possibility of representing such differences by a periodical function, but Prof. Dunér, assuming a systematic difference between the even and odd epochs, explains them otherwise—"that the star Y Cygni consists of two equally large and bright components, which revolve around their common centre of gravity in an elliptic orbit with a period of revolution of 2d. 23h. 54m. 44s. ; the perihelion passages occurring between the even and the odd epochs." If the value of z be found to be real, and not as at present only suspected, we might suppose "a third body, dark or only slightly luminous, which should cause a perturbation in the position of the lines of apsides, such as we recognize in the planets and satellites of our solar system."

To facilitate observation, Prof. Dunér gives an ephemeris for the times of minima expressed in Greenwich mean time. From the latest observations these times may be probably half an hour too late.

Epoch.				Minimum.	d.	h.	m.
1341	...	...	1892	June	9	9	33
1361	...	...		July	9	8	40
1381	...	...		August	8	7	46
1401	...	...		September	7	6	52
1421	...	...		October	7	5	58
1441	...	...		November	6	5	5
1461	...	...		December	6	4	12

NEBULÆ.—The *Monthly Notices* for April contain some notes on observations of nebulæ made by Mr. Burnham with the 36-inch refractor of the Lick Observatory. The work was undertaken by him during the months of September and October, 1891, in order to give fuller details concerning the descriptions, places, and actual existence of several of these objects included in the general catalogue. All the places derived from the measures are referred to the epoch 1860 of the general catalogue, while the numbers used in all cases are those of Dreyer's general catalogue.

During this survey, several new nebulæ were found, although no attempt was made to search for new objects. The following list includes some of these, together with some of the doubtful nebulæ :—

No. 707.—R.A. 1h. 44m. 31s., Decl. −9° 12′·0. In the immediate vicinity of this a new nebula was found, R.A. 1h. 43m. 31s., Decl. −9° 13′·4.

No. 874.—R.A. 2h. 9m. 43s., Decl. −23° 50′·5. No nebula found near this place. Probably a faint star had been seen, as many are near this position.

No. 942.—R.A. 2h. 21m. 30s., Decl. −11° 27′·2. Near this position are three fainter nebulæ, two of which have been observed before, but one quite new. The places for these three are Neb. (*a*) (new) 2h. 22m. 0 5s., Decl. −11° 27′·9 ; Neb. (*b*) 2h. 22m. 23·5s., −11° 28′·1 ; and Neb. (*c*) 2h. 22m. 22·7s., −11° 27′·6.

No. 988.—R.A. 2h. 28m. 34s., Decl. −9° 57′·9. No suggestion of any nebulosity about this star after very careful scrutiny.

Barnard.—R.A. 5h. 14m. 33s., Decl. + 3° 20′·7. In sweeping for this double nebula, another nebula was found in the immediate vicinity, R.A. 5h. 14m. 40s., Decl. + 3° 10′·4.

No. 1988.—R.A. 5h. 29m. 4s., Decl. + 21° 7′·7. Not the least trace of nebulosity here. Dreyer stated that Tempel pointed out that supposed nebula was only a false image of the star. New observation endorses this view.

No. 7447.—R.A. 22h. 53m. 6s., Decl. −11° 16′·7. This object certainly does not exist.

No. 1086.—Near this nebula are two others—

Neb. I. 2h. 40m. 49s., Decl. + 40° 28′·5.
Neb. II. 2h. 41m. 12s., Decl. + 40° 28′·6.

ANNIVERSARY MEETING OF THE ROYAL GEOGRAPHICAL SOCIETY.

THE anniversary meeting of the Royal Geographical Society was held on Monday afternoon, when the Right Honourable Sir Mountstuart E. Grant Duff was re-elected President. The following changes have taken place amongst members of the Council :—Sir Henry Rawlinson and Mr. Clements R. Markham have been appointed Vice-Presidents in the room of Sir Frederick Goldsmid and Sir Beauchamp Walker, both of whom remain on the Council, Sir Beauchamp Walker being appointed Foreign Secretary in place of the late Lord Arthur Russell. In addition to the Councillors who have been elected Vice-Presidents, the following have retired by rotation :—Sir George Bowen, Dr. R. N. Cust, Sir Alfred Dent, the Duke of Fife, and General Maclagan. In their place Lieut.-Colonel J. C. Dalton, Sir Arthur Hodgson, Mr. John Murray (the publisher), Mr. E. G. Ravenstein, Sir Rawson Rawson, and Colonel Tanner have been elected.

During the meeting the Royal Medals for the Encouragement of Geographical Science and Discovery were presented, the Founder's Medal being given to Dr. Alfred Russel Wallace in recognition of the high geographical value of his great works, "The Geographical Distribution of Animals," "Island Life," and "The Malay Archipelago," and his further claim for distinction as co-discoverer with Darwin of the theory of natural selection. The Patron's Medal was presented to Mr. Edward Whymper for the results of his journey in 1879-80, recorded in his work, "Travels among the Great Andes of the Equator," London, 1892, 2 vols., besides a volume on the aneroid barometer. The Murchison Grant for 1892 went to Mr. Robert Swan, surveyor and geologist, who accompanied Mr. Bent in his expedition to Mashonaland, making a careful route-map of the country traversed down to the East Coast at Beira ; the Back Grant to the Rev. James Sibree, for his many years' work on the geography and bibliography of Madagascar ; the Cuthbert Peek Grant to Mr. Charles W. Campbell, for his important journeys in Korea ; and the Gill Memorial to Mr. G. H. Garrett, for important geographical work done during the past fifteen years in Sierra Leone. Mr. Mackinder and Mr. Buchanan gave a short account of the Geographical Lectureships at Oxford and Cambridge. The scholarships and prizes given by the Royal Geographical Society to students in training colleges for 1892 were also presented.

The President delivered the annual address on the progress of geography, in the course of which, after referring to the evening meetings and to the Proceedings for the past year, he said :—

'With our meetings all Fellows of the Society who live in London, and with our Proceedings all Fellows of the Society, may be taken to be more or less familiar, but our Fellows by their contributions do a great deal more for their science than to make it possible to hold meetings and to publish Proceedings ; nor does it seem unadvisable to remind them, from time to time, what they are doing in other ways for science and the body politic. They are aware that an annual vote of £500 is taken in the Estimates in aid of the Society's

finances. In return for that it is bound to keep open for the public at large, and does keep open, a map collection of great importance. During the last year some 2500 persons visited the map room, which is in charge, as you all know, of Mr. Coles, a most competent officer; but if we had more room we could be much more useful. We could, for example, store, in such a way as to make it quite easy to refer to them, all the 25-inch Ordnance Survey maps. That at present is perfectly out of the question. We should like also, if we had the space, to have a room where any Member of Parliament or person holding an official position could at once be supplied with all the information he could desire upon any of the innumerable questions where politics and administration cross the frontiers of geography.

"Another of our duties is to collect and keep together a large collection of books, maps, diagrams, photographs, and other helps to earth-knowledge. Of the first of these we have about 40,000, valued at not less than £10,000. Of the second and third, about 50,000 maps and charts and 7000 atlases; and of the fourth about 4000 copies, together valued at about £8000. We keep, too, a stock of instruments, which we lend from time to time to travellers who satisfy us that they can use them; £680 worth of these have been lent to Government officials since 1888. A further department of our activity is map-making. We have recently produced a large-scale map of East Central Africa, as well as maps of Persia and Tibet, edited respectively by Mr. George Curzon and General J. T. Walker, while we are constantly publishing in our Proceedings original maps which, but for us, would never see the light at all, or, if they did, only after an amount of delay which would greatly impair their usefulness.

"The same officer who presides so well over our map collection renders very useful services to the public, by giving instruction in surveying and practical astronomy to persons who are going into countries the geography of which is little known. Forty-eight servants of the Government, soldiers, sailors, and others, of whom twenty-one were employed on special service and boundary commissions, have recently taken advantage of this teaching. We receive too as students, at the desire of the Colonial Office, all officials who come to us before going out to West Africa, and pay half their fees, while our advice and help is always at the disposal of any of the Government Offices which desire to consult us on the choice and purchase of instruments.

"Another very important function which our Fellows enable the Council to fulfil, is the granting of direct subventions to intending explorers, and you all know what large sums have been given at various times for such purposes. Mr. Conway, a most experienced mountaineer, and a man of large scientific knowledge, started in the beginning of this year to explore the glaciers of the Karakorum. He received from us £250 towards his expenses, and a conditional promise of more.

"To Mr. Pratt, who read at one of the Society's meetings a very valuable paper on North-Western China more than a year ago, and who is now going through the regions, first clearly revealed to science by Mr. Bates in his delightful "Naturalist on the Amazons," to explore the still unknown or little known regions in the extensive valley of that great river, we have given a grant of £100, and have lent him instruments. If he adds considerably to geographical knowledge, our contribution may be increased at a later period. We have given a small grant in aid of a proposed inquiry into the Houssa language and people. To Dr. Nansen we have voted £300. The object of his expedition, it should be remembered, is not so much to reach the North Pole, as to explore the unknown Arctic region. This he proposes to effect, not by following the coast line of Greenland or Franz Josef Land, which might be the best plan *if* their coast lines extend much beyond the points already known; but to reach the edge of the hitherto untravelled region by the help of the surface currents which he believes cross the Polar region from Siberia towards Greenland.

"In the beginning of the year we published a circular prepared by the Orthographical Committee of the Council upon the spelling of geographical names. This was done in pursuance of the policy announced in the Proceedings for 1885, p. 535—a policy in which we were encouraged by observing that the charts and maps issued during the last six years by the Admiralty and War Office have conformed to our views; that the Foreign and Colonial Offices have done the same, and that the Government of the United States of America has adopted a very similar system.

"The death of Mr. Bates rendered vacant the office of Assistant Secretary, and the Council felt sure that it would consult the best interests of the Society by promoting to that position our late librarian, Mr. Keltie, who was made at the same time editor of the Society's publications. The vacancy caused by this promotion was filled after a very careful consideration by the appointment of Dr. H. R. Mill, who has done much already for scientific geography. Our cartographical department has been strengthened by the accession of Mr. Darbishire, a highly promising pupil of Mr. Mackinder's at Oxford, who has also had an excellent German training.

"The Council has requested three gentlemen, well known to the Society, to represent it at one or other of the Congresses to be held at Madrid, in the neighbourhood of Huelva, and at Genoa, in honour of the fourth centenary of the discovery of America by Columbus. The attention of many I address was doubtless called to the Congress at Berne, where, by the way, England 'was conspicuous by its absence' in the Educational Section. A strong wish was expressed there that the next Congress should meet in London, and the necessary steps have been taken to comply with that wish. A committee, of which Major Darwin is the head, is now engaged in initiating arrangements for a Geographical Congress to be held in 1895.

"Hardly inferior in importance to the duty of assisting well-considered exploration and supplying true explorers with an audience to applaud their discoveries—a duty laid upon the Society by all its past—is the duty laid upon it by the necessities of the present to assist in the wider diffusion of geographical instruction.

"In our attempts to increase the amount and improve the quality of geographical teaching in the country we had to put up with some grievous disappointments. We began as far back as 1869 by giving medals to be competed for by the principal English schools. Two schools, and two only, distinguished themselves in the competitions—Dulwich College and Liverpool College. As to the fourteen others, the less said the better. The Society, however, had no idea of allowing itself to be beaten by the *vis inertiæ* or *laches* of individuals. Mr. Freshfield, one of our honorary secretaries, himself an Etonian, was possessed with a perfect passion for giving to others the advantages in respect of geographical instruction which he had not enjoyed in boyhood. Mr. Bates, our late excellent assistant secretary, pondered long, as was his wont, as to whether we ought to throw a substantial portion of our strength into improving education, and having come to an affirmative conclusion, took the matter up with characteristic energy. The Council was of the same mind, and ere long it was determined—

"1. To send Mr. Keltie to report upon geographical teaching at home and abroad.

"2. To open, under the auspices of the Society, an Educational Exhibition, in which all the best appliances for the teaching of geography should be brought together.

"Mr. Keltie accordingly commenced his investigations, travelling very widely while he carried them into effect. His Report was published, and excited much attention. The Exhibition was open during December 1885 and January 1886, and was visited by several thousands of persons interested in education. The collection contained in it has been lent to the Teachers' Guild, and is now exhibited in the museum of that body in Gower Street.

"The movement thus inaugurated resulted in various changes in our policy. We concluded a treaty with the University of Oxford in 1887, and with Cambridge in 1888, by which it was stipulated that we should go shares with each of these learned bodies in paying the salary of a lecturer to teach geography to such of their members as choose to avail themselves of his services. An argument, if it deserves the name, has sometimes been advanced, to the effect that we should not teach geography at our Universities, 'because it is a graphy and not a logy!'

"Throughout Germany the question has been settled. In that country, as well as in Austria and elsewhere, professors of geography are lecturing, and lecturing to excellent purpose, without interfering either with the domain of their historical colleagues on the one side or their geological colleagues on the other. Whether it is taught or not taught in schools and Universities, geography must in the nature of things rule the territory in which the sciences relating to organic life, from history down to the structure of the humblest animate thing, meet the sciences which have to do with inorganic nature.

Call it a 'graphy,' or a 'logy,' or a 'Kunde,' or what you please, it remains the body of knowledge which has to do with the theatre of the activity of man and all things that have life. We may stunt and injure the activity of the next generation by refusing to teach it, but eventually it must obtain the position which the greatest of living systematic botanists claimed for it in 1886. 'It must permeate,' he said, 'the whole of education to the termination of the University career, every subject taught having a geographical aspect.'

"When, in spite of foolish objections, we had sown the seeds of what we may hope, having regard to the slowness with which trees grow in our English climate, to be vigorous saplings about the end of the century and respectable denizens of the forest in the year 2000, we turned to the training schools, and concluded a convention with the Education Department, whereby we engaged to give certain scholarships and prizes to such of their students as were reported by the Inspectors of Schools charged with the conduct of the examinations to be worthy of those distinctions. Then, further, we entered into arrangements in 1888, with the directing Delegates of the Oxford University Extension Lectures, by which we agreed to give, on certain conditions, a yearly grant of £60, in aid of geographical teaching. We have resolved to set on foot regular courses of geographical lectures in London, which will commence probably next November, and be given by Mr. Mackinder and other competent geographers.

"Our very latest measures for the improvement of geographical education have been :—

"1. To agree to some modifications in the distribution of the prizes to the training colleges which the officers of the Education Department advised, and which will better promote the object which the Society has in view.

"2. To co-operate with the Manchester Geographical Society in assisting the governing body of the Victoria University to introduce geographical teaching into the curriculum by making a substantial grant for that purpose.

"3. To award a travelling scholarship of £100—our share being £50—after an examination held at Oxford. This was gained by a young man, Mr. Grundy, who was bound, under the conditions prescribed, to travel for at least three months in one of a number of districts from which he might take his choice, and communicate the results to us. He has selected Bœotia, and will, I make no doubt, furnish the Society ere long with some valuable information.

"We continue the prizes given at the Oxford and Cambridge local examinations, and to the boys of the training ships. These belong to the same period of our history as the Public School medals, but with them we have been more successful. We are in correspondence with the Scotch Education Department as to the best method of further encouraging geographical study on the other side of the Tweed, where it has long been comparatively popular.

"It seems to me quite certain that this part of our activity will fill a larger and larger space in the thoughts of all of us for a long time to come. The day will arrive when it will be of very little importance. Common-sense has a way of conquering in the end, and the proposition that it is highly desirable for intelligent creatures inhabiting this planet to have a good general notion of the opportunities which it affords them is so self-evident, that one would think it did not require a very numerous and powerful Society to urge its general acceptance upon the scholastic world.

"Geography and history are relegated to a subordinate place in almost all our schools which consider themselves to belong to the first or second rank, while the utmost prominence is given, not to reading the classics, to getting thoroughly imbued with classical ideas, and to having the mind filled with whatever of good and great the ancient world has bequeathed to us, but largely to accomplishments in the way of turning out pretty pieces of verse or prose, in the ancient tongues, which bear much the same relations to serious intellectual pursuits as do to the proper works and ways of an intelligent dog the art of jumping through a hoop filled with paper, or that of balancing on his nose a piece of biscuit till he is told that it is 'paid for.' Educators who have given the best years of their lives to these accomplishments naturally abhor the idea of diminishing their importance, and when they are asked to find a reasonable place for history and geography in their schools they piteously point to their time-tables and say, 'How are we to manage it?' Manage it by the elimination of rubbish. Put composition in the ancient tongues as a piece of regular 'school business' behind the fire, and greatly diminish the amount of time given to learning by heart in the interest of Latin and Greek composition. Neither geography nor history will ever obtain their proper position in education until we can get rid of the superstition as distinguished from the religion of the classics. No reasonable man who has a competent acquaintance with the subject can tolerate the idea of the classics being neglected. They form a most important part, and must always continue to form a most important part of literature, and literature is for a large class of minds a most excellent training. For a great many minds, however, it is not an excellent training, and to a considerable proportion of those susceptible of being trained by it the ancient languages present no attractions. I maintain that for a great many minds geography and history, well and carefully taught, would be much more educative than the two studies which as late as the time at which I took my degree, not quite forty-two years ago, almost absolutely monopolized attention in Oxford and Cambridge. Then, too, we must remember that while for everybody classics are mainly educative, and in a much less degree instructive, and while mathematics are instructive in a high degree only to those who are going into any of the no doubt numerous careers for which they are essential, geography and history are instructive in a very high degree to all, even to those to whom they are not educative.

"What I think we as a Society should keep chiefly in view is to try to have a clear and connected account of the leading facts which are known about the theatre of man's activity, together with an intelligent idea of the leading causes which have brought those facts about very much more widely extended through all ranks than they are now. We must keep our aims moderate in geography. There are undeniably a few persons to whom both geography and history, teach them as you will, are thoroughly abhorrent. Well, teach the very minimum of them to such people. A large number of people can be cultivated, and very highly cultivated, better through geography and history than anything else. All I ask for is, that in the education of such people these two sciences should play a very much larger part than they do now. I think that if we could see some thoroughly good hand-book of physical geography and another of political and commercial geography made part of the teaching of all secondary schools, and a subject of the leaving examination which should be borrowed from Germany, if we continue to hold up as we are doing at Oxford, and elsewhere, a very high standard of professorial teaching in our subject, while we at the same time persist in the other lines of educational activity to which I have alluded, we should have done a good deal ; but it is far from improbable that we may ere long see our way to giving further stimulus to sound geographical teaching in various parts of the country. The Society, however, may be assured that we will remember the maxim *Festina lente*, and not waste the resources with which its members supply us in any rash experiments. Geography is rooted in the physical sciences, and makes each of them tributary to her, while history which is not rooted in geography, and which does not learn from geography all it has to teach about the existing conditions of man's dwelling-place, is simply bad history."

The President then referred to the year's exploration. Herr Merzbacher's work in the Caucasus, and Mr. Howell's ascent of Oræfa Jökull in Iceland, were noticed as the chief mountaineering feats. In Asia military exploration had gone on steadily on the northern frontiers, and the Society was making efforts to have the results of such work made more accessible to the public. Lord Lamington's journey in the Shan States, Captain Bower's and Dr. Thorold's adventurous crossing of Tibet also opened up new ground. In Africa Mr. E. A. Floyer crossed the Egyptian Desert from Assouan to the Red Sea ; and in the region of the Great Lakes Captain Lugard, Emin Pasha, Dr. Stuhlman, and the late Father Schynse have added to our knowledge. The Italians have been energetic in exploring Somali-land, and the French, despite the disaster to M. Crampel, have not abandoned their efforts to reach Lake Chad from the west. Captain Gallwey and Mr. Gilbert T. Carter have made important discoveries in Lagos and Benin. Mr. Bent's well-known exploration of Zimbabwe, and Mr. Joseph Thomson's study of Lake Bangweola, which ill-health still prevents him from recording, are the most important pieces of work in South Africa.

The semi-Arctic regions of Labrador and Alaska have received much attention in America, and their topography is being more definitely ascertained.

In Australia the Elder expedition has unfortunately collapsed,

after doing much good work, but Sir William MacGregor has been very active in opening up British New Guinea.

Reference was also made to the progress of the hydrographic surveys in different parts of the world.

In the evening the anniversary dinner of the Society took place at the Whitehall Rooms, Hôtel Métropole, and was attended by a large gathering of Fellows, with many of the leading scientific men and members of the Diplomatic Service as guests. The President occupied the chair. A clever speech was delivered by Mr. Whymper, in response to the toast of "The Medallists." Mr. Bryce, Colonel Maurice, Prof. Flower, Mr. W. T. Thiselton Dyer, and Mr. Norman Lockyer responded to the toast of "The Allied Sciences and Sister Departments."

TRANSFORMERS.[1]

ALTHOUGH transformers are in constant use for changing alternating currents of electricity from high to low or from low to high potential, exact calculations concerning them have hitherto been looked upon by scientific men as impossible because of the complicated law of magnetization which must subsist in iron. Calculations on the assumption of constant magnetic permeability were thought to be worthless, therefore, although these were the only ones which could be made. Certain graphical methods of representing what occurred were, however, based upon the constant permeability hypothesis, and although such graphical methods could only be useful in illustrative work, they were thought to be accurate enough when great accuracy was impossible. The absence of a theory was supplied by vague statements regarding the effects of hysteresis; and the cycle of magnetization being supposed to be exactly the same, however rapidly performed, and Foucault currents being ignored, it was possible for any writer to get his literature on this subject published and read and commented upon.

Prof. Perry has for a long time preached the doctrine that the only theory of the transformer that can be carefully worked out—namely, that in which hysteresis is ignored—ought to be worked out and compared with experimental results; and he insisted that when the known phenomena of magnetic leakage and slight saturation and Foucault currents are taken into account, the results of this theory explain all observed experimental results.

In the present paper he takes up the general case of a transformer with many primary and secondary circuits with magnetic leakage, Foucault currents, choking coils and condensers in series with or in parallel to any or all the circuits. He clears away much of the old difficulty by proving that, in all calculations except that of the idle current supplied to an unloaded transformer, in all practical cases, exactly the same answers are obtained, to four significant figures or more, whether we assume the most complicated of hysteresis cycles or whether we assume the very simplest, which is that of constant permeability. It is, for example, interesting to observe that a formula never hitherto published as correct, often enough used by manufacturers as sufficiently correct for practical purposes, is really a very correct formula. It is also shown that the mathematical difficulties introduced by condensers and magnetic leakage efface themselves completely now that the complete problem has been attacked, and that the numerical working out of the most complicated cases is a very simple matter.

The one problem on transformers in which it is necessary to consider the law of magnetization of the iron—namely, the calculation of the idle current when the transformer is unloaded—is solved by the author in general terms, and he gives a simpler solution, which in his opinion agrees with all experimental results, although it assumes that there is no hysteresis in the iron.

SCIENTIFIC SERIALS.

THE only important paper in the *Nuovo Giornale Botanico Italiano* for April is an elaborate one by Signor G. Paoletti on the movements of the leaves of *Porlieria hygrometrica*. The structure of the plant is described in detail, and especially the anatomy of the "motor nodes" of the leaves and of the leaflets. He distinguishes in them two kinds of tissue, a motor system and a passive system. The cause of the movements appears to reside in the protoplasm and in the osmotic properties of the cell-sap. The author is unable to find in the leaves any hygrometric properties, the supposed presence of which was the reason for the specific name of the plant. The paper is illustrated by four plates.

THE greater number of the papers in the 2nd, 3rd, and 4th numbers of the *Bullettino della Società Botanica Italiana* for 1892 are chiefly of local interest to Italian botanists. Among those of a wider scope are the following:—Signor L. Macchiati describes an appearance presented by *Navicula elliptica*, which he considers strongly to confirm Castracane's view of the occasional reproduction of diatoms by internal germs.—Signor P. Pichi gives the results of experiments on the power of the vine to absorp sulphate of copper through the roots as a specific against the attacks of *Peronospora*. Analysis of the ash showed the presence of copper in leaves taken from both the upper and the lower branches.—Signor L. Piccioli gives some details respecting the destruction of plants by different kinds of land and freshwater snails, with the amount which is devoured of different plants. This is generally greater in the spring than in the summer.

IN the *Botanical Gazette* for April, Mr. G. E. Stone describes and figures a self-registering auxanometer, which can be readily constructed, of much simpler construction than those at present in use in botanical laboratories.—Mr. Conway Macmillan offers suggestions as to the classification of the Metaphyta, *i.e.* of the higher forms of vegetable life.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"On some Phenomena connected with Cloudy Condensation." By John Aitken, F.R.S., F.R.S.E.

This paper is divided into two parts. In Part I. are described the different influences which cause the condensation of a jet of steam when mixing with ordinary air to become more dense than it generally is, and in Part II. certain colour phenomena are described which have been observed when cloudy condensation is made to take place under certain conditions.

PART I.

Steam Jets.

It had been previously shown that when a jet of steam is electrified the condensation suddenly becomes very dense. In addition to electrification, it is found that this change in the appearance of the jet may be produced by other four causes. There are thus five influences capable of producing the dense form of condensation. These are: 1st, electricity; 2nd, a large number of dust particles in the air; 3rd, cold or low temperature of the air; 4th, high pressure of the steam; and, 5th, obstructions in front of the nozzle, and rough or irregular nozzles.

1st. *Electrification.*

It is shown that the mere presence of an electrified body has no influence on the steam jet. In order to produce the increased density the water particles in the jet must be electrified, either by direct discharge, or by an inductive discharge, effected by means either of a point or a flame.

The increased density produced by electrification is due to an increase in the number of water particles in the jet, by the electrification preventing the small drops coming into contact by their mutual repulsions, in the same manner as the water drops in Lord Rayleigh's experiments with water jets, which scatter more when electrified than when not electrified. The coalescence of the drops in water jets takes place only under the disturbance produced by the presence of an electrified body, while such a disturbance produces no effect on steam jets.

Other experiments point to the conclusion that the increase in the density is due to an increase in the number, and not to an increase in the size, of the drops. For instance, if steam is blown into a receiver full of air in which there are many nuclei, the condensation is dense, and, if there are few nuclei, the clouding is thin. The same holds good for the clouding produced by expanding moist air. If many dust particles be present, the clouding is dense; if few, it is thin. The action of the electricity does not seem to be positive, as it has no effect on a mixture of hot moist air and cold air. It seems rather to

[1] Abstract of a paper read at the Royal Society, May 12, by Prof. Perry, D.Sc., F.R.S.

prevent something which takes place in the jet under ordinary conditions. The particles in a jet being in rapid movement, there are frequent collisions, and consequent coalescence of the drops, but when the particles are electrified they repel each other, and coalescence is prevented.

The jet on becoming dense emits a peculiar sound, which is the same whatever be the cause of the increased density. But, when electrified, along with this sound there is another, due to the discharge of the electricity, which causes the electrified jet to appear to make a louder noise. The jet, instead of changing suddenly in appearance when electrified, may be made to change very gradually, either by electrifying it by means of a very sharp point, or by aiding the discharge by a flame. Under these conditions, the jet emits only the sound produced when dense from any of the other causes.

2nd. *A Large Number of Dust Particles in the Air.*

Flame has not been found to have any influence on the steam jet, but on bringing the products of combustion to the jet, it at once becomes dense, and remains dense so long as the supply is kept up, and the jet has exactly the same appearance as if electrified. When in this condition electricity does not increase its density any further. The increased density is here due to the large number of dust nuclei, causing a great increase in the number of water drops, and these being very small, they will have less independent movement, and therefore fewer collisions, and the reduction in number from this cause will therefore be very slight.

3rd. *Low Temperature of the Air.*

When a steam jet condenses in air at ordinary temperatures it has but little density, but, if the open end of a metal tube cooled to 45° be held near the origin of the jet, the condensation at once becomes dense, and neither electrification nor an increased supply of nuclei makes it any denser. In a room at a temperature of 46° the jet is always dense, and neither electricity nor the products of combustion have any effect on it, but when the temperature rises to 47° the jet begins to get a little less dense, and electricity now increases its density slightly. At 50° the jet is much thinner, and both electricity and the products of combustion have a marked effect on it. The change produced by the cold air cannot be entirely due to the lower temperature causing more vapour to be condensed, as the fall of temperature is slight, while the increase in density is great. The increased density is shown to be due to a change which takes place in the films of the small drops with the fall of temperature. When the temperature is above a certain point, the films have no repulsive action, and the drops coalesce on collision; whereas when cooled below a certain temperature the well-known repulsion comes into play and prevents coalescence. This was proved by repeating Lord Rayleigh's experiments with water jets. When the temperature of the water was over 160°, the drops had no tendency to scatter, and the presence of an electrified body had no influence on the jet. It was only when the temperature fell that the scattering began, and the electrical disturbance produced coalescence. The effect of the low temperature is the same as that of electrification: both of them prevent the water drops coming into contact, one by electrical repulsion, and the other by the repulsive action of the water films, and the result is the same—namely, an increase, or rather a prevention of the decrease, in the number of the particles, and a consequent increase in the density of the clouding.

4th. *High Pressure of the Steam.*

Below a temperature of 46° the jet is dense at all pressures, and as the temperature rises the density decreases, but the density may be made to return by increasing the pressure. The increased density of the high-pressure steam jet is due to an increase in the number of drops produced, (1) by the jet being more cooled by the greater amount of air taken into it; (2) by a larger supply of dust nuclei; and (3) owing to the rate at which the condensation is made to take place, a larger number of dust particles are forced to become centres of condensation.

5th. *Rough Nozzles and Obstruction in Front of the Nozzle.*

Rough nozzles and obstruction in front of the nozzle are found to act in the same way as increase of pressure: they aid pressure in producing its effects with a less velocity of steam. They act by producing eddies, which mix more air with the steam, so lowering the temperature of the jet, increasing the number of dust nuclei, and quickening the rate of condensation.

The seat of sensitiveness to all these influences causing the condensation in the jet to become dense is near the nozzle. Both low temperature and obstructions have an effect only when they act very close to the nozzle; while electricity and increase in number of nuclei have a slight, but rapidly diminishing, influence to a distance of 3 or 4 cm. from the nozzle.

PART II.

Colour Phenomena connected with Cloudy Condensation.

The manner in which cloudy condensation changes after it is formed is pointed out, and it is also shown that the number of dust particles which become centres of condensation depends on the rate at which the condensation is made to take place, slow condensation producing few water particles and thin clouding, while quick condensation produces a large number of water particles and dense clouding. It is only when the dust particles are few that all of them become active centres of condensation.

Colour Phenomena in Steam Jets.

Colour has been seen by Principal Forbes and others in the steam escaping from engine boilers, but these colour phenomena have as yet been but little studied. For observing the colour in steam jets, the author has found it to be a great advantage to inclose the jet in a tube, and examine the effect through some length of condensing steam. Steam by itself has no colour in moderate lengths, but when mixed with a certain amount of cold air, and a certain quantity of dust, very beautiful colours are produced. A jet of steam is allowed to blow into the open end of a tube, and the amount of dusty air entering with it is regulated to the necessary amount. When the jet is condensing under ordinary conditions, the colour of the transmitted light varies from greens to blues of various depths, according to the conditions. The colour may be made very pale or extremely deep by varying the conditions. If the condensation in the jet be made to change and become dense by any of the influences already mentioned, the colour changes, and generally becomes of a yellowish-brown.

This yellow colour, seen through steam when the jet is electrified, has been previously observed. It was thought that the colour was due to the electricity, and that the experiment explained the lurid colour of thunder-clouds. There does not, however, seem to be any connection between the electrification and the colour, as the transmitted light becomes of the same lurid hue when the jet is made dense by any of the other influences.

The yellow colours seen through steam are not generally so fine as the greens and blues, but when the density is due to high-pressure steam the yellow is very fine.

Colours in Cloudy Condensation produced by Expansion.

No colours had been previously seen in the light transmitted directly through the clouded air produced by expanding saturated air in a receiver. It was thought this was due to the slowness with which this process is generally made to take place in the expansion experiments. On arranging an experiment to make the rate of condensation quick, beautiful colours were seen on looking through the clouded air. An air pump was connected with a metal tube provided with glass ends. The capacity of the tube was small compared with the capacity of the receivers usually used in these experiments. When the air in the tube was suddenly expanded, the light passing through it became beautifully coloured, and the colour, and the depth of the colour, varied with the conditions. With few dust particles in the air, a slight expansion made the transmitted light blue; a greater expansion changed it to green, and then to yellow; and when the expansion was still further increased the colour changed, and a second blue made its appearance, followed by a second green and yellow. But, if very many particles were present, the same amount of expansion which produced the second yellow only gave a very deep blue. When it is desired to produce these colour phenomena on a large scale a vacuum receiver is used. This receiver is connected with the experimental tube or flask by means of a pipe fitted with a stop-cock. After a partial vacuum has been made in the receiver, the connection between it and the flask or tube in which the colours are to be shown is suddenly opened, when the colour-producing condensation is produced. These colour phenomena fade

rapidly, owing to the differentiation which takes place in the water drops.

The spectroscope shows that when the light is blue there is a general darkening of the whole spectrum, but the absorption is greatest in the red end, and the red end is also much shortened. When the transmitted light was yellow, the blue end was cut out, and the yellow part was much the brightest.

The Cause of the Colour.

In the steam jet when the condensation is dense some of the yellow colour in the transmitted light is due to some of the particles being so small that they reflect and scatter the blue rays. This blue reflected light is polarized. The colours, however, seem in most cases to be produced in the same manner as the colours in thin plates; only a few of the colours of the first order or spectrum are visible, whilst those of the second and third orders are very distinct.

A "Green" or "Blue" Sun.

It is thought that these phenomena give the explanation of the "green" or "blue" sun seen in India and elsewhere in September, 1883, and also on other occasions. The eruption of Krakatão had taken place a few days before the green sun was observed in India. The volcano threw into our atmosphere a great quantity of water vapour, and a vast amount of dust, the very materials necessary for producing a green sun by small drops of water. Prof. C. Michie Smith's observations made in India show that there was a great amount of vapour present in our atmosphere at the time, and most observers frequently refer to a fine form of haze which covered the sky on the days the green sun was seen. It is therefore in the highest degree probable that, under the conditions existing at the time, this haze was greatly composed of water.

A New Instrument for Detecting Dust-polluted Air.

The colour phenomena produced when air is suddenly expanded has led to the construction of a new instrument for indicating roughly the amount of dusty pollution in the air. This instrument has been called a "koniscope," and it is hoped it will be found useful for studying sanitary questions. The instrument consists simply of an air pump and a tube provided with glass ends. The air to be tested is drawn into the tube, where it is moistened and expanded. The depth of colour seen on looking through the tube indicates the amount of impurity in the air. With about 80,000 particles of dust per cubic centimetre the colour is very faint; 1,500,000 gives a fine blue; while 4,000,000 gives an extremely dark blue. These colours are for an instrument having a tube half a metre long. By means of this instrument it is easy to trace the pollution taking place in our rooms by open flames and other causes. We can trace by means of it the pure and impure currents in the room, and note the rate at which the impurity varies.

May 5.—"The Potential of an Anchor Ring." By F. W. Dyson, Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

In this paper the author develops a method of dealing with physical questions connected with anchor rings. He applies it

(1) To find the potential of a solid anchor ring at all external points. The result is obtained in a very convergent series of integrals, each of which may be reduced to elliptic functions. The equipotential surfaces are drawn, when the ratio of the radius of the generating circle to the mean circle of the ring is $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, 1.

(2) The density, at any point, of a ring charged with electricity is found; and the charge is calculated.

(3) The velocity potential of a ring moving in an infinite fluid is found, the kinetic energy calculated, and a few cases of motion discussed.

(4) The annular form of rotating fluid is considered, and the form of the cross-section determined. The cross-section even for large rings is, roughly, of an elliptic shape; the minor axis being parallel to the axis of revolution of the annulus.

May 12.—"On the Embryology of *Angiopteris evecta*, Hoffm." By J. Bretland Farmer, M.A., Fellow of Magdalen College, Oxford. Communicated by S. H. Vines, M.A., F.R.S.

The germination of the spore and the development of the prothallium have been described by Jonkman,[1] who also observed the formation of the sexual organs. The antheridium is formed from a superficial cell of the prothallium, which divides by a wall, parallel to the surface, into an outer shallow cell and an inner cubical cell. The former, by walls at right angles to the free surface, gives rise to the cover-cells; while the inner one, by successive bipartitions, originates the antherozoid mother-cells.

The antheridia are distributed both on the upper and lower surfaces of the prothallium, and apparently without any approach to regularity, though they are somewhat more frequent on the lower surface. I may observe, however, that an antheridium may often occur on the upper surface immediately above an archegonium which has been fertilized.

The archegonia occur exclusively on the lower surface. Their development has been described by Jonkman, who also noticed the division of the neck canal cell, by a transverse wall, into two cells. The division is not, however, invariable, and in one preparation in which the protoplasm had shrunk slightly from the wall, I observed that the cell plate had not extended so as to completely partition the neck passage into two cells.

The oospore, after fertilization, speedily forms an ovoid cellular body, and although I was not so fortunate, owing to scarcity of material, as to see the formation of the earliest cell walls, their succession could be determined with tolerable certainty in the youngest embryo that I met with, consisting as it did of about ten cells.

The basal wall is formed, as in *Isoëtes*, at right angles to the axis of the archegonium. The next one in order of occurrence I believe to be the median wall, which can easily be distinguished, even in advanced embryos, as a well-defined vertical line.

The tranverse wall is much more indefinite, and early loses its individuality owing to the unequal growth of the various parts of the young embryo. The further cell-division is irregular, and to a far greater extent than is the case with the leptosporangiate ferns as described by Hofmeister and Leitgeb.

The anterior epibasal octants together give rise to the cotyledon; the stem-apex is formed, not as in the leptosporangiate ferns, from *one* octant only, but from *both* of the posterior epibasal octants, though one of them contributes the greater portion. The truth of this statement is seen on examining vertical sections through the embryo cut at right angles to the median wall, when a few cells on each side are seen to be clearly marked out, by their dense protoplasmic contents and large nuclei, as meristem cells. There is no single apical cell in *Angiopteris* from which all the later stem tissue is derived, and this fact is, without doubt, to be connected with the character of the apical meristem just described. The root is formed from one of the octants beneath the cotyledon, *i.e.* from an anterior hypobasal one, and is at first indicated by a triangular apical cell, which, in one fortunate preparation, showed the first cap cell. The other octant, together with the two posterior hypobasal octants (which together form the rudimentary foot), round off the base of the embryo. The root presents considerable difficulty in tracing the course of its development, as the apical cell, at no time very clear, is early replaced by two cells. Moreover, the root grows in a somewhat sinuous manner in the embryo, and the cells of its apex may easily be confounded with other triangular cells which occur irregularly scattered in the lower portion of the embryo. It finally emerges, not immediately beneath, nor yet exactly opposite, the cotyledon, but at a distance from it of between one-third and one-half of the circumference of the embryo. The difficulties attending the exact following of its growth, added to the scarcity of the material, have prevented my elucidating completely the details of development, but the important point, that, even before its emergence from the embryo, its apex contains a *group* of initial cells, occupying the place of the single one characteristic of other orders of ferns, can be regarded as established with certainty.

When the embryo has reached a certain size, it bursts through the prothallium; the root boring through below, whilst the cotyledon and stem grow through the upper surface. This manner of issuing from the prothallium at once serves to distinguish *Angiopteris* from those other ferns whose embryogeny is known, and probably the peculiarity of its growth may be reasonably connected with the direction and position of the basal wall which separates the root and short portions of the embryo.

Fresh leaves and roots speedily arise on the young plantlet the second leaf appearing just above the place of exit of the first root—that is, not quite opposite the first leaf. The third leaf rises between the first and second ones, and nearer the first than the second. Their roots observe the same rule of divergence as

[1] "De geslachtsgeneratie der Marattiaceeën," door H. F. Jonkman.

that which obtains in the case of the first root. The stipular structures, so characteristic of the Marattiaceæ, are entirely absent from the first two leaves, but appear in a well-developed condition on the third and all succeeding leaves.

"On the Shoulder-girdle in Ichthyosauria and Sauropterygia." By J. W. Hulke, F.R.S.

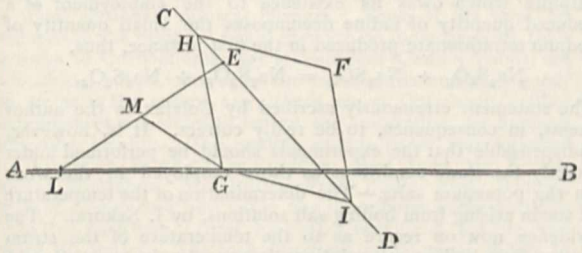
The author discusses the structure of the shoulder-girdle and the homologies of its several parts in these families. He shows that the alleged existence of a precoracoid in the Ichthyosauria rests on an insufficient foundation; offers proofs that in Plesiosauria the anterior ventral ray is not only theoretically but *actually* precoracoid; and also that the dorsal ray in the girdle *is* homologous with the shoulder-blade in Testudinata and other Reptilia.

"On the Development of the Stigmata in Ascidians." By Walter Garstang, M.A.

The author shows that the transverse rows of stigmata, which are present in all the fixed Ascidians, may arise in one or the other of two ways: either as independent perforations, distinct from the first (oozooid of *Clavelina*, buds of *Botryllus*); or as secondary formations, due to the subdivision of a series of primary transverse stigmata on each side (oozooid of *Botryllus*, *Styelinæ*). The former method of development is shown to be a modification of the latter.

The primary transverse stigmata (or "protostigmata") of *Botryllus* and the *Styelinæ* agree precisely with the definitive stigmata of *Pyrosoma* in structure, position, and order of formation. They are accordingly regarded as homologous formations; and the conclusion is drawn that *Pyrosoma* has not been derived from the fixed Ascidians, but represents an ancestral type of Caducichordate Tunicata, antecedent to the whole of the phylum Ascidiacea.

Physical Society, May 13.—Dr. E. Atkinson, Treasurer, in the chair.—Mr. R. Inwards read a paper on an instrument for drawing parabolas. It was designed for drawing curves of short focus such as are required for reflectors and for diagrams of the paths of comets and projectiles. Its construction is based on the fundamental property that every point on the curve is equidistant from the focus and the directrix. In the diagram below, AB is a slot representing the directrix, and FGHI



a rhombus jointed at the corners and pivoted at F, whilst CD indicates a bar capable of sliding through guides at H and I. A rod, LE, is coupled to G by a bar, GM, such that the lengths LM, ME, and MG are equal. As L and G slide along AB, the point E describes a parabola whose latus rectum depends on the distance of F from AB. In the instrument F is carried by a slotted arm so that its position is adjustable. GE is always perpendicular to AB and equal to EF. Prof. Boys inquired whether the instrument could be modified to draw any conic section by arranging that the ratio of EF to EG instead of being unity, might be greater or less than unity. Prof. Perry said an instrument for drawing curves represented by the equation $y = x^n$ was greatly needed for engineering work.—Mr. F. H. Nalder exhibited and described some electrical instruments. The first shown was a ballistic galvanometer with one pair of coils, the distinguishing features of which were accessibility, small damping, great sensitiveness, and the arrangement of the control. The control is effected by a "tail magnet" carried on a horizontal tube supported by a pillar outside the case, as suggested by Prof. R. M. Walmsley. A small magnet on the cover serves for zero adjustment. The suspended system consists of four bell magnets, two being in the middle of the coil and one at top and bottom respectively, arranged so as to be astatic. The sensitiveness of the instrument shown was such that $\frac{1}{4}$ of a microcoulomb gave 300 divisions (fortieths of an inch) when the periodic time was 10 seconds and scale distance about 3 feet. Resistance of galvanometer about 10,000 ohms. To bring the needle to rest quickly, a damping coil mounted on an adjustable stand, and a special reversing key with resistances in its base, are provided. The key has successive contacts arranged so that when pressed lightly, only a weak current passes round the damping coil, whilst when pressed further a much stronger current passes. The strong currents are used to check the large elongations, and the weak ones for finally bringing to zero. A lamp-stand with semi-transparent scale arranged for use with a glow lamp was next shown. Instead of reading by the image of the filament, as is ordinarily done, the lantern is arranged to give a bright disk of light with a black line across the middle. Mr. Blakesley asked if the galvanometer was astatic. For damping non-astatic ones he had found it useful to wind several turns of wire round the bobbin, and put them in series with a few thermo-electric junctions warmed by the hand and a key. In reply, Mr. Nalder said the galvanometer was astatic, but the damping coil could be placed so as to act on one pair of magnets more than on the other. A paper on a portable instrument for measuring magnetic fields, with some observations on the strength of the stray fields of dynamos, by Mr. E. Edgar and Mr. H. Stansfield, was then read. The instrument was described as an inversion of a d'Arsonval galvanometer, for the torque necessary to maintain a suspended coil conveying a constant current parallel to the field gives a measure of the strength of the field. The constant current is furnished by a Hellensen's dry cell which the authors found remarkably constant. The instrument consists of a coil of about fifty ohms, wound on mica and suspended by two German silver strips within a tube. A pointer is fixed to the mica, and a divided head, to which the outer end of one strip is attached, serves to measure the torsion. Within the head chamber is a commutator which automatically reverses the current in the coil when the head is turned in opposite directions from zero. Two readings may thus be taken to eliminate gravity errors due to want of perfect balance in the coil. Means are provided for adjusting and measuring the tension of the suspensions. The constant of the instrument was determined by placing the coil in the field of a Helmholtz galvanometer, and found to be 0·293 per 1°. Any other field is therefore given by $0{\cdot}293\ (n + 1)\theta$, where θ is the angle of torsion in degrees, and n the multiple of 50 ohms in series with the coil. Fields from 2 or 3 C.G.S. lines upwards can be measured to about 2 per cent. by the instrument, and even the earth's field is appreciable. The authors have tested the fields of dynamos at the Crystal Palace Exhibition and elsewhere, and the results obtained are given in the paper. It is noted that the stray fields of multipolar machines fall off much more rapidly than those of two-pole dynamos as the distances are increased, and that near edges and corners of the magnets the fields are much stronger than near flat surfaces. The disturbing effect of armature reactions on the strength of the stray fields were measured, and the shapes of the fields observed in some cases. Experiments on magnetized watches are described in the paper. Mr. Whipple said the Kew Committee were to some extent responsible for the experiments described, for it was on their account that the investigations were commenced. In connection with the rating of so-called non-magnetic watches, it was necessary to know what strength of fields they were likely to be subjected to. The instrument devised for making the tests was a very interesting one, and the results obtained by it of great value. Mr. A. P. Trotter hoped the authors would supplement their work by tracing out the directions of the fields of dynamos, and he described a simple method of doing this by a test needle used as an india-rubber stamp. The question of watches, he thought, must be considered soon; even non-magnetic watches were stopped by being placed in strong fields, owing to Foucault currents generated in the moving parts. Mr. Blakesley inquired whether the instrument could be used in any position. He thought three observations would be necessary to completely determine any field. Mr. Stansfield, in reply, said they used a pilot needle for showing the directions of the fields, and then placed the coil accordingly. The instrument could be used in any position, for the weight of the coil was only about 2 grammes, and did not greatly alter the tension of the suspensions, which was usually about 300 grammes. A watch with a brass balance was not influenced by a field of 10 C.G.S. lines but seriously affected by one of 40.—Mr. Joseph W. Lovibond read a paper on a unit of measurement of light and colour. The paper was illustrated by many coloured charts, diagrams, and models, and several pieces of apparatus by which colour measurements could

be made were shown. The principle of the measurements depends on the selective absorption of the constituents of normal white light by coloured glasses (red, yellow, and blue). The depths of tint of the glasses are carefully graduated to give absorptions in numerical proportions. For example, two equal glasses, each called one-unit red, give the same absorption as a two-unit red, and so on. The units of red, yellow, and blue are so chosen that a combination of one of each absorb white light without colouring the transmitted light. Such a combination is called a "neutral tint unit." By the use of successive neutral tint units, white light can be gradually absorbed without showing traces of colour, and the number of such units required to produce complete absorption is taken as a measure of the intensity or luminosity of the white light. Methods of representing colours by circles and charts were fully dealt with, and the influence of time of observation on the penetrability of different colours was illustrated by diagrams. The results of 151 experiments on colour mixture were explained, and represented diagrammatically. After the reading of the paper the methods used for colour matching and measurement were shown by Mr. and Miss Lovibond.—Mr. R. W. Paul exhibited his improved form of Wheatstone bridge, arranged to occupy the same space, and fulfil the same conditions, as the well-known Post Office pattern.

Chemical Society, April 21.—Prof. A. Crum Brown, F.R.S., President, in the chair.—The following paper was read:—Masrite, a new Egyptian mineral, and the possible occurrence of a new element therein, by H. D. Richmond and Hussein Off. Masrite is the name assigned by the authors to a variety of fibrous alum obtained in Egypt by S. E. Johnson Pasha. It contains from 1 to nearly 4 per cent. of cobalt. This being the first occasion on which cobalt has been met with in Egypt, the authors were led to inquire whether the blue colour used in the paintings on Egyptian monuments contained that element. The samples obtained, however, owed their colour to compounds of copper and iron. The mineral is principally interesting on account of the presence in it of a minute quantity of a substance, the properties of which appear to be unlike those of any known element, which the authors provisionally term masrium, from the Arabic name for Egypt. From an analysis of the oxalate, on the assumption that it is a bivalent element, the atomic weight of masrium is calculated to be 228. The authors point out that there is a vacant place in the glucinum-calcium group of the periodic system for an element having the atomic weight 225. In many of its properties masrium resembles glucinum, and the oxalate is analogous to that of calcium. Masrite has the composition

$$(Al,Fe)_2O_3, (Ms,Mn,Co,Fe)O, 4SO_3, 20OH_2.$$

May 5.—Prof. A. Crum Brown, F.R.S., President, in the chair.—An extract was read from a letter to Sir H. E. Roscoe, written by Prof. Kühne, of Heidelberg, at the request of Prof. Bunsen, expressing his thanks for the address presented to him by the Chemical Society.—The following papers were read:—The existence of two acetaldoximes, by W. R. Dunstan and T. S. Dymond. Acetaldoxime, $CH_3 . CH : NOH$, has hitherto been regarded as a liquid capable of existing in only one form, attempts to obtain evidence of the existence of an isomeride having failed; the authors, however, find that it can be crystallized by cooling. The crystals so obtained are often several inches in length, and melt at 46°·5. On heating them to 100°–150° no decomposition occurs, and the substance boils constantly at 114°·5. If this heated liquid be now cooled, it does not crystallize until nearly 35° below the melting-point of the original substance, and the crystals so obtained become liquid at ordinary temperatures. Many similar observations have been made, and it has been invariably found that on heating the aldoxime the freezing-point is lowered to a greater or less extent. Evidence has in this way been accumulated, showing that a change in the constitution of acetaldoxime occurs when it is heated, the original substance, melting at 46°·5, being gradually converted into a new modification, which melts at 12°. It is noteworthy that the acetaldoxime melting at 12° is slowly reconverted into that melting at 46°·5 on standing at ordinary temperatures. The authors term the substance melting at 46°·5 α-acetaldoxime, that melting at 12° being named β-acetaldoxime. —Sulphonic acids derived from anisoils (No. i.), by G. T. Moody. The author finds that contrary to the statement of Kekulé, and of Opl and Lippmann, anisoil and phenetoil afford only parasulphonic acids on sulphonation. Carefully purified anisoil was dissolved in concentrated sulphuric acid, and the product poured into water, when part of the anisoil was liberated, showing that as in the case of phenol an intermediate compound is formed before the sulphonic acid. The anisoil thus set free was treated with strong sulphuric acid at 80°, when complete sulphonation occurred. The solution yields a well-defined calcium salt; no indications of the presence of an isomeride were found. The calcium, potassium, and sodium salts of the anisoil parasulphonic acid obtained in this way are described, together with the sulphochloride and sulphonamide. Pure phenetoil similarly is shown to yield only the parasulphonic acid. The products of sulphonation, either with sulphuric acid or with chlorosulphonic acid, are in both cases the same, only one sulphonic acid resulting.—The formation of trithionate by the action of iodine on a mixture of sulphite and thiosulphate, by W. Spring. In his paper on the investigation of the change proceeding in an acidified solution of sodium thiosulphate, Colefax credits the author with having stated that trithionate of sodium is produced when iodine acts on a mixture of sodium sulphite and thiosulphate, and further denies that this is the case. The author used potassium salts, and not sodium salts, but, owing to an error in the abstract of Spring's original paper, Colefax was led to believe that sodium salts were used. The difference in the behaviour of the potassium and sodium salts is very striking, and arises from the greater instability of the sodium polythionates already pointed out by the author. Another difference between the two sets of experiments is found in the employment by Colefax of a larger proportion of iodine than that used by the author. The equation

$$K_2SO_3 + K_2S_2O_3 + I_2 = K_2S_3O_6 + 2\,KI$$

requires less iodine than would be necessary to oxidize the sulphite to sulphate, and the hyposulphite to tetrathionate of sodium. The author does not, however, contend that the formation of trithionate takes place in accordance with the equation

$$Na_2S_2O_3 + Na_2SO_3 + I_2 = Na_2S_3O_6 + 2NaI.$$

He is convinced that sulphites have the property of desulphurising the tetrathionates, so as to convert them into trithionates. It would hence be more consistent to admit that the sodium sulphite which owes its existence to the employment of a reduced quantity of iodine decomposes the small quantity of sodium tetrathionate produced in the first instance, thus,

$$Na_2S_4O_6 + Na_2SO_3 = Na_2S_3O_6 + Na_2S_2O_3.$$

The statement erroneously ascribed by Colefax to the author seems, in consequence, to be really correct. It is, however, indispensable that the experiments should be performed under exactly the same conditions as those employed in the work on the potassium salts.—The determination of the temperature of steam arising from boiling salt solutions, by J. Sakurai. The evidence now on record as to the temperature of the steam arising from boiling salt solutions is exceedingly unsatisfactory and inconsistent. Such being the case, the author has devised a method for accurately measuring this temperature, and finds that the temperature of the steam escaping from a boiling salt solution is the same as that of the solution. The conditions for success are:—(1) The thermometer used must be kept from contact even with the smallest drops of the solution thrown up by ebullition. (2) The effect of cooling of the thermometer by radiation must be rendered insignificant in proportion to the heating up by the steam. This condition is readily fulfilled by the expedient of combining the introduction of steam from without with the ebullition by the lamp. (3) The walls of the chamber surrounding the thermometer must be sufficiently protected from external cooling, and yet, at the same time, must not be heated to the temperature of the steam. This is effected by jacketing the steam chamber with the vapour evolved from dilute acetic acid boiling at about 2° lower than the salt solution. The agreement between the numbers representing the temperature of the steam and that of the boiling salt solution is good.—Note on an observation by Gerlach of the boiling-point of a solution of Glauber's salt, by J. Sakurai. Some years ago Gerlach stated that the steam escaping from a boiling solution of Glauber's salt containing a crystalline magma of the anhydrous salt indicates a temperature of 100°, whilst the liquid is boiling at 82° or even 72°. The author finds that this is hardly true, for it is only a wet mass of sodium sulphate crystals that is heated. The steam, consequently, does not arise uniformly from the heated mass, but

escapes from channels produced in those portions of it which are in contact with the sides of the vessel. The central portion of the magma therefore may be at a low temperature, whilst steam at 100° is issuing from the sides.—Chemistry of the thioureas, Part ii., by E. A. Werner. It is pointed out that the paper recently published by Bertram on the monophenylthioureas was evidently written in ignorance of the fact that the bulk of the work detailed therein has been already published by the author. A number of new derivatives of thiourea are now described.

Geological Society, May 11.—W. H. Hudleston, F.R.S., President, in the chair.—The President announced that a bust of the late Sir Charles Lyell had been kindly presented to the Society by Mrs. Katherine Lyell, through the intermediary of Prof. J. W. Judd, F.R.S.—The following communications were read:—On the so-called gneiss of Carboniferous age at Guttannen (Canton Berne, Switzerland), by Prof. T. G. Bonney, F.R.S. It is stated by Dr. Heim (*Quarterly Journal*, vol. xlvi. p. 237) that the stems of *Calamites* have been found at Guttannen in a variety of gneiss, *i.e.* in one of a group of rocks which exactly "resemble true crystalline schists in mode of occurrence. Petrographically they are related to them by passage rocks; at least the line of separation is not easily distinguished. . . . The Palæozoic formations mostly show an intimate tectonic relation to the crystalline schists, and have been converted petrographically into crystalline schists." The Author describes the result of a visit to the section at Guttannen in company with Mr. J. Eccles (to whom he is greatly indebted for kind assistance), and of his subsequent study of the specimens then collected. The belt of sericitic "phyllites and gneisses," presumably of Carboniferous age, represented on the Swiss geological map (Blatt xiii.) as infolded, at and above Guttannen, in true crystalline gneissoid rocks, is found on examination to consist partly of true gneisses, partly of detrital rocks. The boulder from which the stems in the Berne Museum were obtained belongs to the latter. These rocks sometimes present macroscopically, and occasionally even microscopically, considerable resemblance to true gneisses, but this proves on careful examination to be illusory. They are, like the Torridon Sandstone of Scotland, or the *Grès feldspathique* of Normandy, composed of the detritus of granitoid or gneissoid rock, which sometimes forms a mosaic resembling the original rock, and which has been generally more or less affected by subsequent pressure and the usual secondary mineral changes. Thus, if the term be employed in the ordinary sense, they are no more gneisses than the rocks of Carboniferous age at Vernayaz (Canton Valais) are mica-schists, but in some cases the imitation is unusually good, and, so far as the author saw, there are at Guttannen neither conglomerates nor slates to betray the imposition, as happens at the other locality. The reading of this paper was followed by a discussion, in which the President, Prof. Judd, Mr. Eccles, General McMahon, Mr. Rutley, Prof. Blake, Prof. Bonney, and Prof. Seeley took part.—On the lithophyses in the obsidian of the Rocche Rosse, Lipari, by Prof. Grenville A. J. Cole, and Gerard W. Butler. The rock described in this paper differs in no essential particular from that at Forgia Vecchia, or from the obsidian on the north flank of Vulcano; but the specimens show in a specially striking manner the passage through various stages of lithophysal structure, from indisputable steam-vesicles with glassy walls to typical solid spherulites. A full description is given of the formation of spherulites by a double process—firstly, divergent growth from the margins of vesicles outwards, and secondly, convergent growth inwards from the margins towards the centres of the hollows, until in the smallest cases the fibres from the opposite sides of the vesicle may meet in the centre, producing a spherulite, which, but for the occurrence of intermediate stages, might be supposed to have originated entirely by divergent growth. The authors give details of the appearances presented by intermediate stages of growth. The prevailing type of spherulite, both in Lipari and Vulcano, shows in section a dusky fibrous central area, which may possess concentric as well as radial structure, surrounded by an irregular brown cloudy zone of various width. The authors' studies lead them to the conclusion that this type owes its characters to the dual mode of growth, and therefore to the original presence of vesicles in the rock. Commonly the process of infilling does not go so far as this; on the ends of the felspar fibres plates of tridymite are deposited, and this seems to close the growth. It is clear that the lithophysal structure of the Lipari obsidians was formed during the cooling of the mass, and not by subsequent amygdaloidal infilling of vesicles. The authors discuss the effect of confined vapours on such rocks as those forming the subject of the paper, noting that these vapours may be kept at a high temperature for a considerable time, each vesicle thus becoming a sphere of hydrothermal action; so that if the surrounding glass remains at a temperature little below its fusion-point, crystallization will be promoted in it, and at the same time the action of the vapour in the vesicle will produce reactions on its walls. An appendix, by Prof. Cole, treats of the lithophyses and hollow spherulites of altered rocks. While admitting the presence of true lithophyses in many of the Welsh lavas, he is not prepared to abandon a former suggestion that the interspaces between successive coats of the Conway lithophyses result from alteration of a formerly solid mass. In the lavas of Esgair-felen and near the Wrekin he has no doubt as to the production of "hollow spherulites" by ordinary processes of decay. The typical Continental pyromerides are truly spherulitic, as is much of the Wrekin lava. In the latter case and that of the rocks of Bouley Bay it will be difficult to distinguish between infilled primary and secondary cavities. In the discussion which followed the reading of this paper Prof. Bonney, Prof. Judd, General McMahon, Mr. J. W. Gregory, Mr. Rutley, Prof. Cole, and Mr. G. W. Butler took part.

Royal Meteorological Society, May 18.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—Raindrops, by Mr. E. J. Lowe, F.R.S. The author has made over 300 sketches of raindrops, and has gathered some interesting facts respecting their variation in size, form, and distribution. Sheets of slate in a book form, which could be instantly closed, were employed; these were ruled in inch squares, and after exposure the drops were copied on sheets of paper ruled like the slates. Some drops produce a wet circular spot, whilst others, falling with greater force, have splashes around the drops. The same sized drop varies considerably in the amount of water it contains. The size of the drop ranges from an almost invisible point to that of at least 2 inches in diameter. Occasionally large drops fall that must be more or less hollow, as they fail to wet the whole surface inclosed within the drop. Besides the ordinary raindrops, the author exhibited diagrams, showing the drops produced by a mist floating along the ground, and also the manner in which snow-flakes, on melting, wet the slates.—Results of a comparison of Richard's anémo-cinémographe with the standard Beckley anemograph at the Kew Observatory, by Mr. G. M. Whipple. This instrument is a windmill vane anemometer, and is formed by six small wings or vanes of aluminium, 4 inches in diameter, inclined at 45°, rivetted on very light steel arms, the diameter of which is so calculated that the vane should make exactly one turn for a metre of wind. Its running is always verified by means of a whirling frame fitted up in an experimental room, where the air is absolutely calm, and, if necessary, a table of corrections is supplied. The recording part of the apparatus differs entirely from any other anemometer, and is called the anémo-cinémographe, and in principle is as follows:—The pen, recording on a movable paper, is wound up at a constant rate by means of a conical pendulum acting as a train of wheel links, whilst a second train, driven by the fan, is always tending to force it down to the lower edge of the paper; its position, therefore, is governed by the relative difference in the velocity of the two trains of wheel-work, being at zero when the air is calm, but at other times it records the rate of the fan in metres per second. The author has made a comparison of this instrument with the standard anemometer at the Kew Observatory, and finds that it gives exceedingly good results.—Levels of the River Vaal at Kimberley, South Africa, with remarks on the rainfall of the watershed, by Mr. W. B. Tripp. Measurements of the height of the River Vaal have for several years past been made at the Kimberley Waterworks. These gaugings having been placed at the disposal of the Society, the author has compared them with the rainfall of the watershed. There is a marked period of floods and fluctuations at a comparatively high level from about the end of October to the latter part of April, and a period of quiescence during which the river steadily falls, with very slight fluctuations from about April 19 to October 31. The highest flood (52·5 feet) occurred in 1880, the next highest being 50·3 feet on January 24, 1891.

OXFORD.

University Junior Scientific Club, May 4.—The meeting was held in the University Museum. In private, business regulations about the "Robert Boyle Lecture" were passed

by the Club.—Papers were read on the action of light on metallic iodides, by Mr. Douglas Berridge; on the colours of birds, by Mr. F. Finn; and on Caliche, by Mr. P. Elford.

May 13.—At an open meeting Mr. E. F. im Thurn (Exeter) delivered a lecture on "Primitive Games of the Red Men of Guiana." Prof. Tylor afterwards addressed the Club.—The inaugural "Robert Boyle Lecture" will be given at a *conversazione* on May 27. All old members of the Club are cordially invited.

PARIS.

Academy of Sciences, May 16.—M. d'Abbadie in the chair.—Contribution to the history of silico-carbon compounds, by M. P. Schutzenberger. The compound, SiC, has been produced by long heating of silicium diluted with silica in carbon crucibles. The friable mass is broken up, heated with potash solution, which dissolves out the silicium, and some silica, and then boiled with moderately concentrated hydrofluoric acid, by which all the silica is taken up and silicium nitride is converted into silicium fluoride and ammonium fluoride. The clear green pulverulent residue of SiC is not attacked by potash or by boiling HF; it is infusible, and at a white heat forms SiCO.—On the determination of the density of liquefied gases and their saturated vapours; elements of the critical point of carbonic acid, by M. E. H. Amagat. The critical constants for carbonic acid are given as—temp. = 31°·35 C., pressure = 72·9 atmos., density = 0·464.—Observation of the partial eclipse of the moon on May 11–12, 1892, by MM. Codde, Guérin, Nègre, Zielke, Valette, and Léotard.—On the theory of *fonctions fuchsiennes*, by M. L. Schlesinger.—On the relations existing between the infinitesimal elements of two reciprocal polar surfaces, by M. Alphonse Demoulin.—On transformations in mechanics, by M. Paul Painlevé.—The physiological scale of distinct vision, applications to photometry and *photo-esthésiométrie*, by M. W. Nicati.—On a method of separation of xylenes, by M. J. M. Crafts.—Calculation of boiling-points of compounds with simple terminal substitution, by M. G. Hinrichs.—Method for the proximate analysis of chlorophyll extracts; nature of chlorophyllane, by M. A. Étard.—Influence of the nature of the soil on vegetation, by M. J. Raulin.—Presence of fumarine in one of the Papaveraceæ, by M. J. A. Battandier.—On some muscular anomalies in man, by M. Fernand Delisle.—On the apparently teratological origin of two species of *Triclades*, by M. P. Hallez.—On the theory of gills and the parablast, by M. F. Houssay.—The origins of the wing nerve among the Coleoptera, by M. Alfred Binet.—The nervous system of *Nerita polita*, by M. L. Boutan.—On the origin and formation of the chitinous coat of the larvæ of *Libellules*, by M. Joannes Chatin.—On the microscopic structure of ooliths from the *bathonien* and *bajocien* of Lorraine, by M. Bleicher.—The odoriferous properties of alcohols of the fatty series, by M. Jacques Passy. The odoriferous power, as measured by the inverse of the millionths of a gram present in one litre of air when the odour can be just distinguished, increases regularly with the molecular weight.—On the lack of movement of the deep oceanic waters, by M. J. Thoulet.

BERLIN.

Physiological Society, April 27.—Prof. du Bois-Reymond, President, in the chair.—Dr. Boruttau gave an account of experiments made to determine the cause of the difference in latent period observed during the direct and indirect stimulation of muscles, being, as is well-known, greater (with maximal and supra-maximal stimuli) in the latter mode of stimulation. According to some observers the difference is due to the resistance offered by the end-plates, whereas some regard it as due rather to a summation of stimuli during direct stimulation. The speaker had satisfied himself by a careful repetition of the experiments under many varying conditions that the difference is due solely to the resistance of the end-plates. In connection with the above, Prof. Gad pointed out the possible important bearing of the results obtained on the processes which go on in other organs. Thus recent anatomical research has shown that in the central nervous system there is no complete continuity between the axis-cylinders and ganglia, hence the existence of some intermediate structure must be assumed, and a portion at least of the slowing which impulses experience in the central nervous system may be due to the resistance offered by this structure.—Prof. Wolff exhibited a patient in whom the larynx had been completely extirpated some seven months previously, and who was now able, by means of an artificial larynx, to speak quite loud and clearly. Prof. Gad gave an historical account of the construction of artificial larynxes, of the requirements which these instruments must satisfy, and of recent improvements in the cannulæ employed by patients.

Physical Society, May 6.—Prof. Kundt, President, in the chair.—Dr. Gross spoke on the principle of entropy, and criticised several formulæ of Clausius and Zeuner.

[In the reports of the Berlin Scientific Societies, NATURE, vol. xlv. p. 599, *for* Schumbert *read* Schubert, and *for* Lammer and Brodhan *read* Lummer and Brodhun.]

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Genesis I. and Modern Science: Dr. C. B. Warring (New York, Hunt and Eaton).—Analyse des Vins: Dr. L. Magnier de la Source (Paris, Gauthier-Villars).—Tiroirs et Distributeurs de Vapeur: A. Madamet (Gauthier-Villars).—Studies in South American Native Languages: Dr. D. G. Brinton (Philadelphia).—Die Elbe in Westpreussen: H. Conwentz (Danzig, Bertling).—Wood-Notes Wild. Notations of Bird Music: S. P. Cheney (Boston, Lee and Shepard).—Lehrbuch der Botanik, Erster Band: Dr. A. B. Frank (Leipzig, Engelmann).—The Theory of Substitutions and its Applications to Algebra: Dr. F. Netto, translated by Dr. F. N. Cole (Ann Arbor, Michigan, *Register* Publishing Company).—Results of the Meteorological Observations made at the Government Observatory, Madras, during the Years 1851–90, edited by C. M. Smith (Madras).—Watts's Dictionary of Chemistry, vol. iii., revised, &c., by H. F. Morley and M. M. P. Muir (Longmans).—Practical Enlarging: J. A. Hodges (Iliffe).—The First Principles of Photography: C. I. Leaper (Iliffe).—Smithsonian Report, U.S. National Museum, 1889 (Washington).—Key to J. B. Lock's Elementary Dynamics: G. H. Lock (Macmillan).—The Anatomy, &c., of the Blow-Fly, Part 3: B. T. Lowne (Porter).

PAMPHLETS.—On the Organization of Science: A Free Lance (Williams and Norgate).—The Nitrate Fields of Chile: C. M. Aikman.—Sadducee *versus* Pharisee: G. M. McCrie (Bickers).

SERIALS.—Quarterly Journal of the Geological Society, vol. xlviii. Part 2, No. 190 (Longmans).—Engineering Magazine, May (New York).—Himmel und Erde, May (Berlin, Paetel).—Transactions of the Royal Irish Academy, vol. xxix. Part 19 (Williams and Norgate).—Verhandlungen des Naturhistorischen Vereines der Preussischen Rheinlande, &c.—Achtundvierzigster Jahrgang Fünfte Folge, 8 Jahrg., Zweite Hälfte (Bonn, Cohen).—Bulletins de la Société d'Anthropologie de Paris, tome 2 (1891), 3e. Fasc. (Paris, Masson).—Journal of the Chemical Society, May (Gurney and Jackson).—Institute of Jamaica, Bulletin No. 1, A Provisional List of the Fishes of Jamaica: T. D. A. Cockerell (Kingston).—Rapport Annuel sur l'État de l'Observatoire de Paris, 1891, le Contre-Amiral Mouchez (Paris, Gauthier-Villars).—Indian Museum Notes, vol. ii. No. 5 (Calcutta).—Journal of the Institution of Electrical Engineers, No. 98, vol. xxi. (Spon).—Mémoires de la Société de Physique et d'Histoire Naturelle de Genève, Vol. Supplémentaire, Centenaire de la Fondation de la Société (Genève).

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