THURSDAY, MARCH 7, 1901.

THE PRESENT ASPECT OF SOME CYTOLOGICAL PROBLEMS.

The Cell in Development and Inheritance. By E. B. Wilson, Ph.D., Professor of Zoology, Columbia University. Second edition, revised and enlarged. Pp. xxi + 483. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.) Price 14*s.* net.

DURING the few years which have elapsed since the appearance of the first edition of Prof. Wilson's book on the cell, the rapid accumulation of new facts has resulted in the modification, in many important respects, of the views which were entertained concerning many cell phenomena even so lately as five years ago. Hence, though the volume before us is issued as a second edition, it has not only been considerably enlarged, but also much of the original matter has been displaced to make room for new treatment which shall more faithfully reflect the attitude of cytologists towards the problems which confront them at the present time. And we may fairly say that the author's efforts have not only been largely successful, but they have resulted in the production of one of the best works which it has been our good fortune to meet with for a long time.

The whole subject is handled in an easy and masterly fashion, and the reader is enabled readily to grasp the leading facts and to obtain a clear insight into the nature of the chief questions of cytological importance. Of course the book is not without its faults, but they are not, for the most part, serious ones. The author is naturally less at home when dealing with botanical than with zoological work, and indeed he says as much in his preface; but we notice, here and there, slips which might have been easily avoided. Amongst the most obvious of these is a somewhat misleading account of the morphology of the embryo-sac on pp. 264–5. A more trifling matter is the rather irritating recurrence of eulogistic adjectives, and the reader is apt to weary of a "brilliant" hypothesis or an "interesting" observation which is shown a few lines farther on to be untenable or unsound.

The volume opens with a brief historical introduction, in which it is satisfactory to find that to Cohn is given the credit, which undoubtedly belongs to him, of having been the first clearly to identify sarcode with protoplasm. Then follow chapters on the division of the cell and the nucleus, and of the more intimate structure of the cell-constituents. In the account of the details of karyokinesis, a fairly representative series of examples is given; but we could have been well contented had the author seen fit to amplify his treatment of the simpler and more primitive forms of life, seeing that so many of them exhibit remarkable and suggestive deviations from the course of events as pursued in the higher animals and plants.

Prof. Wilson deals with the vexed questions which have arisen concerning the centrosome in a cautious and discriminating manner, and he discusses the various theories which have been put forward respecting the nature and functions of this highly enigmatical body. A considerable mass of evidence has been gradually accumulating which tends to show that a greatly exaggerated importance has been assigned to it by many investigators. There are instances in which it can only be recognised as a transitory structure which persists during special phases of activity, to disappear when these subside. The view was at one time current amongst the majority of cytologists that the centrosome represented a permanent structure which presided over the divisions of the nucleus, and that it was, in fact, *par excellence* the organ which aroused and directed the karyokinetic processes. More extended investigation has, however, failed to support this proposition, and in not a few cases, especially amongst the higher plants, there is no good evidence of the existence of a centrosome at all. Furthermore, the researches of Hertwig, Morgan, and especially the recent ones of Loeb, have proved that eggs in which the original centrosomes have undergone complete degeneration are yet capable of exhibiting the entire processes of division when appropriately stimulated, and this without the entrance of a sperm or any other centrosome-bearer whatsoever.

The question as to the permanence of the chromosomes is also considered, and, on the whole, Prof. Wilson appears to incline to the view that the *same* chromosomes which were visible in the daughter nuclei at the close of a division reappear when the latter proceed to divide once more. In conformity with this idea, he supports the hypothesis that in cases where less than the normal number of chromosomes arise in a nucleus, these are in reality plurivalent—that is, each apparent chromosome is compound, and represents two (or more) true chromosomes united together, although their individuality may be for the time entirely masked. Thus it is well known that the nuclei of both the ovum and the spermatozoon possess only half the number of chromosomes characteristic of the somatic cells of the organism, and that this "reduction" is accomplished in connection with two peculiar and rapidly-succeeding nuclear divisions. Each of these chromosomes (at least in the first division) is then regarded as plurivalent (bivalent)—that is, as composed of, at any rate, two individuals which have not separated from each other. One necessary consequence of this view is that somewhere during one of these divisions, or at any rate before the formation of the sexual cells which arise from them, there must be a *qualitative* distribution of the real primary chromosome-individuals between two nuclei. Such an occurrence was regarded as antecedently probable by Weismann, and his views received a remarkable confirmation at the hands of several investigators, who describe the sequence of events as proceeding in a manner such as to render it apparently clear that a qualitative distribution does actually occur.

On the other hand, many others have been unable to find any evidence for the existence of such a type of division in other organisms, and conclude that the facts are strongly opposed to it. Should their view be correct, even in the case of a single example, the whole objective

evidence relied on by those who see in the phenomenon of chromosome-reduction a confirmation of Weismann's theory falls to the ground. And with it, also, the hypothesis of plurivalency and continued persistence of the chromosomes suffers a serious limitation, for it is obvious that a time must soon arrive, in the sequence of generations, at which the evident chromosomes themselves can no longer consist of the telescoped chromosome units of all the previous life-cycles. In short, each chromosome that appears after the reduction in number cannot be represented in terms of the somatic units as $a+b$, but it must possess a new structure c.

Prof. Wilson very fairly reviews the evidence for and against a *qualitative* reduction (of the quantitative or numerical reduction there is, of course, no question), leaning, as has been said, somewhat in its favour, and it must be admitted that there is some indirect evidence in support of it. Perhaps it hardly falls within the scope of the author's work, but a consideration of the reversion of hybrids to the original stocks, such as indicated by Mendel's law, which has recently formed the subject of important communications by De Vries and by Correns, might have been discussed in this connection.

Exigencies of space forbid us to do more than to indicate the excellence of the treatment of the structure and development of the spermatozoon, of the phenomena of fertilisation, and of parthenogenesis. Our views as to the essential nature of fertilisation are undergoing a change in certain respects as the result of cytological investigations in this field of inquiry. We have clearly to recognise the existence of two distinct factors in the process. The one is concerned with the stimulation of the egg, which is thereby impelled to segment and to develop into a new organism, the other is involved in the fusion of the two sexual nuclei.

Boveri's experiments long ago showed that a fusion of the male and female nuclei was not essential to the segmentation and organised development of an egg. He succeeded in fertilising non-nucleated fragments of echinoderm eggs with the sperms of another species, with the result that larvæ exhibiting the paternal characters only were formed. These experiments were for some time regarded as not being free from objection, but they have been repeated with similar results. Again, as Loeb has recently shown, it is possible, by treating the unfertilised eggs of *Arbacia* with a solution of magnesium chloride, to cause them when replaced in sea-water to give rise to normal larvæ. And once more, Nathansohn has proved that, in the case of *Marsilea*, a sufficiently high temperature suffices to excite parthenogenetic development in the oospheres of these plants. Even in many normally fertilised eggs it has been repeatedly shown that the stimulus which starts the karyokinetic processes in the egg comes from the cytoplasmic (centrosome) portions of the sperm rather than from its nucleus.

As regards the significance of the nuclear fusion, although we are as yet unable to speak with certainty as to its proximate or efficient cause, there can be little doubt but that its teleological significance is to be sought in the fact that these bodies contain in themselves the physical basis of heredity, and thus by their coalescence the hereditary qualities of both parents are mingled in the offspring.

J. B. FARMER.

METHOD IN PHILOSOPHY.

Die Transzendentale und die Psychologische Methode. Dr. Max F. Scheler. Pp. 181. (Leipzig: Dürr'schen Buchhandlung, 1900.) Mk. 4.

IN opposition to the positivism which avers that if we take care of facts method may be left to take care of itself, Dr. Scheler claims that the history of thought, its continuity notwithstanding, shows abundantly that each fresh conquest in knowledge is preceded by a definite, if often half-conscious, breach with outworn method. Kant's historic mission has been fulfilled, and, after a century's probation, the time has arrived to pass beyond him. Not, however, by the adoption in philosophy of that psychological method which, discredited in Condillac and Hume, has been encouraged by recent advances in technical psychology to essay rehabilitation in more plausible forms. Dr. Scheler is with contemporary psychology in its reaction in favour of real as against formal principles, development as against finality, the historical as against the mathematical temper. He is with the Kantian in his recognition of the *quaestio juris* and in his advocacy of an inverse or "reductive" method. In the result he accepts a formula from Eucken—that of a regress from "the well-founded phenomenon" of a culture embodied in a coherent aggregate of institutions to the real forces of which it is the living and still growing product. *Arbeitswelt* and *Geistige Lebensform* are the catchwords of this "noölogical" method.

Dr. Scheler's discussion of "transcendental" method, *i.e.*, the inference from an accepted group of facts to the principle which can and can alone explain them—what evidence of the "alone" could be adduced it is hard to see—directs its main attack, not against its inverse character, but against (1) its static nature due to acceptance of an immutable starting-point, (2) its formalism in its conclusion to grounds of a merely logical kind, (3) its intellectualism with its consequent neglect of "three-fourths of life." Its alleged "synthetic propositions *a priori*," *i.e.*, propositions at once instructive and necessary, are really experiential. The starting-point is really dependent on psychology. Change the period and get a different psychological "climate," and you will find that the transcendental presuppositions will be different. But if so, the psychological ground-propositions will be complete in themselves, and formal conditions established by transcendental deduction are superfluous. The only regress which is not simply a doubling of the data must be towards real, that is, actual and active principles. And the data are neither unchanging nor purely rational.

This general appreciation Dr. Scheler reinforces by a detailed treatment of space, time, causation, and personality. As regards space, the temptation to strengthen the charge of formalism by putting Kant out of touch with a perceptual world has proved too strong for Dr. Scheler. Kant's "empty" space probably means only that all particular contents of space can severally be thought away without altering our space-apprehension. Kant's space is voidable rather than void. Geometer's space, while it is in one sense an abstraction, is not only not a generic concept, but not a concept at all, if the argument as to whole and parts in Kant's metaphysical exposition is to stand. The psychogenetic problem of the perception of a third dimension is irrelevant to Kant's nativism.

The bearing of "metageometry" upon Kant's doctrine of space is still *sub judice*. It is open to the Kantian to maintain either that "bent" spaces fall within Euclidean space, multidimensional spaces being an hallucination due to abuse of algebraic symbolism, or, with Mr. Bertrand Russell, that if Euclidean space is experiential, yet some "form of externality" is *a priori*. Dr. Scheler is, however, throughout the discussion suggestive, if inconclusive.

Less satisfactory is his treatment of causation. The statement that the conception of uniformity is foreign to the Greek period is absurd. That the period of Roman decay was one of lawless happenings is not true in the sense of p. 73, and Dr. Scheler does not save himself by after qualification, in view of the exaggerated position of p. 69, that the causal category which makes natural science possible as a science of experience would make historical science as a science of experience impossible. The treatment of time and the self is relatively slight.

The inadequacy of the psychological method is to be found in its equivocal use of the term "facts of consciousness." Either it is Protagorean and anarchical, and the objects of all sciences and nesciences are on a dead level of "psychical existence," or there are realities which transcend this accommodating rubric. Idealism is prone to the epistemological fallacy, as positivism is prone to the phenomenalist fallacy.

If, however, neither transcendentalism with its reduction, nor psychology with its grip on something real—even falsities—can satisfy us, we must, in default of other probable courses, cast about for some syncretist formula uniting the truths and discarding the defects of both. Dr. Scheler declines Sigwart's irenicon, because of the primacy it involves of the moral and volitional element in life. Surely this is not ineradicable from Sigwart's formula? Rejecting this, and the solutions of which it is the type, he falls back upon the endeavour of his teacher, Eucken, to make jettison of all in both methods that offends the time-spirit, and to fashion what is left, with the aid of something which both had left out, into a non-absolutist, non-sceptical scheme, hereafter to be more fully developed. H. W. B.

OUR BOOK SHELF.

First Stage Botany, as Illustrated by Flowering Plants. By Alfred J. Ewart, D.Sc., Ph.D., F.L.S. Pp. viii + 252. (London: W. B. Clive and Co., no date).

THE author sets forth in the preface that his primary object in writing this book was that of satisfying the requirements of students preparing for the elementary stage of the Science and Art Examinations. A glance through its pages suffices to prove that this end is everywhere kept to the fore. Even the figures, which are very numerous, are labelled all over in large type so as to enable the student, with the minimum expenditure of time and trouble, to get up the maximum amount of facts. In the text the treatment is on analogous lines, and probably the student possessed of a good memory might, with this book as his mentor, succeed in passing a fair examination. Beyond this we have failed to discover why the book was written; and when its author goes on to state that it is also intended to serve as an "efficient introduction to Botany," we simply cannot agree with him. The character of the book is too dogmatic, and too little is left to the student. Indeed, a sentence contained in the preface, advising the student to obtain specimens and "verify upon them the statements made in the text," gives the key to the entire book. Not merely verification, but the fostering of a spirit of *inquiry* ought to be the chief aim of a teacher, and it is this aspect of the matter which we miss in the volume before us. In the paragraph on geotropism (p. 211) this phenomenon is defined as the "tendency of the radicle or main root to grow towards the centre of the earth"; a very inadequate definition both from the point of view of fact and theory, and one of little or no scientific value to the student.

Some subjects, *e.g.* obdiplostemony, are introduced which would have been better omitted. Unless fully discussed they are of no value educationally, and the space they occupy would be better taken up by a more extended treatment of the more elementary matters. Although, in a general way, the book much resembles others of its class, save, perhaps, in the compression of an unusually large number of facts into its pages, it is but right to add that actual errors are remarkably scarce.

The Principles of Magnetism and Electricity. An Elementary Text-book. By P. L. Gray, B.Sc. Pp. xvi + 235. (London: Methuen and Co., 1901.) Price 3*s.* 6*d.*

THE number of elementary text-books on magnetism and electricity probably exceeds that of text-books on any other subject. One would, therefore, naturally expect that anybody attempting to add to their number would do so with a due sense of responsibility, and endeavour to produce a book which might be regarded as surpassing those already in existence either in accuracy of exposition or in freshness of treatment. A careful perusal of the book before us has forced us to the conclusion that the author is destitute of all sense of responsibility, and not afraid to scatter error broadcast with a light heart. Seldom has it been our lot to come across an elementary text-book so full of glaring errors so boldly stated. On p. 18 the author describes a vibrational method of comparing the moments of two magnets in which the moments of inertia of the magnets are not even referred to! On p. 15 we have the startling assertion that in the case of diamagnetic bodies "the induced magnetisation is *at right angles to the field*" (the italics are the author's!). Could there be a greater confusion of ideas than that exhibited by the following sentence? (p. 151): "A pole of strength m will have $4\pi m$ lines of force proceeding from it, so that, if a transverse narrow cut be made across a magnet which has σ lines per sq. cm. in any normal cross-section, the field in the narrow slit H will be equal to $4\pi\sigma$." The author measures magnetic force in *dynes*, and difference of potential in *ergs*. On p. 162, in connection with the induction coil, we read: "Trowbridge has recently obtained sparks nearly seven feet in length, obtaining an E.M.F. of 3,000,000 volts, *the primary current being supplied from a battery of* 10,000 *storage cells*" (the italics are ours). Is the author serious, or does he intend playing a practical joke on his reader, by suggesting that any sane person would use 10,000 storage cells for supplying the primary of an induction coil? Had he taken the trouble to refer to Prof. Trowbridge's papers, the author would have found that the arrangement used for obtaining the 3×10^6 volts had nothing whatever to do with an induction coil. On p. 163 we have the sentence: "The total value of the magnetic force within a circuit is known as the magnetic *flux* through the circuit." Now, what does the author mean by "the total value of the magnetic force within a circuit"? When touching on technical matters, the author does not scruple to make various erroneous statements with an airy assumption of superior knowledge. "Theoretically," we are told on p. 166, "every dynamo could be used as a motor and every motor as a dynamo. In practice, however, this power of reversibility is not used." Again, on p. 170, we read: "Owing to the self-

induction of each section of the armature, a certain amount of energy is used twice in each revolution to establish the current in it. *This energy is lost* so far as the external circuit or the effective output of the machine is concerned" (the italics are ours). This sentence shows that the author has never attempted to study the extremely complicated problem of commutation; it would, therefore, have been wiser to say nothing about it in an elementary text-book.

But we must stop, though we have by no means exhausted the various errors which mar the book. We have noted a few quite as glaring as those which have been adduced as samples. The book possesses some good features, notably the attempt to explain everything by considering the stresses in the medium; but it is so full of error that we feel bound to condemn it very strongly.

A. H.

Die Lehre vom Skelet des Menschen unter besonderer Berücksichtigung entwickelungsgeschichtlicher und vergleichend-anatomischer Gesichtspunkte und der Erfordernisse des anthropologischen Unterrichtes an höheren Lehranstalten. Bearbeitet von Dr. F. Frenkel. Pp. vi + 176. Mit 81 textfiguren. (Jena: Gustav Fischer, 1900.)

THE author has in course of publication, for use in the Gymnasia and Realschulen, a series of wall plates in which the anatomy of the human body is represented, and he has prepared the book now under consideration as a supplement to the plates which illustrate the skeleton. He devotes 176 pages to the description of the human skeleton, and includes an account of the joints which connect the bones with each other. He has adopted as the basis of his arrangement the plan followed by Gegenbaur in the "Lehrbuch der Anatomie der Menschen."

In the course of his description, Dr. Frenkel takes the opportunity of calling attention to the developmental changes which take place in the præ-ossific stage of the skeleton, as well as during the process of ossification itself, more especially in their bearing on the production of variations which, from time to time, come under the notice of anatomists. He contributes an interesting chapter on the variations in the number of vertebræ, more especially in the thoracic, lumbar and sacral regions, and explains the occasional occurrence in the dorsi-lumbar region of a vertebra which partakes partly of the characters of both these groups, and in the lumbo-sacral region of a vertebra which exhibits a transitional form between the lumbar and sacral series.

The opportunity is taken, from time to time, to point out the differences in arrangement and character between the human skeleton and that of the anthropoid apes, though in this respect many additional examples might readily have been given. It is, of course, impossible in a work of this kind to free the descriptions from technical terms and modes of expression; but the author, taking into consideration the class of readers for whom it has been written, has explained the meaning of the terms and, as far as practicable, has couched his descriptions in language to be readily apprehended.

De Paris aux Mines d'Or de l'Australie occidentale. By O. Chemin. Pp. 370 + 2 maps. (Paris: Gauthier-Villars, 1900.)

A DESCRIPTION of Western Australia from the mining point of view, illustrated with pictures characteristic of the scenes presented in a journey from Paris to Perth, and examined during short visits to other places in our premier gold-producing colony. The geography, population, government, mineral resources and gold fields of the colony are surveyed, and the condition and promise of individual mines commented upon. The author spent nearly a year in Westralia, and his book will direct the attention of his countrymen to an immense region, much of which is still little known.

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.*]

Malaria and Mosquitoes.

INTERESTING letters by Mr. D. E. Hutchins and Mr. F. R. Mallet have recently appeared in NATURE, suggesting the possibility of there being some other route for infection in malaria besides that by the bite of Anopheles. Suggestions of this kind always appear to me to give rise to the questions, (*a*) whether the facts are really as stated? and (*b*) whether, if even this is the case, they cannot be explained by the mosquito theory? The notion that clearing jungle causes fever is very widely spread; but this does not prove that it is true. Granting that it is true, it may possibly be explained on the ground (*a*) that persons engaged in clearing jungle and laying out new plantations are not likely to be so well housed as those who live in established settlements; (*b*) that any hard labour encourages relapses of fever among coolies and others who have already been infected; and (*c*) that, as shown by Christophers and Stephens, jungle often contains large numbers of Anopheles. The frequent statements one sees, to the effect that malaria has prevailed largely when mosquitoes were few, are generally too vague to be of value, because it is not added whether the cases were relapses or fresh infections, or to what kind the "few" mosquitoes present belonged. When a man says that mosquitoes are numerous he generally refers to the genus Culex, which probably assert themselves more than do Anopheles. The idea that the water of the rivers of western India can cause fever when it is drunk is certainly opposed to my personal experience. In 1891 I went fishing with Mr. G. Tait, of Bangalore, in the River Bhawani, near Ootacamund. I remember that at the time I did not think that fever could be acquired by drinking such water, and I used daily to drink the unboiled water of this river (which flows amongst thick jungle). I remained quite free from fever, without taking quinine; but Mr. Tait was afterwards attacked. So far as I remember (but I am not sure), he had refused to drink Bhawani water; but I am not certain that his fever was malarial. Again, the idea that malaria is absent in the Nilgiri Hills round Ootacamund unless the soil is turned does not accord with my personal experiences. I acquired fever at Kalhutti (5000 feet above sea-level) in 1897, when I was investigating the disease in the Sigur Ghat. I thought at the time that I had acquired it in the plains below, but, in the light of our present knowledge, have little doubt that I became infected in the dak-bungalow at Kalhutti, where a succession of kitmutgars and their families had been taken ill. I noted particularly at the time that there was no freshly turned soil in the neighbourhood of the bungalow. Lastly, the case mentioned by Mr. D. E. Hutchins, namely that of a medically authenticated case of malaria being produced by fresh earth carried past a window in baskets by coolies, seems to me to be open to criticism. *Which* fact was medically authenticated—the fact that the patient suffered from malaria, or that his malaria was caused by the earth carried past in baskets? I can understand the first fact being certified by a doctor, but scarcely the second. How did the doctor prove that the fever was produced by the earth in the baskets? It seems to me that the only way in which he could have done so in a trustworthy and scientific manner would have been to infect a second person by having the baskets carried past a second time. I doubt whether such instances—and we see hundreds of them in the Press—will bear close examination. Those who cite cases of fever apparently due to freshly-turned earth, seem to forget that there are millions of people constantly engaged in digging without suffering from the disease more than others do.

Liverpool, February 25. R. ROSS.

Abundance of Peripatus in Jamaica.

MR. P. H. GOSSE in the "Naturalist's Sojourn in Jamaica" (p. 66) makes the first reference to the occurrence of Peripatus in Jamaica, having found in 1845 five or six specimens near Bluefields, on the south-west coast of the island. Gosse regarded them as "rather allied to the Annelida than to the Mollusca." No further mention of the animal is made until it was rediscovered at Bath in 1892, nearly fifty years after, by a local naturalist, Mrs. Swainson. Seven Peripatus were sent to

the museum of the Institute of Jamaica, and later were briefly described by Messrs. Grabham and Cockerell in NATURE (1892, p. 514), when the specific term *Jamaicensis* was suggested. The year following over a dozen specimens were received by Dr. Grabham, also from Bath. The locality is in a most humid part of the eastern extremity of the island. Two or three examples have since been secured from widely separated spots, but the species has hitherto been regarded as one of much rarity, and as uncertain in its distribution. Various attempts made by different collectors to secure specimens have been unsuccessful.

Prof. E. L. Bouvier, who has lately been making a systematic study of the genus, recognises two species—*P. jamaicensis* and *P. juliformis* var. Gossei—among the Jamaica representatives, (cf. *Quart. Jour. Micr. Sci.*, vol. xliii. p. 750). Prof. Ray Lankester, on behalf of Prof. Bouvier, has recently communicated with the Institute of Jamaica asking for additional specimens. A general description of Peripatus was accordingly inserted in the local newspapers, and offers of reward were made with the object of encouraging the peasantry to search for the animal, but this was of no avail. A visit, since made by the writer, to Bath resulted in the securing of a number of examples. These were exhibited in the neighbourhood and a sum was offered for further specimens, with the result that before long numbers began to pour in and soon upwards of fifty were obtained. Dr. Grabham also secured a large supply. Afterwards more than eighty specimens were dispatched to the Museum, then another fifty were offered, and now that a local enthusiasm has been created it would seem that examples in plenty might be procured at any time. It is thus obvious that the animal is by no means so rare as has been supposed.

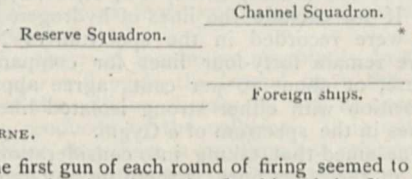
The creatures are found under stones and rotten wood, often buried for a short distance in the earth. Most are blackish brown or green, much lighter on the ventral surface; others are reddish black above and light flesh-coloured beneath; but many intermediate tints occur. A reddish-brown colour is extracted at first by alcohol, and the distinctive colours are soon lost. Specimens of all sizes were obtained, including individuals in which parturition took place during preservation. The length of the newly born was as much as 2 cm. J. E. DUERDEN.

Institute of Jamaica, Kingston, February 12.

Audibility of the Sound of Firing on February 1.

FROM the letters written to NATURE and to the *Standard* by correspondents who heard at very great distances the guns fired at Portsmouth on February 1, it seems to be the general impression that the firing was by volleys, if one may use a convenient but probably technically incorrect expression. This was not the case. It would be very desirable that the official order of firing should be published. If this is not done, there may be some interest in a note on the order as it appeared to me, watching from the sea-front near Southsea Castle.

The disposition of the fleet was roughly thus:



The first gun of each round of firing seemed to me to be fired far down the line, from the flagship of the Reserve Squadron; but of this I cannot be sure. It was immediately succeeded by the gun from the *Majestic*, flagship of the Channel Squadron; and from this the firing ran down the double line, the intervals between the successive pairs of flashes being about half a second. It was impossible to see from Southsea whether the Reserve Squadron followed the lead of the Channel Squadron or of its own flagship. In the latter case, after the leading guns from the flagships there would have been four guns, in the former case two guns every half second, for a space of some seconds.

These details are from memory, and may require some correction. The important fact is that the guns were fired in quick succession, and not simultaneously.

The line of ships was about eight miles long, roughly east and west, and Southsea was about a mile north of the eastern end. But the roll of the guns lasted only about twenty seconds—that is to say, scarcely any sound reached us from the western division of the line, which was hidden from sight by a projecting point of land. It is not surprising, therefore, that nothing was heard at Chichester and other places comparatively near Portsmouth. ARTHUR R. HINKS.

Cambridge, February 26.

Protective Markings in Animals.

I ENCLOSE a photograph of my cat asleep, in which may be plainly seen the resemblance to open eyes, borne by the markings above the orbits. In the living cat this resemblance is so striking that my attention was first drawn to it by my fancying that he was sleeping with his eyes open.

I have noticed the same markings in other cats, but never quite so distinct. The advantages, to a non-domesticated animal, of such an arrangement are obvious, and I think it may interest some of your readers. Besides these marks over the eyes, I observe in a good many cats that the fur on the lower jaw is generally light and bounded by markings following the line of the mouth, thus giving a heightened effect when open, whilst when shut, during sleep, the cat has, at a distance, the appearance of having the mouth still open. CLARENCE WATERER.

Highfield, Northdown Avenue, Margate, February 26.

Snow Crystals.

A FALL of snow stars, similar to that described by Mr. Wm. Gee (p. 420), occurred near Sutton Coldfield about 1876, as near as I can remember. I was much struck by their beauty and the graceful way they fell to the earth. C. J. WOODWARD.

Municipal Technical School, Birmingham, March 2.

THE NEW STAR IN PERSEUS.[1]

DR. COPELAND was kind enough to inform me by telegram, on the afternoon of February 22, of the discovery by Dr. Anderson of a new star in the Milky Way in Perseus on the early morning of that day. It was stated that its position was R.A. 3h. 24m. 25s. and Declination +43° 34′, its magnitude 2·7, and colour of a bluish-white. Later in the evening this information was corroborated by another telegram from the "Centralstelle" at Kiel.

Owing to cloudy weather, no photographs could be obtained at Kensington until the evening of the 25th. Momentary glimpses of the star on the evening of the 22nd, between the hours of 6 and 7.30 p.m., indicated that the Nova had considerably brightened since the time of its discovery, as it was estimated as a little brighter than a first magnitude star; no satisfactory observations of the spectrum could be made.

Another glimpse on the early morning (1.30 a.m.) of Monday (25th) showed that the star was still of about the first magnitude.

Prof. Pickering reports that the Nova was dimmer than an eleventh magnitude star on February 19. On the 23rd it was as bright as Capella.

The star, therefore, was then at least 10,000 times brighter than it was four days previously, and ranks as the brightest new star recorded since that which appeared in the year 1604.

Since the 25th the brightness has diminished slightly, and on the evening of the 27th was estimated between the first and second magnitude (1·7). If this reduction of brilliancy continues at the same rate, the new star will evidently be shorter lived than those to which it has most closely approximated in luminous intensity at the maximum, and less time will be available for studying the spectral changes which may be anticipated. I may state that Tycho's Nova (1572) was visible for nearly one and a half years, and Kepler's (1604) for about the same period.

It is interesting to note that the star was described by Dr. Anderson as being of a bluish-white colour at the

[1] Preliminary note. By Sir Norman Lockyer, K.C.B., F.R.S. Received and read before the Royal Society, February 28.

time of discovery. Since it has diminished in brightness this has changed, and on the night of February 27 a reddish tinge was observed.

Although the sky on Monday evening was by no means free from clouds, ten very satisfactory photographs were secured with the three instruments in regular use for stellar spectra. Edwards's isochromatic plates were used, as it was considered desirable to secure a record of the green part of the spectrum.

Although there has not been time for a complete discussion of these photographs, it may be stated that the spectrum contains numerous dark lines, several of which are associated with bright bands on the less refrangible side. Further, the spectrum, as a whole, greatly resembles that of Nova Aurigæ.

One of the chief features of the principal bright lines is their great width, amounting to 30 tenth-metres, and each is accompanied by a dark line of considerable breadth on its more refrangible side. A comparison spectrum of γ Orionis, photographed alongside that of the Nova on one of the plates, indicates that the middle portions of the bright lines are not far from their normal positions; those of the dark ones, however, are displaced by some 15 tenth-metres towards the violet, thus indicating a differential movement of something like 700 miles a second.

Movements more rapid and disturbances more violent than those observed in Nova Aurigæ are therefore indicated; both by the greater displacement of the dark lines relatively to those that are bright and the greater breadth of the bright and dark lines.

tested by inquiring whether other prominent enhanced lines of iron so strongly visible in the spectrum of α Cygni were present.

A comparison with the spectrum of this star photographed with the same instruments suggested that many lines between F and *h* in the Nova probably correspond with lines in α Cygni. Certainty could not be arrived at in consequence of the great breadth of the lines in the Nova.

Hence, as the Nova bore some resemblance to both Nova Aurigæ and α Cygni, a reference was suggested to the lines recorded in the spectrum of Nova Aurigæ which were observed when the light of that star was on the wane, and when the lines were thinned enough to be easily measurable. I may also add that these observations were made before the work on enhanced lines was undertaken.

The importance of this reference was strengthened by the consideration that with such a tremendous outburst we should expect the original invisible swarm to have been (very rapidly) advanced to a considerable condensation at the locus of impact, and therefore to resemble some "star" which had (slowly) arrived at a position pretty high up on the ascending temperature curve in the ordinary course of evolution on the meteoritic hypothesis.

A comparison of the bright lines recorded by Campbell[1] and Vogel[2] in the spectrum of Nova Aurigæ with the strongest lines of α Cygni—a very detailed record of the spectrum of which star has been recently compiled here

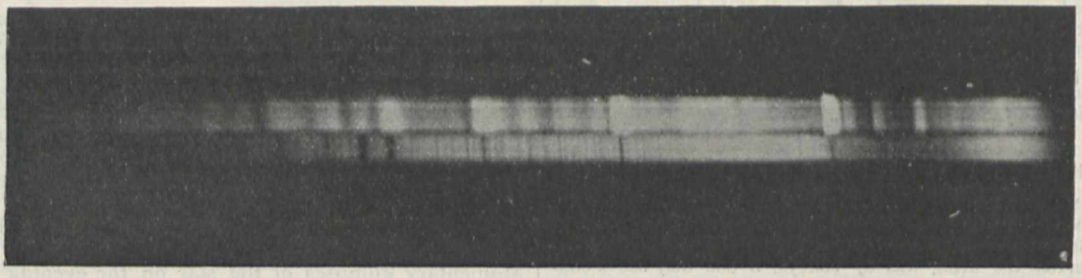


FIG. 1.—Spectrum of Nova and α Persei compared.

The comparison of spectra shows us that we are dealing with two swarms, one of which, the less dense, gives us broad bright lines and is almost at rest with reference to the line of sight; the denser swarm, indicated by the dark lines, is in most rapid movement in the line of sight towards the earth.

An interesting feature of the spectrum is the presence of fine dark lines down the middle of each of the bright lines of hydrogen and calcium; these are most probably reversals, and if this be so, they will be of great service for accurate determination of the wave-lengths of the other bright lines.

The dark hydrogen line Hγ, and perhaps Hβ and Hδ, are also possibly reversed.

Eye observations showed among the chief lines a group of four in the green; one probably Hβ, the others near λλ 492, 501 and 517; a bright line at or near D, and a brilliant red line probably corresponding to Hα. Each of these was accompanied by a dark broad line on its more refrangible side. Other lines of less brightness were observed both in the green and red.

It at first seemed probable that two of the bright lines in the green (λλ 492 and 501) might be due to asterium, while that in the orange was perhaps the helium line D_3. Subsequent investigation, however, suggested as an alternative origin that these lines might be the enhanced lines of iron at λ 4924·1 and 5018·6, which are very nearly in the same positions as the asterium lines. This view was —shows that there is a close agreement between the two sets of lines. These strong α Cygni lines are almost without exception the representatives of "enhanced" lines of some of the metals, chiefly Fe, Ti, Cr, Ni, Ca, Sr, and Sc. If we exclude the lines of hydrogen from those which were recorded in the spectrum of Nova Aurigæ, there remain forty-four lines for comparison. Thirty of these, or about 70 per cent., agree approximately in position with either strong isolated lines or groups of lines in the spectrum of α Cygni.

It may be assumed that, taking into consideration the broad nature of the Nova lines, if there be any genuine connection between them and the lines of α Cygni, any close groups of separately distinguishable lines in the latter spectrum would be thrown together in the Nova spectrum, and appear as broad bands. A good instance of this appears in Campbell's list. He records a band extending from λλ 4534 to 4501. In the spectrum of α Cygni there is a strong line at each of the positions given, and between them there occurs a strong quartet of lines. The former are well enhanced lines of titanium, and the latter of iron. It seems extremely likely, therefore, that the six lines thrown together produce the apparently continuous band observed by Campbell.

If the stage of α Cygni has really been reached, the following considerations come in:—

[1] *Ast.-Phys. Jour.*, vol. xi. p. 807, 1892.
[2] *Ast.-Phys. Jour.*, vol. xii. p. 912, 1893.

In the orderly condensation of swarms, according to the meteoritic hypothesis, the earlier stages are—

Ascending temperature.

Cygnian	Dark lines, corresponding chiefly with the enhanced lines of various metals.
Polarian	Dark lines, comprising both arc and enhanced lines of various metals.
Aldebarian	Dark lines, chiefly corresponding to those which appear in the arc spectra of various metals.
Antarian	Mixed bright and dark flutings and dark lines. Bright hydrogen lines in those stars which are variable.
Nebula	Bright lines.

In the case of new stars, after the maximum of luminosity has been reached, however high they ascend, short of the apex of the temperature curve, this order must be reversed, and hence we should expect to find the spectrum varying in accordance with the foregoing sequence, but in the reverse order.

In Nova Coronæ (1866), according to the observations of Sir William Huggins and Dr. Miller, the absorption spectrum was very similar to that of *a* Orionis, which is a star of the Antarian group, so that the temperature attained was relatively low; this, indeed, is demonstrated by the fact that at present it shines faintly as an Antarian star, and doubtless did so before the collision. The collision, therefore, probably did not take Nova Coronæ very much above its initial stage of temperature, and when the disturbance was over it simply reverted to its old conditions.

The spectrum of Nova Cygni (1876) was not photographed, and as special attention was given by most observers to the bright lines, there is no satisfactory record of the absorption spectrum.

This now appears as a nebula, and doubtless it was a nebula to begin with, as Nova Coronæ was a star to begin with.

In Nova Aurigæ (1892), as we have seen, the comparison with *a* Cygni indicates that the Cygnian (that is, a higher) stage was reached, and in the final stages its spectrum corresponded with that of the planetary nebulæ, that is, a stage lower than that reached by Nova Coronæ. The intermediate stages, however, were not observed, possibly because the star was never very brilliant, and partly because of the difficulty of observing closely grouped lines, such as occur in the Polarian and Aldebarian stages when they are rendered broad by such disturbances as those which were obviously present in the Nova.

The observed maximum magnitude in the case of a new star will evidently depend upon the distance and size of the colliding masses, as well as upon the temperature produced by the collision. It is not remarkable, therefore, that there is no apparent relation between the greatest brightness and the temperature indicated by the spectra. Nova Coronæ, with its relatively low temperature, shone for a time as a second magnitude star, while Nova Aurigæ, with a much higher temperature, scarcely surpassed a star of the fifth magnitude.

I now return to Nova Persei.

If the idea that in the present Nova the swarm which gives the dark line spectrum resembles *a* Cygni be confirmed, as its temperature is reduced we may expect it to pass successively through some or all of the stages of temperature represented by stars of the Polarian, Aldebarian and Antarian groups, enhanced lines being first replaced by arc lines and then by flutings. Whether it remains at one of these stages or undergoes a further backwardation into a nebula will be a point of the highest interest.

If, like Nova Aurigæ, the present Nova should end as a nebula, it will furnish a most convincing proof of the fundamental metallic nature of nebulæ.

In conclusion, I wish to express my thanks to Dr. W. J. S. Lockyer and Mr. F. E. Baxandall, of the Solar Physics Observatory, and to Mr. A. Fowler, of the Royal College of Science, who have greatly assisted me in preparing the present note, and who, with the addition of Mr. Butler, of the Solar Physics Observatory, secured the excellent set of photographs and eye observations on the night of the 25th, from which the new knowledge has been derived.

The preparation of the slides I owe to Mr. J. P. Wilkie.

Solar Physics Observatory, February 28.

RECENT SWISS GEOLOGY.

THE glaciers of the Alps have lost considerably in bulk during the last forty years. This began at rather different dates, for some were still advancing in 1860, while by 1870 the diminution was very marked. Since then there have been slight oscillations, but until lately loss, on the whole, has exceeded gain; now, perhaps, the tide has turned. The report on the Unter Grindelwald glacier, by Prof. A. Baltzer,[1] describes the changes this glacier has undergone during the above-named period, and the results of some special observations made between 1892 and 1897. It was unusually well suited for the purpose, for its changes had been very conspicuous, and they had been already more closely observed than in many other glaciers.

In 1858, as is shown in a photograph, the glacier descended to the level of the valley beneath Grindelwald, where the Weisse Lütschine, in the summer of that year, issued from an ice cave. By 1870 the glacier had retreated up the glen between the Eiger and the Mettenberg, exposing three great rocky steps, the existence of which, it may be remarked, is anything but a favourable testimony to the excavatory power of ice; and its thickness higher up had so much diminished that the writer looked down a cliff, fully sixty feet high, on to the surface very nearly at the place where he remembered stepping easily from the ice to the rock on his way from the Strahleck Pass. A photograph representing the state of the glacier in 1895, on which Prof. Baltzer has indicated its former extent, shows how great the change has been; the modern ice stream looking, by comparison, like a caterpillar crawling to hide its diminished head in a rocky gorge (Fig. 1). One remarkable effect of this shrinkage (as described by Mr. F. F. Tuckett in the *Alpine Journal*, vol. vi. p. 30), was to lay bare, in 1871, a quarry in a bed of mottled pale red and green marble, which had once been extensively worked, but for about a century had been completely hidden beneath the ice. By the retreat of the glacier large areas of ice-worn rock have been exposed, several of which are represented by photographs in Prof. Baltzer's memoir. From study of these he concludes that there are two forms of ice-erosion; one—the ordinary—smoothing or abrading of the rock surfaces; the other, a tearing and a splitting off of fragments in cases where the rock is much traversed by divisional planes. As he deems this to have been less generally recognised, he illustrates it by photographs. It is difficult without actual examination of the localities to form an opinion on this point. That the rock, chiefly from mechanical causes, is readily broken is beyond question; but, though the fragments thus formed would be more easily removed than from a solid mass, it is doubtful whether the ice plays more than a secondary part, so that the remark would be equally true of any other kind of erosion. Given an irregular surface, the friction of a body moving over it would tell upon the prominences; but probably more pieces fall away than are broken away.

[1] Vol. xxxiii., part 2, of the *Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft.*

The more minute observations on the changes in the volume of the glacier, which have been carried on from 1892 to 1897, prove constant variation, and suggest a connection with the prevalent temperatures. It is to be hoped these will be continued, for they will aid in the discovery of the causes to which the greater changes are due. The past history of the glacier shows a marked period of advance to have begun about the year 1600, reaching a maximum in 1620, after which it retreated. A strong advance set in at the beginning of the eighteenth century, and it attained a maximum just a hundred years after the former one, the ice then retiring. About 1743 it again advanced, but only for a short time, and this was followed by a marked retreat. But from 1770 to 1779 there was a great advance (which probably buried the marble quarry, and, so far as is known, hid it for nearly a century). But since then the oscillations have been considerable, for two periods of advance are recorded, one from 1814 to 1822, the other from 1840 to 1855, the effect of the latter remaining, as has been said, for four or five years. It is at present difficult to explain these singular changes of volume in the glaciers ; very probably they are connected with both winter snowfall and summer temperature, but the former, as chiefly affecting the upper part of a glacier, may be some years before it produces an effect at the lower end, while that will be more immediately sensitive to summer warmth. Hence each glacier must be separately studied, as this one has been by Prof. Baltzer. The importance of the investigation is now generally recognised, and that not only in the Swiss Alps. In these, according to Dr. Richter (*Archiv. Genev.* vi. 1898, p. 22), of fifty-seven glaciers observed in 1897, fifty were still decreasing, five were stationary, and twelve were increasing, so that it will evidently be difficult to fix very precisely a date for the maximum and minimum of a whole region.

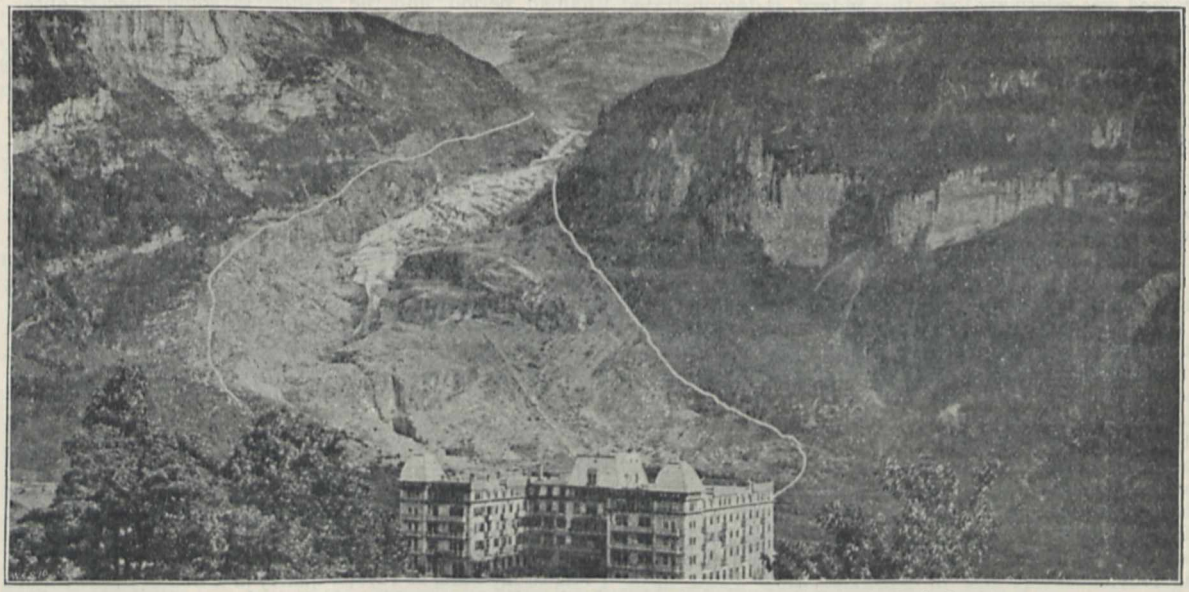


FIG. 1.—The Unter Grindelwald Glacier in 1895. The white lines show the extent of the glacier in 1858.

Other memoirs recently issued by the Swiss Society of Natural Science deal with various subjects. Vol. xxxvi. (1899), Part i. contains two memoirs. One, by Dr. M. Standfuss, "Experimentelle Zoologische Studien mit Lepidopteren," illustrated by five plates, is an investigation of the effect of temperature, either continuously higher or lower than the average, but within the possibilities of nature, upon the imago of lepidoptera, the pupa of which have been thus treated. The cold, speaking generally, seems to reduce the size of the imago and makes it paler in colour, the heat having the contrary effect. The second memoir, "Monographie des Genus Elaphoglossum," by Dr. H. Christ, illustrated by four plates, is an elaborate botanical study.

Vol. xxxvi. (1900), Part ii. also contains two memoirs. One is by Prof. Ed. Fischer, "Untersuchungen zur vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen," illustrated by six plates and four cuts in the text, in which the relationships of the several forms are elaborately worked out. The other, by Dr. Emil Hugi, "Die Klippenregion von Giswyl," with six plates of sections and scenery, gives a full and careful description of one of these remarkable isolated rock masses, which are so frequent on the northern margin of the Alps and Carpathians. Sections representing the actual stratigraphy of the district are followed by others showing how this has been produced ; namely, by an overfolding followed by denudation, more especially affecting one of its limbs, and that by a second folding in this portion which has resulted in an overthrust.

Dr. Zschokke's memoir on "Die Tierwelt der Hochgebirgsseen," vol. xxxvii. (1900), pp. 400, with three maps and eight plates, gives much information on the physiography of the lakes of the Higher Alps, as well as a full account of their fauna. Here we find local reproductions of almost Arctic conditions in the midst of a temperate zone, and the fauna, in many respects, may be representative of glacial times. During these the lakes would be mostly, if not wholly, occupied with ice, but as it gave place to water this would be peopled by organisms, partly transferred by birds, partly making their way up stream from lower levels. Of this fauna Dr. Zschokke gives lists and descriptions. It is far from inconsiderable, having representatives of the majority of the invertebrata from the rhizopods upwards, with fishes and amphibians as vertebrates. Of the former, thirteen species are mentioned as occurring in lakes over 1400 m. above sea-level, *Salmo lacustris* and *S. salvelinus* having the highest range, for they occur in the Finailsee, 2690 m. Of amphibians six are enumerated, of which *Rana fusca* reaches the greatest elevation, being found up to 2400 m.

Dr. Zschokke's memoir is full of most valuable information and will be for long consulted by all interested in the distribution of life in the Alps.

Dr. Lorenz's monograph[1] deals with a rather isolated range of no great elevation, the culminating point, the Fläscherspitz, being only 1137 m. above sea-level, but it is one of great interest, which has attracted the attention of Swiss geologists for quite half a century because of its palæontology (the strata range from the Inferior Oolite upwards) and its tectonic structure. On the former ground it is chiefly remarkable, because here the fauna of the "Dogger" changes from its western to its eastern facies; on the latter because its geological structure is extremely complicated, and the relation which it bears to the neighbouring parts of the chain is not easily determined. The range has a general trend from north-west to south-east, the smaller part being in the Principality of Liechtenstein and the rest in Canton Graubunden. A study of the tectonic structure shows the range to consist of Jurassic and Neocomian beds, its south-eastern portion being formed of a much-broken overfold pointing towards the north-west, followed in this direction by a synclinal, which includes a minor overfold and has its axial plane roughly parallel to the former one. Dr. Lorenz connects these crust wrinklings with the famous "Glarner doppel-falte," which, however, he would prefer to call the "Glarner Bogen." The structure, in his opinion, is a result of the sinking (senkung) of the Oberland massif. He gives a succession of sections along the line of curve to prove the relationship, but we should substitute "upheaval" for "sinking" in explaining the structure. The crystalline core indicates the region where the oldest rocks have been raised to the greatest elevation, and have thus produced, by their resistance to further movement, the wrinkling, overfolding and overthrusting of the peripheral sedimentary masses. He thinks also that there have been two sets of movements, which indeed is corroborated by other regions of the Alps.

[1] "Monographie der Fläscherberges." By Dr. Th. Lorenz. Beiträge zur Geologischen Karte der Schweiz, Neue Folge, X Lieferung, with geological map, 4 plates of sec ions, and 13 other illustrations. Pp. 64.

GEORGE FRANCIS FITZGERALD.

THOSE who knew the University of Dublin twenty years ago will remember that the idol of the undergraduates and the hope of the older men was George Francis FitzGerald. He was of high intellectual lineage on both sides: his father was the most distinguished prelate in the Irish Protestant Church, and his uncles are men of large and original scientific achievement. His early education was conducted at home, in company with his two brothers, one (now professor of engineering at Belfast) a year older than himself, the other younger. He was good at physical science and all subjects requiring close observation, from his earliest years; and the ambition to become a master was soon aroused. The mathematical and physical tendency seems to have come mainly from his mother's side, his strong metaphysical bent from both sides of the family. In his student career he attained all the distinctions that lay in his path with an ease, and wore them with a grace, that endeared him to his rivals and contemporaries. On taking his first degree in 1871 he settled down, at twenty years of age, after the manner of the pick of the Dublin men, to a wide and independent course of reading with a view to a Fellowship. At that time vacancies were of very rare occurrence; so that it was not until 1877, on his second time of trying, that he attained the position of a Fellow of Trinity College. The examination in mathematical and physical science included papers on selected portions of the works of the great mathematical physicists; to a mind of the calibre of FitzGerald's, the early and intimate acquaintance which was thus promoted with the classical writings of Lagrange and Laplace, of Hamilton and MacCullagh, with their modes of thought as well as the results that they won, must have formed the best possible foundation for a scientific career. A training which aims only at sound knowledge and established results may find a shorter path in the study of the latest text-books of the day; but if a man is to be a true leader he must be interested even more in the philosophy than in the facts of his science. It must have been of rare value to a maturing mind of keen temper to observe closely at first hand the lines of attack of the great masters of the past age on problems which were crystallising into knowledge. Acquaintance with the present state of science, however detailed and exact, assumes its full value as an instrument of progress only when it is accompanied by appreciation of the difficulties that had to be circumvented in order to reach it, and by observation of the way in which complete logical precision may have to be attained at the expense of temporary limitation. The subjects that were grouped around physical optics were approached in Dublin, in those days, through the study of MacCullagh's optical memoirs; these writings were based on a remarkable combination of keen analysis of the facts and direct application of the generalised dynamical methods of Lagrange, thus presenting all that interest of nascent scientific discovery which the same topics still retain in their wider connection with the general problem of the æther. Whatever may be the defects of MacCullagh's analysis, it had the saving merit that it put forward no claim to finality; its critical comparison and contrast with those of Cauchy and Neumann and Green, and the difficulties which its procedure suggested from a restricted dynamical point of view, were the very things with which a mathematical analyst might be impatient, but over which a mind constituted like FitzGerald's would eagerly brood. When the great Treatise of Maxwell, which threw a flood of light on these fundamental problems from an altogether novel source, came into hands thus prepared for its appreciation, it is not surprising that a main scientific interest became established for life.

After obtaining his Fellowship, FitzGerald became attached to the department of experimental physics, and conducted or influenced much of the teaching in physical science, in addition to carrying on the work of a College tutor. In the latter capacity he was eminently successful. It was an object of ambition to gain admission to his side, which was always full a long time in advance. He had considerable athletic prowess, which was kept up for many years; and his services were in great request for presiding over and administering the athletic organisations of the College. He gave up tutorial work in 1881 on succeeding to the chair of experimental philosophy, which he held for the rest of his life. He became a Fellow of the Royal Society in 1883, and in 1899 received the award of one of its Royal Medals.

In those early years there were three main centres of development of the new departure in electrical theory which has since revolutionised the whole domain of physical science. Maxwell's own presence as a professor had guided the trend of physical thought at Cambridge predominantly into that direction which it has since largely retained; in Berlin, Helmholtz was devoting his great powers and turning the attention of his pupils to the discussion and elucidation of the subject; while in Dublin its study and investigation became vital under FitzGerald's lead and influence. His chief formal memoir, "On the Electromagnetic Theory of the Reflexion and Refraction of Light," was presented to the Royal Society at the end of the year 1878; it retains a place among the classical writings of modern physics. In the years from 1880 to 1885 he contributed to the

publications of the Royal Dublin Society, of which he was secretary for about ten years, many short condensed papers, on the optical and electric influence of the Earth's motion, on the amount of the electric radiation from an alternating current, on a model illustrating the properties of the æther, all of which went straight without superfluous analysis to the core of the matter on hand, and eminently merit Mr. Heaviside's description (*infra*) as "not large in bulk, but very choice and original." At the present time, after so much progress has been made in the abstruse but fundamental topics with which they deal, these pioneering papers, like Maxwell's Treatise on which they are based, still repay careful study. It is much to be desired that they may soon be republished in more accessible form, along with their author's other scattered writings.

As years passed, the calls on his time became more numerous, in the tender care of his family, in the discharge of public duties, and in response to requests for advice from an ever-widening circle of devoted scientific friends; so that his opportunities for continuous study almost disappeared. But he always managed to keep wonderfully abreast of scientific progress in a very wide range of knowledge, and spent most of his spare time in deeply pondering over its meaning. The scientific public of this country was placed very early in touch with Hertz's magnificent and decisive verification of electrodynamic theory, through the attention commanded by FitzGerald's brilliant exposition in his British Association address of 1888. It was fitting that this should come from him; for, as Lord Kelvin has recalled, he had five years before pointed out to the British Association the possibilities of the very plan of obtaining electric radiation of manageable wavelength which in Hertz's hands has led to success. His own activity became more and more absorbed in the administration of the College laboratory, rendered more arduous by limited funds and distance from other scientific centres, and in the promotion of the practical and technical side of physical science. Yet he still followed very closely the progress of abstract mathematical physics; hardly any one could be named who had thought more deeply, or whose knowledge was more available and many-sided, more entirely free from all prepossession or prejudice. At the meeting of the British Association last September he was, as usual, present, and was of course one of the prominent figures; the writer, speaking from full knowledge, can testify that the proceedings of the physical section were interesting and successful from one cause beyond all others—the assiduity with which he devoted himself to attendance, and the unceasing flow of valuable suggestion and appreciative criticism which he contributed. His stores of knowledge were ripening and maturing in fibre year by year; his memory was unfailing, and each new fact or phenomenon seemed to find its place at once in the setting to which it belonged. Whatever views were presented to him, however much they jarred with his own ideas, were certain to receive patient and careful consideration. There was nobody who did more to encourage younger men and to bring out what was best in them; the time which he was accustomed to devote without stint to the elucidation and improvement of the work of others sadly diminished the opportunities for work more especially his own. His advice and judgment were valued over the whole range of physical science, not less in foreign lands than at home, notwithstanding that he published so little. When a physicist or physical chemist came to a puzzle or paradox, or was in doubt between various plans of procedure, it seems to have come to be almost the natural course to write to FitzGerald. A letter of inquiry or criticism always elicited a prompt reply, entirely devoid of pretension to magisterial authority, but certain to bring out new aspects of the subject and exhibit its connections with other problems. He was constantly acting as referee of scientific papers for the Royal Society and other bodies, and was accustomed to interest himself in them as if they were his own work.

He frequently acceded to requests to serve as examiner on physics in other Universities, notwithstanding the serious drafts on his time and energy that were involved; his connection with the University of London in that capacity has been almost uninterrupted since 1888. He became one of the Commissioners of National Education in Ireland in 1898, and immediately threw himself into the task of reconstituting primary education on more practical lines, undertaking a tour through the United States in the autumn of that year in order to study American methods. Last year he was appointed a member of the Irish Board of Intermediate Education, and much was expected from his assistance in working out the difficult problems that engage their attention. In his own University he was always in the forefront of progress, and often wished to move faster than an ancient institution is usually inclined to allow.

In a private letter, in response to a hurried intimation of FitzGerald's death, Mr. O. Heaviside writes as follows:—"I only saw him twice knowingly, once for two hours, and then again for six hours, after a long interval; yet we had a good deal of correspondence at one time, and I seemed to have quite an affection for him. A mutual understanding had something to do with that. You know that in the pre-Hertzian days he had done a good deal of work, not large in bulk but very choice and original, in relation to the possibilities of Maxwell's theory, then considerably undeveloped and little understood; and his way of looking at things was more like my own than anybody's. Well, he found that I had done a lot of work in the same line, and he was most generous in recognising and emphasising it. Too generous, of course. You remember that review of my 'Electrical Papers' that he wrote? No one knew better than myself how to allow for his temperament and desire to help me. He used to write to me a good deal about electromagnetic problems, and I laid down the law to him like—like myself, in fact. He took it all very pleasantly. But I knew all the while that he had a wider field than myself, and no time to specialise much. He had, undoubtedly, the quickest and most original brain of anybody. That was a great distinction; but it was, I think, a misfortune as regards his scientific fame. He saw too many openings. His brain was too fertile and inventive. I think it would have been better for him if he had been a little stupid—I mean not so quick and versatile, but more plodding. He would have been better appreciated, save by a few."

Prof. W. Ramsay writes on the day following his return from India, when the first news came to him:—

"I understand that it has been thought right for some of FitzGerald's friends to contribute each a short notice of him as a tribute to his memory. The blow is so recent and the feeling of personal loss so acute that this is a difficult task. But to me, as to many others, FitzGerald was the truest of true friends; always interested, always sympathetic, always encouraging, whether the matter discussed was a personal one, or one connected with science or with education. And yet I doubt if it was these qualities alone which made his presence so attractive and so inspiring. I think it was the feeling that one was able to converse on equal terms with a man who was so much above the level of one's self, not merely in intellectual qualities of mind, but in every respect. I know that FitzGerald would have been the last to acknowledge this, for he had no trace of intellectual pride; he never put himself forward, and had no desire for fame; he was content to do his duty. And he took this to be the task of helping others to do theirs. This was happily expressed by the President of the Royal Society in awarding him one of the Royal Medals, when he alluded to the great influence exercised on the progress of science, due to FitzGerald's placing his services

unreservedly at the disposal of every one anxious to carry on physical or chemical research.

"I do not think that FitzGerald ever harboured an angry or uncharitable thought about any one, nor have I ever known any one who, knowing him, did not regard him with the greatest love and respect; for he was known to be absolutely true to himself, and therefore to his fellow men. Although he held strong views on many points and could defend them with vehemence, his argument was never a personal one; and it was obvious that he was actuated solely by a love of truth, and that his only object was to defend what he thought to be right. Moreover, what FitzGerald thought to be right was pretty sure to turn out to be right in the long run. May I suggest as the reason why FitzGerald was so universally beloved, that he was a Christian in the truest sense of the word, and that he followed very closely the footsteps of his Master?"

In a letter from Prof. Tilden to the *Times* of February 27, in which, as Dean of the Faculty of Science of the University of London, he "places on record their high appreciation of his brilliant qualities as a man, as a teacher, as an investigator, as a leader of scientific thought," he goes on to speak on his own behalf of FitzGerald's modesty and extreme unselfishness, of the clarification and enlightenment which many a scientific man has owed to his inspiring conversation, of the "most memorable discourse" which he delivered to the Chemical Society in 1896 as the Helmholtz lecture. The key of deep personal loss is struck in a touching and eloquent tribute communicated to the *Electrician* by Dr. O. Lodge, and in a shorter notice in the *Times* and the *Philosophical Magazine*, coming from one who writes with authority on the industrial applications of science.

Prof. Perry, speaking as President of the Institution of Electrical Engineers, records that "in all engineering questions he had not only the laboratory experimenter's point of view, but also that of the practical engineer. His was a mind that saw the bearing of all scientific knowledge on any practical problem. I have no hesitation in saying that in Prof. FitzGerald our profession has lost one of its greatest, most beneficent forces." In proposing a vote of condolence, Prof. Ayrton spoke to the same effect.

The pride and affection which he inspired in his own College is revealed in a masterly appreciation contributed to the *Athenaeum* by one of his colleagues on the literary side. "His appearance was not unworthy of his fame. More striking he was than handsome; but his ample grey locks and beard, his furrowed brow, his penetrating eyes, reminded one of the bust of some Greek philosopher, which we cannot look upon without that instinctive feeling of respect which intellect and character command among civilised men."

For some years he had been in precarious health. He was subject to recurring attacks of digestive trouble; but the buoyancy with which he threw them off, and the unabated zeal with which he returned to his scientific pursuits in the intervals of health, concealed the real gravity of the situation. News of a sudden crisis was received in London and Cambridge with universal feelings of deep concern. He has now passed (on February 21) from the scene of an active and most beneficent career, in the fiftieth year of his age. His memory will not die. It will be carried on by a school of experimental physics, including the names of Joly and Preston and Trouton and W. E. Wilson, which he was mainly instrumental in creating; while in a wider sphere men such as Heaviside and Lodge and Ramsay and Perry have been proud to testify to their indebtedness and to claim him as their master. His scientific place will be henceforth alongside Rowan Hamilton and MacCullagh and Humphrey Lloyd, and the other famous men who have secured for the Dublin school so prominent a position in the edifice of modern physical science. In the higher domain of heart and conduct the recollection of his qualities will be an abiding treasure to all who knew him. J. L.

NOTES.

WE learn from the Political Notes in the *Times* that the recent dismissals at Coopers Hill College were discussed on Monday at a meeting held in one of the committee-rooms of the House of Commons. The meeting was convened by Sir W. Anson, Sir Michael Foster, Mr. Milward, and Mr. C. P. Trevelyan; and the attendance included Mr. Haldane, Mr. Emmott, Mr. C. Douglas, Mr. Yoxall, Mr. Palmer, Mr. Spear, Mr. E. Gray, Mr. Lecky, Mr. Cohen, Mr. J. G. Talbot, Mr. Bartley, Mr. Norman and Mr. Howard. Apologies for inability to be present were received from Sir R. Jebb, Sir J. Batty-Tuke, Mr. J. A. Campbell, Sir L. McIver and Mr. Leigh-Bennett. This list, it will be seen, includes not only members of all the British parties, but the representatives of all the Universities. It was decided to request another interview with Lord George Hamilton, in order to press upon him the necessity for an inquiry into the whole circumstances. Failing success in this endeavour the matter will be brought forward in the House at the earliest possible opportunity.

IN the House of Commons on Tuesday, Lord George Hamilton said, in reply to a question by Mr. O'Mara:—Colonel Ottley's suggestions for the rearrangement of the course of study at Coopers Hill are dated June 13, 1900, and the report of the board upon them is dated the 24th of the same month. The visitors who signed the report are, with scarcely an exception, experts of the highest authority upon the technical questions submitted to them, and thay are selected in order that they may advise as experts.—Mr. O'Mara asked whether the conclusions were come to by the committee at a single sitting. Lord G. Hamilton said that the committee had the memoranda some time before them. The report was a long and exhaustive one, but he could not say whether its consideration only occupied one sitting. Mr. O'Mara: "Was not the meeting to consider the report called for the 24th, and did not the committee report the same day?" No reply was given. In answer to a further question by Mr. O'Mara, Lord G. Hamilton said:—Colonel Ottley was informed when he became president that the existing system of instruction was not considered to be satisfactory and required remodelling. Colonel Ottley has an unbroken experience of twenty-five years' service in India in almost every department of civil engineering, and the special knowledge he thus obtained of the training and capacity of the young engineers working under him from Coopers Hill pre-eminently qualified him to advise as to the special technical training required for the Public Works Department in India.—Mr. O'Mara asked whether he was to understand that the code of regulations, which provided that the president should be assisted by the teachers in regulating the course of studies, was not carried out by the present president. Lord G. Hamilton understood that Colonel Ottley had been in frequent communication with the teachers.

A SMALL zoological expedition is just starting for the Malay Peninsula. It consists of Mr. N. Annandale, who was a member of the "Skeat" expedition to the Siamese Malay States in 1899, and Mr. H. C. Robinson, hon. research assistant in the Zoological Department of University College, Liverpool. They intend to settle for a year in the native State of Jalor, near the east coast of Lower Siam, and to explore the neighbourhood of Patani and Biseret. Collections will be made in all branches of natural history, while one of the special objects of the expedition is the study of the pre-Malayan tribes.

of Negrito stock who inhabit the centre of the peninsula. A thorough investigation will also be made of the fauna—both living and extinct—of certain very large limestone caves which are found in the district, and are said to extend for great distances underground. The birds of the district will also be studied, and observations made on mimicry and allied phenomena. The ethnographical work ought to be interesting, since Jalor is on the borderland in which the Siamese and Malay races meet. Mr. Robinson is supplied with dredges and tow-nets for the investigation of the marine fauna, and he proposes, by the method of pumping sea-water through fine silk nets, to make a collection of the surface plankton of the Red Sea and Indian Ocean on the voyage out.

COMMANDER R. F. SCOTT, R.N., in naval charge of the British Antarctic Expedition, has stated to a representative of Reuter's Agency that the preparations for the British Antarctic Expedition are now practically complete. The *Discovery*, the expedition's ship, will be launched on March 23, and, after she has been handed over by the contractors, will come round to London, where her equipment and provisions will be put aboard. The *Discovery* has been built on whaler lines, only with greatly increased strength to withstand ice pressure. She is 171 feet long, and 34½ feet beam, and has 1500 tons displacement. She will have auxiliary steam, and is fitted with engines of the latest type. In her construction the lines of the *Fram*, though carefully studied, have not been adopted, as Nansen's ship would have been ill-adapted for the heavy seas the *Discovery* will have to encounter. The expedition will leave London in July or August, and will proceed to Melbourne, reaching there in November. The actual work of the expedition will then begin. The naval staff, in addition to Commander Scott, consists of Lieut. A. R. Armitage, Lieut. Charles Royds, and two other officers yet to be appointed. The scientific direction will be under Prof. Gregory, of Melbourne University, assisted by Mr. Hodgson (biologist), and Mr. Shackleton (physicist). The medical staff will consist of Dr. Koettlitz and Mr. Wilson.

HIS MAJESTY THE KING has signified to the president and council of the Marine Biological Association his pleasure in becoming the patron of the Association.

A MEETING of the International Association of Academies will be opened at Paris on April 16. Several delegates of the Royal Society will be present.

THE Bessemer gold medal of the Iron and Steel Institute for 1901 has been awarded to Mr. J. E. Stead, of Middlesbrough, in recognition of the value of his researches on iron and steel. The presentation will take place at the annual general meeting on May 8. Owing to the death of the Queen, the annual dinner will not be held. The autumn meeting will be held in Glasgow, simultaneously with the International Engineering Congress on September 3 to 6.

THE Naples Academy of Mathematical and Physical Sciences has awarded the mathematical prize of 1000 lire for 1899 to Dr. G. Torelli, professor at Palermo. The subject fixed was the totality of prime numbers. The theme for the next award is the theory of invariants of the ternary biquadratic considered preferably in relation to the conditions for splitting into lower forms. The essays may be written in Italian, French or Latin, and must be sent in, designated by a motto, before March 31, 1902.

THE success of the banquet recently given to Prof. Marey by the Scientia Club of Paris, has induced a number of his colleagues, friends and students to form themselves into a committee having for its object the presentation to him of a medal in token of their esteem. There are probably others who would like to show their appreciation of Prof. Marey's work by subscribing to the fund being raised for the preparation of the medal to be struck in his honour. Subscriptions should be sent to M. P. Masson, 120, Boulevard Saint-Germain, Paris.

THE Easter cruise to the Isles of Greece, organised by Dr. Lunn and Mr. Perowne for schoolmasters only, is, we understand, already full. As the idea is evidently an attractive one, another cruise to the principal cities of Spain has been arranged for the Easter vacation, under the direction of Mr. E. H. Blakeney, of the Sandwich Grammar School. The party will leave London on the Wednesday morning before Easter, spending Good Friday at Burgos, Easter Day at Madrid, and visiting Cordova and Seville. Those who then wish to return to England can do so, and will get into the direct express at Seville. A party, however, will be formed to visit Granada, returning from Granada to Seville; and a further section will visit Toledo, those who have not time to take in both cities going straight back, after the visit to Granada, from Seville to London. During the cruise Mr. Blakeney will deliver a couple of lectures on (1) "The Moorish Domination in Spain, (2) "Some Cities and Cathedrals of Spain." We should like to see similar cruises organised for men of science, as has already been done in connection with the *Revue générale des Sciences* (see p. 381).

THE fifth triennial International Congress of Physiologists will be held at Turin, September 17 to 23 of this year. The Institute of Physiology of the University, under direction of Prof. Angelo Mosso, will be placed at the disposal of the Congress. The membership of the Congress is open to (1) representatives of physiological and similar purely scientific societies, for example, the Physiological Society, England; the American Physiological Society; Société de Biologie, Paris; Physiologische Gesellschaft, Berlin. (2) Persons proposed by the National Committee of their own country. In connection with the Congress an exhibition of apparatus will be open from September 14 to 23. To it the Marine Biology station at Naples will contribute a collection of marine forms of animal life useful for comparative physiology. In addition to the General Secretaries, for the work of preparation toward the the fifth Congress, Dr. F. S. Lee, secretary of the American Physiological Society, will discharge secretarial duties in the United States. Those desirous of attending the Congress or contributing to the exhibition should communicate with Prof. Sherrington, General Secretary for the English-speaking countries, Thompson Yates Laboratories, the University College, Liverpool.

THE *British Medical Journal* announces that Dr. Gerhard Armauer Hansen, the discoverer of the lepra bacillus, will celebrate his sixtieth birthday on July 29. His friends and admirers, both in and out of the medical profession of Norway, have decided on that occasion to erect a marble bust of him in the Lungegaard Hospital, Bergen, where he discovered the bacillus. A committee of Norwegians has been appointed to solicit subscriptions from Dr. Hansen's friends in the Scandinavian countries, and Prof. Lassar, of Berlin, has undertaken to collect subscriptions for the purpose on the continent.

A CONFERENCE was held at Liverpool on Monday between representatives of the Liverpool and Manchester Chambers of Commerce and the Liverpool School of Tropical Medicine, with reference to the unhealthy conditions of the towns on the West African coast. Mr. A. L. Jones, who presided, said that the West African merchants and shipowners would do well in their own interest, as well as in the interests of humanity, to take advantage of anything that would tend to improve the condi-

tions of life of the people they might send to the tropics to push their commerce. Hitherto Liverpool merchants had had more to do with the development of trade in that part of the world than perhaps any other merchants. That trade promised to be of great magnitude, and no amount of time and money could be devoted to a better purpose than to improve the conditions of life on the West Coast. They in Liverpool had done something by establishing the School of Tropical Medicine, which had inspired the whole world with a sense of its responsibility. Prof. Boyce suggested that the chambers should send out an expedition of experienced medical men and a young engineer to draw up definite schemes for drainage and water supply. Mr. A. Hutton, chairman of the African section of the Manchester Chamber of Commerce, declared that the sanitary condition of some West African coast towns was disgraceful. If they decided that a commission should be sent out they had better send it themselves, and not wait for the Government. Major Ross agreed with the suggestion to send out another commission. Municipal regulations, he said, were absolutely ignored on the coast, and the Government should be urged to take an interest in the matter. It was unanimously decided to ask Mr. Chamberlain to receive a deputation to consult with him on the questions of sewage disposal, water supply, malaria, and dysentery in West Africa.

A REGRETTABLE state of affairs with regard to the preparation of a Lexicon of the native language of New Zealand, is described in an obituary notice of the Rev. W. Colenso, F.R.S., just published in the "Year Book of the Royal Society." We trust that the following plain statement of the position of the work will lead to something being done to ensure its completion. "In 1861 Mr. Colenso entered Parliament as representative of Napier, when he moved and carried a resolution that the time had come for the State to make an organised attempt to rescue the dying language of New Zealand from oblivion. Being at the time unable to undertake such a work himself, he offered to present the Government with his whole collection of materials for it. In 1865 the Government took up the subject, and in 1866 Mr. Colenso, then being more at liberty, was successfully urged, as the one man in New Zealand thoroughly qualified, to take up the work. Seven years was fixed for its completion, the remuneration to be 300*l.* per annum. Before half that period had expired, another Ministry, with other views of the value of a Lexicon, had supervened, by whom its author was informed that, half the time allowed for the completion of the work having expired, one-half of the work itself should have been in the press. On the unreasonableness of this view in the case of a work requiring innumerable cross references being represented, a committee of qualified persons was appointed to examine and report on the progress made. The report was to the effect that the author had advanced further in his work than was due up to the time employed, that thousands of pages had been written from the first word to the last, and that seven years was too short a time for the completion of a work of such magnitude. The report was withheld from Parliament, funds for proceeding with the Lexicon were refused, and the unfinished materials were thrown upon the author's hands, one finger of which was permanently disabled by writer's cramp, due to his labours on the Lexicon. A sample portion was, however, demanded to be laid before the House, and letter A produced, but this was "lost," and not discovered till eighteen years afterwards in a departmental pigeon-hole. It was then printed and distributed by Government, partly at its author's expense, in the year preceding his death. Its appearance, dedicated to his old friend Sir George Grey, has been followed by urgent representations to the Colonial Government that the whole materials, which are bequeathed to the State, should be entrusted to a competent editor for publication."

WE have received from Dr. Hergesell, president of the International Aëronautical Committee, a preliminary account of the results of the ascents on February 7. A manned balloon from Cracow attained a height of 4000 metres and recorded a minimum temperature of −11° F. One of the unmanned balloons from Berlin reached an altitude of 9490 metres and registered a temperature of −67°; a manned balloon was also sent up. Two unmanned balloons ascended from Trappes (near Paris); one of them reached 12,700 metres and recorded a temperature of −67°. From Strassburg two ascents were made; a paper balloon rose to 8000 metres and a temperature of −49° was registered. Ascents were also made from Vienna and Bath. M. Teisserenc de Bort has promised to send one of his co-adjutors to Moscow with the view of organising unmanned balloon ascents from that place.

An interesting description of the Lake Superior mining district is contributed to the *Century Magazine* by Mr. W. Fawcett. The yearly output of ore in the district amounts to twenty million tons, which is more than double the product of any other iron-mining region in the world during any single year in history. None of the mines in the Lake Superior country are more than a hundred miles from the lake, but the hills on the summits of which the deposits are found are, in some cases, more than a quarter of a mile above the level of the lake. Several methods of mining are in vogue in the four ranges of the iron region. On the Mesabi range the ore is taken out by means of steam-shovels. The Mesabi ore is found in great masses on the slopes of hills, and virtually the only task before the miner is to scoop it up and load it into the trucks standing on the siding, which are run into the mine just as trucks are often backed into a stone-quarry. Out of some of these immense holes in the ground more than a million tons of ore are taken every year, and it is all dipped up by steam-shovels. Improved systems of mine haulage are also used. Electric or compressed-air motors draw trains, each composed of about twenty trucks, from the mouth of the shaft to the point underground where the ore is being dug out, and machine-drills, driven by compressed air, have displaced the hammer and drill of the pioneer miner.

AT the Institution of Civil Engineers on Tuesday, February 26, Messrs. W. H. Stanger and B. Blount described the rotatory process of manufacturing cement. By this process it is possible to approach the theoretical ratio of acids to bases, and to obtain a cement which is stronger and sounder than the best cements commercially prepared by discontinuous processes. The largest and most complete installation of rotatory kilns is that at the works of the Atlas Cement Company of Northampton, Pennsylvania. The output of this works is between 8000 and 9000 tons per week, *i.e.* about four times the amount of most large European works, and the whole quantity is obtained from rotatory kilns. The raw materials used by the Atlas Company are a calcareous shale and a limestone. These are crushed, dried, finely powdered and fed mechanically into rotatory kilns. The kilns are steel cylinders 60 feet by 6 feet 6 inches, set on a slight incline and capable of being rotated by suitable gearing. The fuel is powdered coal driven in by a blast of air through an injector burner at the lower end of the kiln. An intensely hot flame, readily controllable, is thus produced, and heats the raw materials introduced at the upper end of the kiln, and caused to travel downwards in a direction opposite to that of the blast. The materials are thus heated systematically, and at the lower end of the kiln near the burner become converted into clinker. This falls into a rotating cylinder lined with firebrick, through which passes a current of air serving to feed the coal-dust flame. A great part of the heat of the clinker is thus regenerated. The clinker is then roughly crushed between rolls which work under

a spray of water and passes through a final rotating cooler into trucks, by which it is conveyed to stock-boxes over the grinding-plant. From the crushing of the raw materials to the storing of the finished cement, no hand labour was employed, all conveyance, distribution and transmission being done mechanically.

IN the *Journal* of the Royal Statistical Society, lxiii. part iv., Mr. Thomas Welton discusses the distribution of population in England and Wales and its progress from 1801 to 1891. In 1801 the author finds (1) that urban populations, including most small towns, amounted to 35 per cent. of the total population; 2) that rural districts, exclusive of areas surrounding towns, included 91 per cent. of the total area; (3) that "populous" areas were less than 1 per cent. of the whole; (4) that the density of population averaged 47 per square mile in sparsely peopled districts and 103 per square mile in the better peopled rural districts. In the unprogressive districts, Mr. Welton finds much uniformity (1) in the comparative large increase of population from 1811 to 1821; (2) in the maintenance of a reduced increase from 1821 to 1841; (3) in the prevalence of low rates of increase in unprogressive towns and populous districts from 1851 to 1891; (4) in the absolute decrease of population in rural districts, with certain exceptions, from 1851 to 1891. The general inquiry brings out the vast change in the territorial distribution, the amount and the means of support of our population since 1801, and at the same time the moderate extent of country affected by the developments of this period.

THE whole of Part i. of vol. lxix. of the *Zeitschrift für wissenschaftliche Zoologie* is devoted to an important paper by Herr J. Meisenheimer on the developmental history of the bivalve mollusc *Dreissensia polymorpha*. In addition to figures in the text, the memoir is illustrated by thirteen beautifully executed plates.

WE have received the tenth annual report of the Society for the Protection of Birds. The advance of this body, both in the number of its members and in its financial resources, is reported to be steady, although its efforts might be greatly extended if a larger income were at the disposal of its council. Among the efforts of last year, a special crusade has been made against the pole-trap; and, as a model to other landlords, a paper of instructions has, by permission, been issued to the gamekeepers on the estate of Lord Barnard, forbidding the use of this instrument and the destruction of certain specified birds. The practice of ornamenting poulterers' shops with the carcasses of non-edible birds at Christmas has also been discouraged. The announcement of several clutches of great skua eggs for sale in London last June drew the attention of the Society to the necessity of further protection for the bird in question; and on their initiation a proposed sale at the same time of the eggs of other British birds taken during last season was abandoned. Attention is also directed to the resolution recently passed by the B. O. U., discouraging the collecting of eggs or skins of certain of our rarer birds. The latter part of the report deals with work abroad.

IN the *Ibis* for January, Mr. Chalmers Mitchell, from the study of the anatomy of kingfishers, makes a further important contribution to a right understanding of that peculiar feature in the arrangement of the quills of the wings of certain birds now known as "diastaxy." It will be within the recollection of many of our readers that in 1899 Mr. Pycraft and Mr. Mitchell independently made communications to the Linnean Society in which they showed that the gap which occurs in the diastaxic wing is not due to the loss of a quill, whence they were led to abrogate the original term "aquinto-cubitalism." In his own communication Mr. Mitchell showed that among pigeons both "diastaxy" and "eutaxy" (a regular series of quills) might occur, and also that the latter was the more specialised type. Similar conditions are now shown to obtain among the kingfishers, in which also, as indicated by their myology, eutaxy is the specialised modification. The gradual change from perfect diastaxy to complete eutaxy in this group is most clearly explained by the diagrams illustrating Mr. Mitchell's communication.

ARTICLE 19 of vol. xiii. of the *Bulletin* of the American Museum of Natural History contains a revised memoir on the phylogeny of the European rhinoceroses, by Prof. H. F. Osborn. The author is of opinion that the rhinoceroses (inclusive of the Siberian Elasmotherium) are divisible into six distinct phylogenetic subfamilies, three of which are represented by existing members of the family. Rhinoceros proper, he considers, is now restricted to the Indo-Malay countries, as is Ceratorhinus, as represented by the Sumatran species, the two African species being assigned to a third genus, Atelodus. More importance is attached to the structure of the skull (especially the form of the nasal bones) than to that of the molar teeth, which may have been independently modified for grass-eating in two or more species. Accordingly, Elasmotherium, in place of being considered a specialised type akin to the white rhinoceros of Africa, is affiliated to the middle Tertiary Aceratherium. Again, the great two-horned rhinoceros of the Indian Siwaliks (*R. platyrhinus*) is removed from its association with the aforesaid African species to find a position next to the living Sumatran animal.

THE Council of the Zoological Society has given instructions for the publication of an index-volume to the new generic names mentioned in the "Zoological Record," vols. xvii.–xxxvii. (1880–1900). The volumes previous to vol. xvii. have been indexed in the "Nomenclator Zoologicus" of Scudder, published by the Smithsonian Institution in 1882. The contemplated index-volume of the "Zoological Record," in order to increase its usefulness, will include names omitted from Scudder's list and from the volumes of the "Zoological Record." Thus zoologists may have at their disposal (in the "Nomenclator Zoologicus" and the new index together) a complete list of all the names of genera and subgenera used in zoology up to the end of 1900. It is requested that any one who knows of names omitted from Scudder's "Nomenclator," or from the volumes of the "Zoological Record," will forward a note of them, together, if possible, with a reference as to where they have been noticed or proposed, so that the new list may be made practically complete. Such information should be addressed to the editor of the "Zoological Record," 3 Hanover Square, London, W.; or to Mr. C. O. Waterhouse, British Museum, Natural History, South Kensington, London, who is engaged in compiling the list.

THE *Journal* of the South-Eastern Agricultural College contains an article by the Principal, Mr. A. D. Hall, on the economic aspects of the cultivation of sugar beet in England. The matter is gone into very fully, both from the point of view of utilising the produce as food for farm stock, and of the manufacture of sugar. In a feeding experiment with sheep, where mangels were tried against sugar beet, the advantage rested with the mangels, the writer's verdict being that "The superiority of the mangold is very manifest, and it is clear that it will not pay the farmer to grow sugar beet for feeding purposes." Nor, with foreign bounties on exported sugar, does it appear that there is any prospect of producing sugar at a profit in England. The writer has shown that the price obtained by the German grower cannot be looked for in this country, and concludes that "At the present price of sugar, no factory could afford to pay for sugar-beet a price that would be remunerative to the farmer." The same issue of the *Journal* also contains an article by Mr. Hall on the influence of certain manurial substances on the

quality of barley, the results of his experiments being confirmatory of the best agricultural practice, namely, that though a moderate dressing of soluble phosphate may not have much effect on the yield, it produces a marked improvement on the quality of the grain.

THE *Revue Scientifique* contains an article by Prof. Thoulet on the International Congress of Oceanography held at Stockholm in 1899. A full account is given of the proceedings and conclusions of the Congress, and Prof. Thoulet expresses profound regret at the non-participation of the French Government and at the lack of interest in the subject in France generally. A number of the physical and chemical points dealt with by a section of the Congress are discussed, and certain questions raised, particularly with regard to the specific gravity of seawater *in situ*, which merit the attention of the Committee appointed by the Congress to report on such matters.

La Géographie contains an account of two scientific expeditions on the east and west coasts of Madagascar, by Mr. E. Colin. The work of these expeditions was chiefly topographical and magnetic. From Andevorante, Vatomandry and Mahanoro the coast turns more to the south-south-east than appears on the maps, and the positions of the two last-named towns lie more to the south. Combining the magnetic observations of 1892, 1896 and 1900 at Tamatave, Ampanotoamaisina, Andevorante, Vatomandry, Marosika, and Mahanaro, it appears that along the zone of the east coast the declination increases and diminishes alternately in the order of the stations named, the maximum occurring at Andevorante and the minimum at Vatomandry; and that the declination and dip vary in opposite directions.

A REPORT on the permo-Carboniferous Coal-measures of Clermont, by Mr. B. Dunstan, has been published by the Geological Survey of Queensland. In the district described there are several tracts of Coal-measures, the largest area exposed being that of Blair Athol. There are also tracts of granite, of slates and schists with auriferous quartz-reefs, and of Devonian and Tertiary strata. It appears that upwards of 65,000 tons of coal have been obtained from the Blair Athol coal-field during the past ten years, and that more than seven million tons of the best Clermont coal are still available. The coal is well adapted for locomotives, and has been mainly used for them. It is remarked that in the Coal-measures there are strata derived from the auriferous slates and schists, and that therefore there might have been streams entering the old Carboniferous lagoon, which brought gold into channels now hidden by more recent accumulations: hence future developments may lead to the discovery of some of these gold-bearing alluvial deposits below the coal-seams.

THE ninth course of public lectures in connection with the Childhood Society, which exists for the scientific study of the mental and physical conditions of children, will be given in the library of the Sanitary Institute on Thursday evenings during this month. The subjects will be, Food dietaries in relation to school life, by Dr. R. Hutchinson; Examinations in their relation to mental growth, by Prof. H. L. Withers; Experimental psychology, and the study of childhood, by Dr. W. H. R. Rivers; Observations of children after the methods of natural history, by Dr. Francis Warner.

IN view of the widespread opinion that in future many of the fundamental principles of theoretical chemistry will have to find a place in elementary lectures on inorganic and analytical chemistry, we note with interest a series of lecture experiments described by Messrs. Noyes and Blanchard in the *Zeitschrift für physikalische Chemie*, vol. xxxvi. pp. 1–27. The experiments illustrate various phases of the theory of electrolytic dissociation, the laws of equilibrium in solution and the velocity of chemical reaction. They are well chosen, and the necessary details of manipulation are carefully described.

Bulletin No. 89 of the U.S. Department of Agriculture (Office of Experiment Stations) consists of a report of experiments on the effect of muscular work upon the digestibility of food and the metabolism of nitrogen, carried out at the University of Tennessee by Prof. C. E. Wait. Although the effect of muscular work has been considered already in numerous dietary studies, yet up to the present very little information in this special connection has been obtained. As a result of sixteen detailed experiments it is found that, comparing the elimination of nitrogen in the urine during the periods of little muscular activity and normal diet with that during periods of increased activity and a diet furnishing energy largely in excess of the heat equivalent of the measured work performed, there is a slight decrease under the latter condition. This is true even when the possibility of a lag of considerable duration between the breaking down of nitrogenous material within the body and the excretion of nitrogen in the urine is admitted.

AMONG the recent captures made at Plymouth by the Marine Biological Association the most noteworthy are the polychæte *Bispira voluta-cornis*, the crustacea *Galathea strigosa* and *Pirimela denticulata*, the mollusca *Lima hians*, of which many specimens were found in a small patch of muddy stones, making their nests in the crevices between the stones, *Pinna pectinata* and *Scalaria communis*, and the Blenny *Blennius galerita*, of which a small specimen was found between tide-marks. The following animals, among others, are breeding:—Crustacea: *Galathea squamifera*, *Eurynome aspera*, *Pirimela denticulata*, *Gnathia maxillaris*, *Dynamene rubra*. Mollusca: *Lacuna vincta*, *L. pallidula*, *Purpura lapillus*. Pisces: *Cottus bubalis*. An increasing number of larval forms is shown by the tow-net captures, especially of Trochospheres, Veligers, Nauplii and Zoææ. It is to be feared that the octopus (*Octopus vulgaris*) will again be in evidence this summer, as there are already records of its appearance at Plymouth and Mevagissey.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. W. Field; a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by Mr. E. P. Rickcord; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Mr. Geo. Smithers; a Blotched Genet (*Genetta tigrina*) from Africa, presented by Captain R. L. Haddock; a Slender-billed Cockatoo (*Licmetis nasica*) from South Australia, presented by Lady Gertrude Lawford; a Virginian Colin (*Ortyx virginianus*) from North America, presented by Mr. B. N. H. Jones; a White-collared Teetee (*Callithrix torquatus*) from Brazil, a Pig-tailed Monkey (*Macacus nemestrinus*) from the East Indies, a Red-bellied Thrush (*Turdus rubriventris*), a Blue-fronted Amazon (*Chrysotis aestiva*) from South America, a Rose-coloured Pastor (*Pastor roseus*) from India, two Fox Sparrows (*Passerella iliaca*), two Chipping Sparrows (*Spizella socialis*), two Snow Birds (*Junco hyemalis*), two White-throated Song-Sparrows (*Zonotrichia albicollis*) from North America, two Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, a Sclater's Cassowary (*Casuarius philipi*) from New Guinea, three Toco Toucans (*Ramphastos toco*) from Guiana, an Allen's Porphyrio (*Hydrornia alleni*) from West Africa, deposited; two Emus (*Dromaeus novae-hollandiae*) from Australia, purchased; four Chinese Bulbuls (*Pycnonotus sinensis*) from China, received in exchange.

OUR ASTRONOMICAL COLUMN.

VARIABILITY OF EROS.—In the *Astronomische Nachrichten* (Bd. 154, No. 3688), Dr. E. von Oppolzer describes his observation of the planet Eros, which led to his announcement of its variations in brightness. The measures were made with the Zöllner photometer on a Grubb refractor of 8¼ inches aperture at Potsdam.

In the same journal there are further confirmatory reports from the observatories of Königsberg and Heidelberg.

NEW TYPE OF SHORTENED TELESCOPE.—In the *Astronomische Nachrichten* (Bd. 154, No. 3691), M. E. Schaer describes some experiments he has made at the observatory of Geneva with the object of facilitating the use of long focus objectives. The light from the object glass is reflected backward and forward from two silvered plane mirrors, so that the distance between eyepiece and objective is only about one-third the focal length. Good photographs of the sun's surface were obtained by using unsilvered glass mirrors and giving an exposure of about one-fiftieth of a second.

CATALOGUE OF NEW VARIABLE STARS.—Harvard College Observatory Circular, No. 54, contains a catalogue of sixty-four new variable stars discovered by the observers at that institution. The majority of these have been detected on examination of the Draper Memorial spectra, by reason of the presence of bright lines of hydrogen in the peculiar cases. For the purposes of this catalogue the variables have been divided into two main classes (1) those having a large range of variation, (2) those in which the extent of variability is small—from half a magnitude to a magnitude. The variables examined are then classified under these headings, 39 of long, and 25 of short period.

NEW COMPONENT OF THE POLAR MOTION.—In the *Astronomical Journal* (vol. xxi. No. 490), Prof. S. C. Chandler makes a preliminary announcement of the detection of a new component relating to the motion of the terrestrial pole. In addition to the already known 428-day and annual terms, he now finds a variation having a period of 436 days and a radius of 0″·09—considerably smaller, therefore, than the others. In the absence of more minute data, the orbit is assumed circular, and the author proceeds to investigate the nature of the variation produced as the resultant of the old 428-day and the new 436-day motions.

The combined motion is found to be subject to a period varying from 431·4 and 415·0 days, the mean length being 428·5 days. The fluctuations are embraced in a cycle of about 57 periods, or 67 years. With respect to the whole cycle, however, the changes of period are of a remarkable character. During five-sixths of the cycle the period remains between its mean value and the upper limit, *i.e.* between 428·5 days and 431·4 days; then it suddenly shortens to minimum, 415 days, and immediately rapidly lengthens again. In addition to this the variations of the radius of motion are also singularly asymmetrical. It is at present about 0″·07 and approaching its minimum value of 0″·05; there was a decrease from 0″·17 to 0″·11 between 1890 and 1897. It will be interesting to note whether the predicted variation of the period actually takes place. Between 1850 and 1890 it persisted at the value 430 days, is now about 428 days, and should continue to shorten to the minimum value of 415 days within the next few years; but of course no sharply-defined numerical limit can be stated on account of the fact that the length of the harmonic cycle, which depends on the difference of the two component periods, is imperfectly determined by existing observations.

INAUGURATION OF A BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

DURING the last few years, the Institution of Electrical Engineers has actively encouraged the formation of local sections, each having headquarters in some industrial centre.

These local sections are free to manage their own affairs, but the parent Institution arranges that important papers read at any of the local centres are incorporated in their journal, as also are local contributions to the discussion of papers read originally in London. Of the five branches now existing, the most recently formed is that in Birmingham.

The Birmingham local section of the Institution of Electrical Engineers has been fortunate in its first chairman, Dr. Oliver Lodge, principal of the new University, who delivered an address from the chair on Wednesday evening, February 27, at the Inaugural Meeting of the section, before a large gathering of engineers. The president of the Institution, Prof. John Perry, was present to support the local movement.

In the course of some opening remarks, Dr. Lodge congratulated the parent Institution on its wisdom and enterprise in forming local branches. Multiplicity of publishing centres was bad for science; but the lack of stimulus to local exertion was bad too. By the present action of the Institution both evils were avoided.

The original Society of Telegraph Engineers dealt chiefly with cable enterprise. Then it took over successively the telephone, electric lighting, transmission of power, and tramcars; and now it seemed about to take over underground traffic, and, in some countries, the railways themselves. Again, a warship was full of electrical contrivances, and the Institution sent a corps of experts to add to the land forces in South Africa.

With regard to the engineer's education, the chairman pointed out that it must be truly scientific. Some said that a general education and mathematics were unpractical and useless encumbrances. What they really meant was that if a youth had these and nothing else he was useless, and that he would be more useful if he failed to possess these, but did possess many other powers and aptitudes. This was true; but the two were not mutually incompatible.

Mathematics, for example, was often so taught that by the time a man had acquired a great deal of it he was somewhat unfitted for anything else. A common-sense mathematical training was an essential for an engineer or for a physicist. Euclid himself was splendid. So was his book for its day and generation, and its purpose as a system of geometrical philosophy admirable; but it had had its day, and for elementary and popular purposes should now cease to be. We were too busy; there was too much to learn nowadays to have time to cross every river by ascending to its source and walking down the other side. Professional guides along the old river path still attempted to hide the bridges, because if they were too easily seen their occupation would be gone; but the bridges were there, and sooner or later even schoolboys would be permitted to make use of them and enjoy the country on the other side, without spending all their days in a toilsome and deterrent mode of getting there over a route approved by the ancients.

The pursuit of pure science for its own sake was a good and wholesome formula up to a certain point, because the tendency of unregenerate man had always been opposed to it. The usefulness of scientific application needed no preaching, but, strangely enough, there was a great tendency to forget or ignore the scientific foundation on which they rested. And the human mind was so constituted that, as a rule, the necessary powers and aptitudes for the two things did not go together. The man who could pursue pure science did so best, as a rule, when he was not distracted by considerations of utility; the applier of science, on the other hand, soon got so immersed in practical details and pecuniary considerations which were clearly vital that he had neither leisure nor inclination, nor always the right kind of ability, for advancing the pure science itself.

Pure science must always advance into territory which appeared for the moment rather useless and barren and aloof from humanity; it must be so, since it was new ground never open to humanity before. Consequently there was a weird unearthliness about it which to people engaged in the turmoil of business might be cold and repellent, if ever they allowed themselves to be assisted to breathe its atmosphere for a moment. The strange, new, unknown, bracing air had a fierce fascination of its own, akin to that of the lone ice-packs of the Arctic seas to the healthy and intrepid explorer, or as the mountain tops were to the members of the Alpine Club. So enticing did the atmosphere of pure science become to those who frequently breathed it that to them sometimes it seemed the only air worth breathing, and the everyday atmosphere of humanity was close and stifling in comparison. Let such men of genius alone; encourage them in their quest; they were not too numerous, and whither they showed the way others hereafter would follow. Moreover, the region which they entered was no limited Arctic circle in reality; it was, as it were, the Arctic entrance to another world, whence, if they penetrated further in pursuit of the pioneers, they would ultimately reach the temperate zones of work and livelihood and applied science; nor

need they doubt but that at some far distant date the human race might at length make its way on through those regions too, and attain, even by that apparently arid path, the rich tropical belt of luxurious verdure and bright sunshine where conflict ceased and art and enjoyment and emotion and religion began. Facts known to few with effort were science, but those same facts when known to all without effort were æsthetic; they could then be appreciated in a fuller and higher way, could be seen in an altogether new light, so that they became fit subjects for poetry, for music, and for art.

Meanwhile, the justification of all pure, dry science lay essentially in its ultimately human bearings. If a subject could be proved to be never capable of any human influence or any relation to humanity, however developed it might become, then its pursuit would be rightly condemned. But such proof could never be given. Again and again had the most unlikely channels developed into fruitful watercourses. We must trust the instinct of our leaders and let them advance unhampered, in the faith that where they felt so much enthusiasm, where they seemed to see their way so clearly and so well, we too, in time, or our descendants, should be able to enter with their aid, and should realise that the remote and at first sight hopelessly inaccessible region was full, after all, of human interest, and of that which contributed to the enrichment of life.

Referring to the present state of electrical knowledge, Dr. Lodge spoke as follows:—

"We are in the beginning of a great era in connection with the pure science of electricity. The almost despised and neglected subject of electrostatics, as known to Franklin, is rearing its head again and pressing to the front.

"The experiment of a charged rod and pith balls is typical of much, perhaps typical of all that goes on in electricity; and how much this means some of us are beginning to guess. It is to the works of Larmor and the late Prof. Fitzgerald that we must look for an explanation of the nature of an electric charge—that blank, that absolute void so wisely left by Clerk Maxwell in his scheme, and by Helmholtz in his—a void occupied only by the isolated brilliant surmise contained in the phrase 'one molecule or atom of electricity.'

"But even before we understand the nature of an electric charge we shall find that the labours of J. J. Thomson have enriched the science of our times with what appears likely to be a unifying and comprehensive generalisation such as philosophers of all time have groped after, for which some of them have strongly hoped."

Concluding his address, Dr. Lodge illustrated with a few simple experiments the most recent views of the nature of the electric current. The atom was ordinarily associated with a charge, and force was required to separate them. This atomic charge, when separated, was known as an electron.

In the electrolyte there was a bodily transfer of atoms with their atomic charges.

In a metallic conductor the charges were handed on as electrons from atom to atom.

But it was in the discharge through highly rarefied gases that the electric current was in its most simple form, for here there was a flow of electrons travelling by themselves, of disembodied charges or electric ghosts. It was interesting to notice that, with their enormous speed of one-tenth of that of light-wave propagation, these electrons were the fastest moving of all known terrestrial objects.

A revolving electron was a magnet. A vibrating one could start light vibrations. And it might even be that inertia itself—that familiar but unexplained property of matter—was but electromagnetic inertia in disguise.

Prof. Perry, in thanking the chairman for his address, remarked that the country was now very much alive to the need for improvement in the scientific education of practical men. All the scientific world was watching to see what Dr. Lodge was going to make of the great problem that was before him of the Birmingham University.

He deprecated the tendency in this Institution to array professors and engineers against one another, and advocated the cultivation of a spirit of mutual helpfulness as between men whose various endowments must be interdependent if they were to be fully utilised.

Prof. Perry congratulated the new local section on its successful start and on its locality, saying that the people of Birmingham were very early in introducing scientific methods of manufacture. The stress of international competition called for the greatest activity in scientific methods in all our centres. The Institution of Electrical Engineers was doing a great work and had a great future before it in binding together the best thinkers in a great association for the common good.

Prof. Threlfall seconded the motion, and the meeting concluded with a feeling reference to the untimely death of Prof. G. F. FitzGerald, who was chairman of the Dublin local section of the Institution.

THE TAMNAU MINERALOGICAL ENDOWMENT.

IN the year 1879 occurred the death of Dr. Friedrich Tamnau, a rich Berlin banker, who was also an enthusiastic collector of minerals; his collection was well known, and was frequently used by mineralogists; a considerable portion of it was given to the Berlin Museum during his life-time, and at his death the remainder was bequeathed to the technische Hochschule at Charlottenburg.

Dr. Tamnau's services to the science of mineralogy did not end with his death. He left to the University of Berlin a sum of 36,000 marks for the purpose of founding a mineralogical travelling fund.

By the statutes of the founder it is enacted that when the fund has accumulated to a sufficient extent it shall be employed in sending away a young and promising mineralogist to some interesting locality, in order to study the modes of occurrence of fine or rare minerals, to collect, and to report upon them. It is expressly stipulated that the fund is to be applied to mineralogical, not geological, purposes. The specimens are to go in the first instance to the Berlin University collection, then to the technische Hochschule, but they may also be given or exchanged to other collections. The administration of the fund is in the hands of three trustees; those named by the founder to hold office at the beginning were Profs. von Rath, of Bonn, Groth, of Strassburg, and Websky, of Berlin.

The first application of the Tamnau fund was made in sending Dr. Tenne, of Berlin, on a successful mineralogical tour in southern Spain.

Two of the original trustees are dead, and the fund is now administered by Profs. Groth, of Munich, Klein, of Berlin, and Bauer, of Marburg.

The second award, 10,000 marks, was made in 1896. Dr. F. Grünling, the well-known assistant of Prof. Groth, first at Strassburg and subsequently at Munich, and now curator of the State collection of minerals in Munich, was commissioned to undertake a mineralogical expedition in Ceylon.

The valuable results of Dr. Grünling's tour have now been published. A triple Heft (Nos. 3-5) of the thirty-third volume of Groth's *Zeitschrift für Krystallographie und Mineralogie* is almost entirely occupied by the scientific work done upon the material which was brought back from Ceylon, and those who wish to see the excellent results of a wise scientific endowment wisely administered cannot do better than glance over this publication.

Dr. Grünling brought back rich collections, especially of the dolomite and the minerals which it contains, of the graphite and of the gem-stones; among the latter the most remarkable are the tourmalines, which constitute a unique series of beautiful crystals.

All these minerals have now been examined by various workers in Prof. Groth's laboratory. The graphite has been the subject of exhaustive study by Dr. Weinschenk, the lecturer on petrology in the University of Munich, who has already published papers on the subject in the *Zeitschrift für Praktische Geologie* and in the *Abhandlungen* of the Bavarian Academy of Sciences. The dolomite has been analysed by Dr. Schiffer, whose results have been given as an inaugural dissertation. And now has appeared this triple Heft of Groth's *Zeitschrift*, containing a general description of Ceylon and its minerals by Dr. Grünling, a research upon the chrysoberyl, the sillimanite and the blue spinel by Dr. Melczer, and a voluminous report upon the tourmaline crystals by Dr. Worobieff, whose memoir occupies nearly 200 pages, and is in reality a crystallographic monograph of the mineral.

The fact that so much has been achieved will suggest to the reader that the collection and scientific study of Ceylon minerals has been sadly neglected by our own countrymen. A perusal of Dr. Grünling's paper serves but to strengthen this conviction.

With the exception of an interesting paper on the graphite and rocks of Ceylon, contributed last June to the Geological Society of London by Mr. Coomára-Swámy, but published too late to be alluded to by Dr. Grünling, little has been done. Mr. Coomára-Swámy himself remarks, "No geological survey is in progress in Ceylon; it is much to be hoped that the Government will soon realise the importance of instituting one."

To give a very brief survey of the scientific results :—

Dr. Grünling makes it clear that the graphite always occurs in typical symmetrical veins, though these have been much crushed and altered by earth movements which have spent their energy upon the soft graphite, and have consequently spared the country rock (granulite). Dr. Weinschenk comes to the conclusion that the graphite is of volcanic, and certainly not of organic origin, and is probably due to the action of vapours containing carbon; he suggests that carbon dioxide and cyanogen compounds have played the chief part in its production. Among the associated minerals it is remarkable that, as at Passau, nontronite is one of the invariable decomposition products accompanying the graphite.

Dr. Grünling is of opinion that the gemstones of the sands and gravels were derived from the dolomitic limestone which abounds in some parts of the island, for the spinel, which is certainly found in the limestone, contains sapphire, phlogopite, &c., while the corundum contains phlogopite, rutile and spinel. A granular marble from Wattegama, on the Kandy railroad, proves to be a theoretically pure *dolomite*; it contains, among other minerals, a remarkable blue apatite, which has been analysed by Dr. Schiffer and is found to be a fluor-apatite containing 15 per cent. of chlor-apatite. It is curious that Dr. Grünling was unable to obtain any information concerning the original locality of the tourmalines; they are probably all derived from the cabook or laterite, and from some one place.

Worobieff's crystallographic measurements relate to 110 crystals remarkably rich in faces, and have resulted in the establishment of no less than 131 new forms; one crystal alone presented the faces of fifty-nine forms; the table of calculated angles fills forty-three pages. He finds that the symmetry of tourmaline is undoubtedly ditrigonal, and not tetartohedral as has been supposed by some authors. The paper also contains numerous observations upon the pyro-electric properties of tourmaline, and distinguishes between the faces of the analogous and of the antilogous poles.

Dr. Melczer's paper establishes beyond doubt that the chrysoberyls of Ceylon, of Brazil and of the Urals (Alexandrite) possess the same axes, and that the twinning takes place parallel to (031), not to (011). His optical study of the spinel leads him to the conclusion that the refractive index of this mineral varies with the colour; it is least in the most highly coloured parts.

The whole series of investigations reflects much credit upon the administration of the Tamnau fund, upon those who have collected and studied the minerals, and upon Prof. Groth, in whose laboratory the investigations have been successfully carried out.

The next award of this useful fund will be expected with interest. H. A. MIERS.

CRANIOLOGY.[1]

WE have assembled here to-day in order that we may commemorate the merits of John Hunter and such other persons whose labours have contributed to the extension of our knowledge in comparative anatomy, physiology, or surgery. Hunter's life in all its various aspects has been so frequently dwelt on in former orations delivered in this theatre that it is beyond my power to throw any fresh light on this subject. His fame is attributable to his having possessed an intense love of science, indomitable energy, and a self-reliant, manly character. If we turn to his portrait hanging on the walls of this theatre, it would seem that at the time when this likeness was painted Hunter was engaged in the study of the craniology of man and anthropoid apes, for on the table before him there is an open volume, and on its pages we see clearly drawn a human skull and the skull of a chimpanzee. Hunter is portrayed, pen in hand, in deep thought, having just turned away from the book he had been studying, and though his notes on comparative anatomy were unfortunately destroyed with his other manuscripts, we can hardly doubt that craniology was a subject in which he was deeply interested, or it would not have held so prominent a position in this famous picture. It would, therefore, seem that on an occasion such as the present we can do no higher honour to Hunter's memory and to that of some of the able men of science who have followed him than by endeavouring to give in as few words as possible a *résumé* of their labours, with especial reference to the subject of craniology and the light it is capable of throwing on the prehistoric inhabitants of western Europe and of the evolution of the race of men to which we belong. One of the most brilliant and original thinkers who has occupied the presidential chair of this college, Sir William Lawrence, in his ever-memorable lectures on the natural history of man, delivered in this college in the year 1819, from his researches in comparative anatomy, foreshadowed the idea that man and apes were derived from common ancestors. Lawrence's opinions were received with a storm of adverse criticism. Mr. Abernethy, for instance, charged him with "propagating opinions detrimental to society and endeavouring to enforce them for the purpose of loosening those restraints on which the welfare of mankind depend." Time, however, has proved that Lawrence was right, and in the course of lectures delivered in this theatre in February 1899, Prof. Keith, from a careful analysis of the maximum number of anatomical characters common to man and apes, arrived at the conclusion that they are derived from an identical or a kindred stock. While admitting without reserve that man and apes are structurally almost identical, nevertheless, as pointed out by Prof. Huxley in the year 1863, they differ very materially as regards the relative weight of their brains. The carcass of a full-grown gorilla is heavier than that of an average-sized European, but it is doubtful whether a healthy adult European's brain ever weighed less than 32 ounces, or the brain of the heaviest gorilla ever exceeded 20 ounces in weight. Although at the present time there is this marked relative difference between the weight of the brain and the form of the skulls of Europeans and apes, this was not always the case, for the calvaria of the earliest discovered human beings were in form not very far removed from those of contemporary anthropoid apes. This fact leads us to inquire into the nature of the conditions which have led to the increased capacity of the human cranium and to the vast superiority of man's intellectual endowments over those of all the other primates. If we turn to Hunter's preparations in our museum we find among them some remarkable specimens which he describes as "compressed," "unsymmetrical" human crania, which he believed were the result of premature consolidation of one or more of the sutures of the skull. Since Hunter's day various authorities have devoted much time to the subject of the abnormal closure of the cranial sutures in man; prominent among them are the names of the chief of England's craniologists, Dr. Thurnam and Dr. Barnard Davis—the splendid collection of prehistoric and other skulls made by the latter gentleman are now in the possession of our college. From evidence of this nature we have come to learn that the size and form of the skull depends to a large extent on the growth of the bones of which it is formed along the lines of the various cranial sutures.

It is well known that the frontal bone, which forms the vault of the anterior part of the cranium in the young of man and apes, is divided by a suture, and so long as this line of growth, together with the coronal and other sutures by which the frontal is separated from surrounding bones, remains open, the fore part of the skull, and with it the anterior fossæ which it encloses, can expand. But if the frontal and the other anterior sutures of the cranium consolidate early in life the fore part of the skull cannot increase in capacity beyond the size it had reached in infancy. Prof. Deneker, in his work on the embryology and development of anthropoid apes, has shown that in consequence of the early closure of the anterior sutures of the skull of these animals the fore part of their brain does not increase beyond the size it had attained at the end of the first year of life, but in man these sutures do not consolidate until a much later period, so that the anterior lobes of his brain are enabled to, and actually do, become far more perfectly developed than the corresponding lobes among apes; men of the same bulk have four times as much superficial brain surface as anthropoid apes.

Whatever other functions the anterior lobes of the brain perform, their cortical nerve elements, in conjunction with

[1] "The Hunterian Oration." Delivered in the theatre of the Royal College of Surgeons of England on February 14, by Mr. N. C. Macnamara. Abridged from the *Lancet*.

those of the other lobes of the brain, control, to a large extent, our higher intellectual faculties. If we study the collection of preparations of the brains of apes in our museum, it seems to me we shall arrive at a similar conclusion to that expressed by Prof. Edinger, which is, that the gyri of the brain of man and of the anthropoid apes are similar in character, with the marked exception of those convolutions which enter into the formation of the frontal lobes. The superior and the middle gyri of these lobes in anthropoid apes are always much shorter than they are in the brains of average Europeans, and what is of especial importance is, that in the brains of anthropoid apes the inferior frontal gyri only exist in a rudimentary condition of development; this deficiency is very marked with respect to that area of the left inferior gyrus which contains the nerve elements which control our faculty of articulate language. It seems probable that the rudimentary condition of this gyrus in apes is therefore the anatomical expression of the inferiority of these animals to man in intelligence; our intellectual development depending on our possessing the faculty of speech. It may be, anthropoid apes having only rudimentary, if any, specialised nerve centre of speech, that the other parts of their anterior lobes have remained in a comparatively undeveloped condition; whereas the left inferior frontal lobe of man's brain having become highly specialised, and, with it, his power of language, the other convolutions of his anterior lobes, which govern his intellectual faculties, have been stimulated to increased action, and in this way the characteristic expansion of the fore-brain has been evolved among all the more highly civilised races of the human family. But our contention is that the factors which govern the growth of the skull differ from those which develop the brain, and that the imperfect evolution of the frontal lobes among anthropoid apes is to a large extent due to the premature ossification of that part of the skull which encloses the fore-brain. However this may be, the possession of fully-developed anterior lobes of the brain, especially of its left inferior gyrus, is the distinctive character of the central nervous system of all those families of mankind who possess well-developed intellectual capacities. On the other hand, if we compare the skull of an Englishman with that of one of the natives of Australia, we see what a wide difference there is between the development of their frontal regions, and also as to the nature of the sutures of many of their skulls. We shall further discover, from specimens in our museum, that the inhabitants of western Europe in the later tertiary and early quaternary period, as regards the ossification and form, especially of the frontal region of their skulls, more closely resembled that of the chimpanzee than the race of men now inhabiting Europe.

Since Hunter and Lawrence's time, considerable progress has been made in the science of geology and anthropology. Nevertheless, in our search for knowledge concerning the origin and development of prehistoric man in western Europe, we are still hampered by the limited supply of his remains. It could hardly have been otherwise, considering the perishable nature of the human skeleton and the vast length of time, and the great geological changes which have occurred since man appeared in our part of the world. But we have additional evidence concerning the prehistoric inhabitants of this part of Europe, for they have left us some of their imperishable handiwork in the shape of flint and stone implements, which during the past century have been carefully studied in relation to the geological strata in which they were discovered, by Lord Avebury, Prof. Boyd Dawkins, Prof. Prestwich, Sir John Evans, the late Sir William Flower, together with many other English and foreign anthropologists. From the form and workmanship of these stone implements we are now able to classify and assign them to the various periods in which they were manufactured by the early inhabitants of our part of the world.

Up to within recent times it was held that no human beings existed on the earth before the quaternary geological epoch, but in the year 1867 the Abbé Burgeois exhibited a collection of chipped flint weapons which he had discovered in a previously undisturbed tertiary formation; it was not, however, until 1872 that these instruments were admitted to have been made by man or some other animal living previously to the commencement of the quaternary period. Precisely similar flint weapons have since been discovered in tertiary strata in various localities in Europe and in Asia. In the year 1894 Dr. Eugene Dubois found the upper part of a skull (calvaria) in close proximity to a femur and two molar teeth in a well-defined tertiary geological formation in the island of Java. Dr. Dubois was employed by the Dutch Government to examine and report on the fossil-bearing strata of Java, and while engaged on this work he discovered, embedded in a hard mass of tertiary tuffs, the bones above referred to; he brought these fossils to Europe and submitted them for examination to the leading anatomists of this and other countries. They concurred in the opinion that the femur was a human bone belonging to a man of a very low type; "and demonstrating the fact that while rendering its possessor capable of the bipedal mode of locomotion, he still retained some vestiges of adaptation to an arboreal existence." There was a difference of opinion concerning the calvaria, for it was calculated that the capacity of this skull did not exceed 850 cubic centimetres, the capacity of the largest cranium of anthropoid apes being 600 cubic centimetres. Until the Java skull was found, the earliest known human skulls had a cranial capacity of about 1220 cubic centimetres. After an exhaustive analysis of the anatomical characters of the Java calvaria as compared with the skulls of man and apes, Prof. Schwalbe has arrived at the conclusion that the Java skull, taking its capacity and form into consideration, "is on the border-line between that of man and anthropoid apes"; it is more closely allied to the skulls of the Neanderthal group of men than it is to the crania of the higher apes, but it is much nearer in form to the skulls of the chimpanzee than it is to the cranium of the average adult European of the present day. Nevertheless, from a study of the impressions of the convolutions of the brain on the interior of this calvaria it is shown that the inferior frontal convolutions are well marked and approach in form those of man; and although the superficies of this convolution is less than half that of the men of the present day, it is double that of the largest brain of any known anthropoid ape. This fact suggests that the Java man possessed in some slight degree the faculty of speech and that his intellectual capacity was higher than that of any of the anthropoid apes. The post-orbital index or narrowing of the Java skull is 19·3, as compared with the average of living Europeans, which is 12. In this measurement the Java skull comes nearer to the Neanderthal group than to that of anthropoid apes.

In the employing of skulls, which we believe to be the most trustworthy test of human races, we classify them under three heads according to the measurement of their cranial indices. In other words, the measurement of the greatest breadth of the cranium, expressed in percentage of its greatest length, is our guide as to the race to which an individual belongs from a craniological point of view. When the cranial index rises above 80 the head is called "brachycephalic," a broad head; when it falls below 75 the term "dolichocephalic," or long head, is applied to it. Indices between 75 and 80 are characterised as "mesocephalic," intermediate heads.

We have in our museum casts of two crania, and other bones, forming part of human skeletons which were found resting on a ridge of calcareous rock overlooking the river Orneau, in the commune of Spy, Belgium. These remains were unearthed with great care, and there is every reason to believe that they were originally deposited where they were discovered, being covered over with four well-defined beds of débris and clay, in which were found the bones of the rhinoceros and the mammoth, also flint weapons of the Mousterian epoch. One of these skulls has marked palæolithic characters, its brow ridges, like those of the higher apes and the Java skull, are prominent, and the forehead indicates the low type of human being of which this cranium formed a part. Its form, like that of all the other human inhabitants of Europe as yet discovered in the early geological strata of the quaternary (pre-glacial or inter-glacial) period, is of the long type; its sutures are simple and for the chief part are consolidated. We have another cast, presented to our museum by Prof. Huxley, one of our most talented and earnest workers in the science of anthropology, taken from the Neanderthal cranium. This cranium was found, with other portions of a human skeleton in a limestone cave near Dusseldorf. This cave was raised some sixty feet above the existing bed of the river Dussel, and its floor was covered to a depth of five feet by fluviatile deposits, beneath which these human remains were discovered. We have in our collection a skull of the characteristic palæolithic type, presented to the college by one of our former presidents, whose memory is treasured by all who knew him, Prof. George Busk; it was found in a layer of brecciated talus under the north front of the Rock of Gibraltar.

We have also a cast of the calvaria of one of this race found in county Sligo. Another skull of the same type was discovered at Bury St. Edmunds, with the remains of extinct animals and Mousterian flint weapons.

The anterior surface of the lower jaw among the existing races of Europe projects to form the chin. Among apes the reverse is the case, for the anterior surface of their mandibles recede. The Marlarnaud and the Naulette mandibles, of which we have casts, are evidently those of human beings; they were found in geological formations (which also contained the bones of extinct species of animals and palæolithic flint weapons). These bones are distinctly ape-like in character, having receding anterior surfaces, and also the sockets of all the molars are equal in size. The bones of the legs of these pre-glacial or intra-glacial inhabitants of Europe are of ape-like form, and together with the bones of their arms prove that they were a short, powerful race of beings whose average stature did not exceed five feet. They are known as the Neanderthal group of men.

When the glaciers which had extended over the greater part of Europe moved northward, the reindeer passed away with them from our part of the continent. These animals, which could easily be captured by man, had roamed in vast herds over the surface of the country, and had probably afforded the human inhabitants of that period living in western Europe an ample supply of food. The climate of our part of the world at the termination of the glacial period became such as we now experience. Britain was separated from France by sea, and fine rivers, containing numerous fish, filled the valleys of our land; the red deer, wild horse and various fleet-footed animals abounded in the splendid forests which overspread the country. But these animals and the fish of our lakes and rivers were not easily captured, and the human inhabitants of western Europe were therefore compelled to exert their intellectual capacities to an extent not heretofore necessary in order to supply themselves with food and with the skins of animals for clothing. Man was able to overcome the difficulties he had to face, possessing an innate power by means of which (as already explained) his brain was able to develop and so meet the increased demand made upon it in the struggle for existence. That such was the case we judge from the discovery, in geological formations of the post-glacial period, of the skulls of men having the same physical type as those of the strictly palæolithic epoch of western Europe, but with increased brain capacity. These post-glacial human skulls indicate, in my opinion, a gradual transition in form from the ape-like characters of the previous period to a higher standard and distinctly greater brain capacity in the frontal region; this most important question, however, requires further study. With this improvement in the form of the human skull, the flint, stone, bone and horn instruments made by the post-glacial inhabitants of western Europe become more highly finished, indicating the possession of increasing intellectual power on the part of those who made them.

The Engis skull, of which we have a cast, presented to this college by Sir Charles Lyell, is a well-known example of a human cranium of the early neolithic or post-glacial period. Huxley, in his description of this skull, observes: "It takes us, at least, to the further side of the biological limit which separates the present geological epoch from that which preceded it," that is, from palæolithic times. The Borris and Egisheim skulls probably belong to this period, their characters being similar to those of the Tilbury cranium described by Sir Richard Owen, of which we have casts in our museum. These and various other skulls found in geological formations of the time referred to are all of the same type, and lead us to believe that the inhabitants of Europe consisted, in the early neolithic period, of only one race, the descendants of the human beings who inhabited our part of the world during the previous or early palæolithic epoch. They had long (dolichocephalic) skulls, with slightly projecting supraorbital ridges, well-formed noses, and a fairly-developed frontal region as compared with the far more ancient Java and Neanderthal crania. Their lower jaws and the bones of their legs were less simian in character than those of their remote progenitors; they were a small race of beings. We find no metal weapons or instruments with their remains, and we therefore conclude that they were ignorant of the use either of bronze or of iron, nor do they seem to have possessed domestic animals or to have had any knowledge of agriculture. This race of primitive inhabitants of western Europe are best known as the Iberians, and we may conveniently employ this term so long as it is understood to designate the Africo-European stock who were, so far as we know, the only human inhabitants of Europe in the later palæolithic times. It should be clearly understood that no *bonâ-fide* human remains belonging to the early palæolithic period have hitherto been discovered in western Europe which were not of the same type as those above described.

As we pass from the early to the mid-neolithic epoch, we come upon the remains of a race of men who, as regards their physical character and state of civilisation, essentially differ from the people above referred to. The stone implements found with their skeletons are beautifully formed, many of them being highly polished and having sharp cutting edges. A few of the purest bronze axe-heads have been discovered with these remains, and also the bones of domestic animals belonging to species indigenous to Asia but foreign to the palæolithic fauna of Europe. Lastly, we have evidence that these people were acquainted with agriculture and with the manufacture of sun-dried pottery. They paid great respect to their dead chiefs, burying their bodies in natural caves or in tombs formed of huge flag-stones placed edgeways side by side with similar stones laid on the upright ones to form the roof of the building. These structures, the well-known long dolmens, have been found, built on precisely the same plan, in Ireland, England, the greater part of Europe, the west of Asia, India, Arabia and northern Africa. They were not only sepulchres for the dead, but many of them also contained an altar, a place of mourning and of offering, where intercession was made to the spirits of departed chiefs by their relations and tribesmen. The Rodmarton long dolmen or temple tomb (near Cirencester) affords us a good example of one of these structures; it is 180 feet in length and 70 feet broad. We have in our museum a fine human skull which was found in this dolmen, with some well-polished stone implements. If we compare the skull with that of palæolithic man or with the skulls of the early neolithic human inhabitants of western Europe, we are immediately struck by the marked difference that exists between them and the Rodmarton skull. Dr. Thurman's unique collection of crania may be seen in the Anatomical Museum, Cambridge; these crania, for the most part, were unearthed by himself from various English long dolmens and barrows, and they resemble in form, although they are of a higher type than, the skulls found in the caves of Cro-Magnon and Mentone; they are identical in character with skulls found in the long dolmens of France and other countries of Europe. The cranial index, capacity, and other features of the bones of these skulls lead us to assign them all to one and the same race, of which the Cro-Magnon are probably some of the very earliest specimens as yet discovered in western Europe. The three Cro-Magnon and three Mentone skeletons were those of people some six feet four inches and upwards in stature, so that a race of giants in far distant times was no myth. Their cranial capacity was above that of average Europeans of the present day. From their physical conformation and from the remains of the animals found buried with them, which are of Asiatic species, and from other evidence, we are led to the conclusion that the Cro-Magnon race represents the advance guard of the proto-Aryan human family, of which the Rodmarton and many other long dolmen skulls show a more advanced type. These people in far distant ages migrated from the east into western Europe, and from thence spread into our islands; southwards they passed into India, Persia and Arabia, Asia Minor and northern Africa. Over this vast area and far away in eastern Asia we find their remains, with flint and stone implements of the early neolithic type, buried in long dolmens or barrows. The roots of many of the words used by this ancient people exist in most of the languages now spoken in Europe, and their religious sentiments, myths, and, above all, their racial, mental and physical characters, as portrayed in the Ri̯-Veda and on the ancient monuments of Egypt, are pronounced features in the existing Teutonic and Anglo-Saxon people. From the form of the crania found in many of these long dolmens we know that this tall, fair, handsome, long-skulled race intermarried with the pre-existing short dark Iberian inhabitants of Europe. The fair tall race probably did not at any time, unless in the north of Europe, form a large proportion of the population; they were a dominating, fighting and priestly caste who compelled the primitive small, dark (Iberian) inhabitants of western Europe to work as their slaves.

During the neolithic era, while the descendants of the proto-Aryan stock were slowly feeling their way from the

East along the valley of the Danube into Europe, a very different race was passing from northern Asia into the Baltic provinces. These people formed settlements on the islands of Denmark and westward as far as the north of Ireland. They were the first of the broad-skulled races of the human family who had entered Europe. Their skulls were brachycephalic in form with broad faces and noses, the latter being deeply concave at the base. Their remains are found in the islands of Denmark, especially that of Möen, also in Yorkshire and county Antrim, in which localities their descendants may still be recognised by their physical characters. These people belonged to the stone age of Europe, and by comparing their skulls with those of the Rodmarton or Cro-Magnon crania we see the great difference in form of the prehistoric long and the broad-headed races of men. Until the close of the neolithic epoch there were, therefore, three pure races who formed the sole human inhabitants of Europe, with the exception of those who were the outcome of the intermarriage of the people of these three races with one another.

Passing from the neolithic to the succeeding bronze age, we find that Europe, including our islands, was overrun by a small, olive-coloured, broad-skulled people having characteristic Mongolian features. These were the lake-dwellers of Switzerland and other parts of Europe. They were traders in bronze, and probably, as Prof. G. Mortillet and other authorities hold, they gradually replaced stone, horn and bone with bronze instruments and weapons, effecting in this way a great revolution in the social and industrial habits of the pre-existing inhabitants of western Europe. In these far distant times deep mining operations were out of the question. Superficial copper ores were abundant in most parts of Europe and Asia, but alluvial tin was extremely scarce on our continent, and it is still only found in large quantities in south-eastern Asia. Cornwall, the Scilly islands, the south of Ireland, and some few other places also contained superficial ores of tin. It seems probable that the Mongolians inhabiting the highlands of south-eastern Tibet long before the commencement of the bronze age in Europe spread into Burma, the Malay Peninsula and Cochin China, and there acquired the art of mixing copper and tin in such proportions as to form bronze, the weapons and instruments which they manufactured of this metal being a ready and profitable source of barter in Europe. Together with the broad skulls and other remains of these people we find in the débris of the lake dwellings numerous ornaments made of jade, nephrite and chloromelanite, minerals found in large quantities in south-eastern Asia but not in Europe; and, lastly, vases on which are depicted people in oriental costume and instruments used only by the south-eastern Tibetans have been discovered in connection with the remains of the lake-dwellers and the round or oval burrows of Europe. These people, as a rule, cremated the bodies of their dead, and numerous cinerary urns containing their remains are found scattered over the Wiltshire and other ranges of hills in the south of England. Some of their skeletons, however, have been discovered in the round barrows which are so numerous in many parts of England, Ireland and throughout Europe and Asia. With these remains bronze instruments have been found, indicating, like the stone implements of palæolithic man, various stages of excellency in workmanship. One of the finest skulls in our museum was taken from a round barrow at Codford, Wilts. The form of this brachycephalic skull, together with its nasal bones and orbits, are characteristic of the southern Mongolian race, well known to us as the Gurkhas and Burmese of our Indian empire; a lazy, bright, rollicking, fighting people, intensely superstitious and home-loving—"the Irish of the East" as they have been aptly called. In the course of many centuries the Mongolian people of western Europe have become absorbed into the pre-existing Ibero-Aryan population and a cross-breed has resulted, and from this stock the ancient British people of our islands were derived. Their skulls are mesocephalic (a combination of the long and broad skull) and are amply represented in our museum, the cephalic indices being about 78. Subsequently to the bronze age the ancient Britons were well-nigh exterminated in England by Teutonic races who invaded our country from the north of Europe, the Anglo-Saxons taking the place of the pre-existing ancient British population of England and Scotland. Nevertheless, in some districts of England, such as North Bedfordshire, a number of the descendants of the ancient British stock continue to flourish up to the present day, as also in the greater part of South Wales, much of Cornwall, and the south and west of Ireland, the upper classes in Ireland being clearly derived from the ancient Aryan stock who passed from Gallia into that country during the neolithic period.

We possess the measurements of the heads of some 25,000,000 of the present inhabitants of Europe and the United States of America. From these measurements we learn that a large proportion of the people now dwelling in the countries bordering on the Mediterranean Sea are a short, brunette, long-skulled race, descended, we believe, from those who, from the form of their skulls and other physical characters, occupied that part of Europe and the north of Africa in far distant ages—the Iberian race. Scandinavia and North Germany are inhabited by a tall, fair, long-skulled people, derived from the proto-Aryan races who settled in that part of our continent in the neolithic epoch. A vast triangle, having its base in eastern Russia and its apex on the Atlantic in south-western France, is inhabited by a broad-skulled people derived from Mongoloid or Turanian ancestors. We do not for a moment affirm that these races, as such, have remained pure, far from it, but the results of the measurements of the heads of a great number of the existing inhabitants of Europe point to the conclusions above indicated; and this idea is confirmed by the indices of the splendid collection of crania which occupy so large a space in the museum of this college—a collection which was commenced by John Hunter and upon which a great amount of time and labour has been spent in describing and classifying the skulls which it contains; a work which, in my opinion, should be completed up to the end of the past century.

The characteristic physical type of palæolithic man may be still recognised among the inhabitants of western Europe, although their skulls have grown more capacious, especially in the frontal region. This change in the form of the cranium marks a corresponding advance in the capacity and organisation of the brain, and consequently of the intellectual ability of man: it is, in truth, evidence of his inherent power to overcome the demand made on his mental capacity in order to cope successfully with his ever-increasing struggle for existence, consequent on the growth in number of his fellow-creatures and the more complicated social conditions of his surroundings. Doubtless the form of skull of a large proportion of the inhabitants of our island indicates a cross-breed formed by the intermarriage of the long and broad-skulled families of man who in distant ages met and intermarried in western Europe, thereby improving the stock of their descendants. Races of men, such as the natives of Australia, who have remained in an unchanged environment and without intermarriage with other people, have made but little progress in their intellectual capacity, the form of their skulls continuing of the same type as those possessed by the palæolithic inhabitants of Europe.

The same causes to which we have referred, acting for long periods of time on people of the same race, have led, not only to the hereditary transmission of their physical characters, such as those existing respectively among the northern, central and southern inhabitants of Europe, but have also developed specialised areas of nerve structure in their brains, by means of which they have come to think, feel and reason alike. In this way we are able to comprehend the source and the meaning of large bodies of men belonging to the same race being frequently moved to take common action on matters affecting the well-being of their race; they possess, in fact, like innate sentiments although separated from one another by great distances and living under diverse climates and environment. Their emotions and ideals harmonise because their progenitors existed for many ages under similar external conditions and consequently developed like specialised nerve-centres, which have been transmitted, together with their physical characters, to their successors and become crystallised in their laws and reflected in their conceptions of religion as well as in their social institutions.

In illustration of our meaning we may refer to those revolting pages of history during which Belgium and the Netherlands passed under the dominion of Spain; the Iberian dominating for the time being over a thoroughly Teutonic race. Or we may contrast the existing condition of the Iberian population of South America with the Teutonic Anglo-Saxon inhabitants of the United States, or between the latter and the negro population of America, a subject which is more fully elucidated in my book "On the Origin and Character of the British People."

We have a chart here which shows the result of the recent general election held in this country; the question at issue was one in which the whole of the people in Great Britain were deeply interested. It is remarkable what a large proportion of

the inhabitants of England and of Scotland, mainly of Anglo-Saxon origin, voted together on this subject; whereas a contrary opinion regarding this same question was held by the greater proportion of the people of Ireland, and to a large extent by the Welsh, most of whom are derived from Ibero-Mongolian ancestors. It is difficult to account for the diversity in the sentiments of the people above referred to unless we consider it due to their racial mental qualities. Environment has doubtless played an important part in the evolution of these people, but their inherited racial character has had more to do with the position which the Anglo-Saxon race has gained in the world than the mineral wealth, climate, or protection afforded us by our seagirt coast.

The environment under which even a few generations of men exist would seem capable of influencing the structure of their central nervous system, as illustrated by comparing the mental qualities of our rural and urban population. The conditions under which the city-bred person, child and man, lives engender in the course of a few generations an unstable state of nerve structure, resulting in an excitable character which, if carried beyond a certain point, leads to unsoundness of mind, and may account for the increasing number of lunatics in this and the other large cities of Europe. General Sir Redvers Buller, again, in speaking of the soldiers under his command in South Africa, refers to the fact that our city-born men have imperfect sight compared with men reared in the open plains of the Transvaal, thus affording us another example of the effects of environment on the race. These are a few of the many interesting and important subjects which arise in connection with the study of anthropology, including craniology; and the contents of our museum and library offer unrivalled opportunities to the student seeking for knowledge in those branches of science.

In conclusion, as already stated, much of Hunter's reputation was founded on the result of his labours in those branches of science which tend to elucidate man's nature; and during the past century a succession of English surgeons has carried on the work commenced by our great master, enriching our museum and endeavouring to make this college, not only an examining and licensing body, but, what it certainly should be, an imperial institution for the cultivation and diffusion of those departments of knowledge which bear on the art and science of surgery. The ideas entertained by John Hunter's immediate successors on this subject were ably stated by Sir William Lawrence in his lectures already referred to. He observes that "our own individual credit, and the dignity, honour and reputation of our body, which we are bound to maintain, demand that surgeons should not be behind any other class in the possession either of the cultivation of branches of knowledge directly connected with surgery or in any of the collateral pursuits less immediately attached to it. It is only in reference to such views and objects that the Hunterian collection could have been accepted or can be of any use to this college." Hunter would, if he had still been with us, have thrown all his indomitable energies into the successful working of such an institution, and amidst the turmoil, strife and competition going on around him would, as we see him in this picture, have been engaged in the earnest, accurate, patient study of nature. It remains for our younger members to emulate the example set them by John Hunter, and by such service to secure for themselves lasting satisfaction, and beyond that add to the real dignity and utility of their college and their profession.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 222nd meeting of the Junior Scientific Club was held on Friday, February 22. Mr. H. B. Hartley (Balliol) read a paper entitled, "Polymorphism; an Historical and Experimental Account," which was followed by a paper by Prof. Townsend entitled, "The Conductivity of Gases."

CAMBRIDGE.—The subject for the Adams prize in 1903 is, "The bearing on mathematical physics of recent progress in the theory of the representation of discontinuous quantity by series, with special consideration of the logical limitations of the processes involved." The prize is open to all graduates of the University, and is of the value of 225*l*. Essays are to be sent privately to the Vice-Chancellor by December 16, 1902.

The tender for the new School of Botany, to be erected behind the Sedgwick Museum, amounts to some 23,000*l*. It is recommended for acceptance by the syndicate.

AN animated debate occurred in the House of Commons on Tuesday on the attitude taken up by the Board of Education towards higher-grade elementary schools in which science is taught, leading to the judgment in the case of "Regina *v.* Cockerton," that grants made by School Boards for scientific instruction are illegal. In the course of his reply to various criticisms, Sir John Gorst said that the Government proposed to introduce a Bill for the creation of secondary education authorities having power to provide instruction in subjects that were not contained in the Elementary Day School and Evening Continuation School Code. He agreed that we should not have a proper system of education until one authority was established in a district, having control over schools of every kind and every grade. If a change of that kind were made, overlapping would cease and the existing chaos would disappear.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—"The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers." By James Dewar, M.A., LL.D., F.R.S., Professor of Chemistry at the Royal Institution, and Jacksonian Professor, University of Cambridge.

In a former paper it was shown that a platinum-resistance thermometer gave for the boiling point of hydrogen $-238°{\cdot}4$ C., or $34°{\cdot}6$ absolute. As this value depended on an empirical law correlating temperature and resistance which might break down at such an exceptional temperature, and was in any case deduced by a large extrapolation, it became necessary to have recourse to the gas thermometer. The gases used as thermometric substances were hydrogen, oxygen, helium and carbonic acid.

Taking the average values given by the experiments as being the most probable, then the boiling point of oxygen is $-182°{\cdot}5$ and that of hydrogen is $252°{\cdot}5$, or $20°{\cdot}5$ absolute. The temperature found for the boiling point of oxygen agrees with the mean results of Wróblewski, Olszewski and others. If the boiling point of oxygen is raised to $-182°$, which is the highest value it can have; then an equal addition to the hydrogen value must follow, making it then $-252°$ or $21°$ absolute. In a future communication the temperature of solid hydrogen will be discussed.

February 14.—"On the influence of Ozone on the Vitality of some Pathogenic and other Bacteria." By Dr. Arthur Ransome, F.R.S., and Alexander G. R. Foulerton.

The experiments have shown that ozone in the dry state, and in such strength as the authors used it, has no appreciable action on the vitality of the various bacteria experimented with, and, so far, the results are in accordance with those of Sonntag and Ohlmüller. Nor did a prolonged exposure to the action of ozone diminish in any way the pathogenic virulence of *B. tuberculosis* in sputum. Single experiments would also tend to show that ozone can have little, if any, effect on the pathogenic virulence of *B. mallei* and *B. anthracis*.

On the other hand, the experiments would appear to confirm the conclusion arrived at by Ohlmüller as to the bactericidal property of ozone when passed through a fluid medium containing bacteria in suspension.

A comparison of the inactivity of ozone as a disinfectant in the dry state with its action in the presence of water suggests a superficial resemblance with other gases, such as chlorine and sulphur dioxide. In the absence of further experiment, however, it would not be possible to press the analogy too closely.

In the dry state, and under the conditions in which it occurs in nature, ozone, then, is not capable of any injurious action on bacteria so far as can be judged from the experiments; and it is concluded that any purifying action which ozone may have in the economy of nature is due to the direct chemical oxidation of putrescible organic matter, and that it does not in any way hinder the action of bacteria, which latter are, indeed, in their own way, working towards the same end as the ozone itself in resolving dead organic matter to simpler non-putrescible substances.

"On the Functions of the Bile as a Solvent." By Benjamin Moore and William H. Parker. Communicated by Prof. E. A. Schäfer, F.R.S.

In this paper evidence is brought forward that the bile exercise

an important action as a solvent, and the authors claim that this is the chief, if not the only function of that secretion. It is pointed out that the bile in this respect has a twofold action: first, in aiding in the excretion of cholestearin and lecithin; and, secondly, in aiding in the absorption of fatty acids and sodium soaps from the intestine. All these substances possess a low solubility in water, and have their solubility increased in bile chiefly by virtue of the properties of the bile salts. The fact that cholestearin is still but slightly soluble in bile explains the well-known fact that gallstones are composed almost exclusively of that substance, while lecithin is very soluble in bile and hence is never deposited. This view as to the action of the bile also furnishes an easy explanation for the so-called "circulation of the bile." It further explains the faulty absorption of fat in the absence of either bile or pancreatic juice, and the almost complete failure of fat absorption when both these secretions are excluded from the alimentary canal.

"On the Application of the Kinetic Theory of Gases to the Electric, Magnetic, and Optical Properties of Diatomic Gases." By George W. Walker, B.A., A.R.C.Sc., Fellow of Trinity College, Cambridge, Sir Isaac Newton Research Student. Communicated by Prof. Rücker, Sec. R.S.

Zoological Society, February 19.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—Dr. W. G. Ridewood exhibited some microscopic preparations of the hairs of three species of zebra, viz. *Equus burchelli*, *E. zebra* and the newly described *E. johnstoni*, in order to show that the hairs of the last-named animal agreed in structure with those of the other two zebras. A letter received from Prof. Ewart on the same subject stated that he was quite of the same opinion.—Mr. F. E. Beddard, F.R.S., exhibited and made remarks upon a specimen of a female Schmidt's monkey (*Cercopithecus schmidti*) with four mammæ.—Mr. R. Lydekker, F.R.S., described, under the provisional name *Sotalia borneensis*, an apparently new species of estuarine dolphin from Borneo, a specimen of which had recently been received at the British Museum.—Mr. Lydekker also gave a description of the Kashmir ibex (*Capra sibirica sacin*), and pointed out the differences between this and the three other races of *Capra sibirica*.—Mr. F. E. Beddard, F.R.S., read a paper on the broad-nosed lemur (*Hapalemur simus*), which dealt with the points of difference in structure between this species and *H. griseus*.—A communication from Dr. J. G. de Man contained a description of *Potamon* (*Potamonautes*) *floweri*, a new species of crab obtained by Captain S. S. Flower on the Bahr-el-Gebel, during his expedition up the White Nile in 1900, and remarks on other species of Potamon.—Mr. R. H. Burne read a paper entitled "A Contribution to the Myology and Visceral Anatomy of the Fairy Armadillo (*Chlamydophorus truncatus*)," in which the myology of this rare Edentate was reviewed, with special reference to the two previous descriptions by Hyrtl and Macalister, and features were pointed out in which this individual showed a greater similarity to *Dasypus* than those hitherto examined.—Dr. C. I. Forsyth Major read a paper on some characters of the skull in lemurs and monkeys, in which he pointed out, amongst other results, that the *os planum* of the ethmoid, about which some doubts had existed as to its presence in lemurs, was found to occur in the young stages of many of these animals, and that the facial expansion of the lachrymal bone in the lemurs as well as in the monkeys was not a primitive condition but an extreme specialisation.—Mr. Martin Jacoby read a paper containing descriptions of fourteen new species of phytophagous coleoptera of the family Chlamydæ.

Royal Meteorological Society, February 20.—Mr. W. H. Dines, president, in the chair.—Mr. E. Mawley presented his report on the phenological observations for 1900. During the greater part of the winter and spring the weather proved cold and sunless, but in the summer and autumn the temperature was, as a rule, high and there was an unusually good record of bright sunshine. As affecting vegetation the two most noteworthy features of the phenological year ending November, 1900, were the cold, dry and gloomy character of the spring months and the great heat and drought in July. Throughout the whole of the flowering season wild plants came into blossom much behind their average dates, indeed later than in any year since 1891. Such spring emigrants as the swallow, cuckoo and nightingale were also later than usual in visiting these shores. Taking the British Isles as a whole, the crops of wheat, barley and oats were all more or less under average. The yield of hay was poor in the southern half of England, but elsewhere varied from a fair to an abundant crop. Turnips and swedes were almost everywhere deficient, but there was a heavy crop of mangolds. Potatoes were under average. This was a bountiful year as regards fruit, the yield of apples, plums and all the small fruits being in excess of the average.—Mr. A. E. Watson read a paper entitled "A review of past severe winters in England with deductions therefrom." From an examination of the records of the severe winters of the last 300 years, he has come to the conclusion that they are most frequent in the years with the numbers 0-1 and 4-5. He is also of opinion that the severe winter in the middle of each decade is generally a late one (January to March) while that at the beginning or end of each decade is generally an early one (November to January).

MANCHESTER.

Literary and Philosophical Society, February 19.—Prof. Horace Lamb, F.R.S., president, in the chair.—Mr. Charles Bailey made a communication entitled "On *Ranunculus Bachii*, Wirtgen, as a form of *Ranunculus fluitans*, Lamarck." This aquatic plant is very polymorphic, as seen in the series of British examples exhibited. In the south of England, the stout stems are several feet in length, the leaves and peduncles are from six inches to a foot long, and the flowers are as large as a shilling or a florin. It is a frequent plant in the Herefordshire Wye and in the Severn, but in the immediate neighbourhood of Manchester it has been gathered in but one station, viz., the Derbyshire Derwent, at Whatstandwell. The plant occurs in canals and swift-running brooks, but its most congenial station is a well-filled river. It becomes less frequent in Great Britain as one ascends northwards, and just manages to occupy a few of the southern counties of Scotland. The range of examples exhibited showed that there exist all intermediates between the diminutive form collected at Ayton in the north, and the nine or ten feet plant of the New Forest in the south. Mr. Bailey's conclusions regarding this plant accord with Wirtgen's later view of it, namely, that the differences between it and the type are merely comparative.—Mr. R. S. Hutton exhibited an almost exact reproduction of Moissan's electric furnace, which has been set up at the Owens College. There it is possible, with a 50 horse-power engine, to produce a current of 700 amperes at 50 volts, and by that means it is anticipated that researches at the high temperatures thus available—viz., 3500° C., or higher—will shortly be able to be carried out. Graphite prepared in electric furnaces was also shown, as well as specimens of various carbides, carborundum, &c., from the Niagara works. The specimens exhibited illustrated the facility with which some of the rarer metals now become available, those shown being chromium and manganese. A modern form of the Lippmann electrometer was also exhibited by Mr. Hutton.

PARIS.

Academy of Sciences, February 25.—M. Fouqué in the chair.—The appearance of a new star in the constellation of Perseus, by M. Loewy. This star, when discovered by Dr. Anderson, at Edinburgh, on February 21, was of the magnitude of 2·7. Two nights later it was estimated by M. Robert, at Saint-Jean-d'Angély, as being of the first magnitude.—Studies on the agricultural value of land in Madagascar, by MM. A. Müntz and E. Rousseaux. The soil of the belt on the coast line from its composition would probably prove fertile, but the ferruginous earths of the central *massif* are poor and unfit for culture, except at the bottoms of the valleys. The island, taken as a whole, is poorly provided with the materials necessary for plant growth, and it does not appear likely that it could ever support a dense population.—On the appearance of a new star in the constellation of Perseus, by M. Flammarion. A letter to the Permanent Secretary containing the results of observations on the new star, by MM. Lucien Bosc, A. Robert, Lotte, and Bruguière.—On the variations in magnitude and position of the satellites of Jupiter, revealing the existence of a cosmic atmosphere, by Dom Lamey. The observations recorded by the author can only be satisfactorily explained by the assumption of the existence of an atmosphere in the form of a ring, composed of a material too subtle to condense, but sufficiently dense to modify by refraction the images of stars traversing it in the equatorial plane.—On a certain category of transcendental functions, by M. Edmund Maillet.—The superficial traces left by the tools in the operation

of sawing metals, by M. Vasseur. From the analysis given, it would appear that the lines discovered by M. Fremont have no relation with the curves of distribution of deformations in vmetals, but depend upon the nature and condition of the saw employed.—On the insulating properties of snow, by M. Bernard Brunhes.—On certain conditions of reversibility, by M. Albert Colson. The reversibility of the reaction between carbon dioxide and silver oxide is dependent upon the presence of water vapour.—The compressibility of solutions, by M. Guinchant. Up to a pressure of four atmospheres the volume of the dissolved body is independent of the pressure.—Contribution to the study of indium, by MM. C. Chabrie and E. Rengade. On prolonged boiling, cæsium indium alum deposits pure indium oxide. Determinations of the molecular weight of indium acetylacetonate in boiling ethylene bromide are consistent with the trivalency of this element.—On a new crystallised sulphate of molybdenum, by M. Bailhache.—Some new reactions of organo-metallic derivatives, by M. E. E. Blaise. A mode of synthesis of alkyl-ketonic esters.—Action of the organo-metallic derivatives upon alkyl esters, by M. A. Behal. The final product of the action of an excess of magnesium iodoethylate upon an ester, $R.CO.OEt$, is an ethylenic hydrocarbon, $R.C(CH_3):CH_2$.—Synthesis of tertiary alcohols in the fatty series, by M. Henri Masson.—On the absorption spectra of the indophenols and the colouring matters derived from triphenylmethane, by MM. C. Camichel and P. Bayrac.—On the constitution of glucose, by M. L. J. Simon.—The diastatic actions of colloidal platinum and other metals, by M. G. Bredig. A solution of colloidal platinum shows a remarkable analogy with the enzymes in its catalytic action towards hydrogen peroxide. Both the colloidal metal and the enzyme increase in activity with increasing temperature up to a certain point, and then fall off, and both are similarly influenced by the addition of minute quantities of hydrocyanic acid or sulphuretted hydrogen.—The function of the peritoneal canals, by M. S. Jourdain.—The action of chloroform upon the reducing action of the blood, by MM. M. Lambert and L. Garnier.—On the identity of the modifications of structure produced in vegetable cells by cold, plasmolysis, and by drying, by MM. L. Matruchot and M. Molliard.—Food value and culture of the furze, by M. A. Ch. Girard.—The examination of a meteorite which fell in the island of Ceylon on April 13, 1795, by M. Stanislas Meunier.

DIARY OF SOCIETIES.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.—Further Observations of Nova Persei: Sir Norman Lockyer, F.R.S.—Some Physical Properties of Nitric Acid Solutions: V. H. Veley, F.R.S., and J. J. Manley.—The Anatomy of Symmetrical Double Monstrosities in the Trout: Dr. J. F. Gemmill.—Preliminary Communication on the Œstrous Cycle and the Formation of the Corpus luteum in the Sheep: F. H. A. Marshall.—To be read *in title only*: On the Composition and Variations of the Pelvic Plexus in *Acanthias vulgaris*: R. C. Punnett.—On the Heat dissipated by a Platinum Surface at High Temperatures. IV. High Pressure Gases: J. E. Petavel.

LINNEAN SOCIETY, at 8.—A Contribution to the Fresh-water Algæ of Ceylon: Messrs. W. West and G. S. West.—On Mediterranean Malacostraca: A. A. Walker.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Insulation on Cables: M. O'Gorman.

CHEMICAL SOCIETY, at 8.—(1) Nomenclature of the Acid Esters of Unsymmetrical Dibasic Acids; (2) Additive Compounds of α- and β-Naphthylamine with Trimitrobenzene Derivatives; (3) Acetylation of Arylamines: J. J. Sudborough.—Formation of Amides from Aldehydes: R. H. Pickard and W. Carter.

RÖNTGEN SOCIETY, at 8.—Exhibition of Skiagrams and Apparatus.

FRIDAY, MARCH 8.

ROYAL INSTITUTION, at 9.—Vitrified Quartz: W. A. Shenstone, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Partial Solar Eclipse, 1900 November 22, observed in Western Australia: W. E. Cooke.—On the Observation of Position Angles of Polar Double Stars: R. T. A. Innes.—On the Oxford Photographic Determinations of Stellar Parallax; Reply to the Criticisms of Sir D. Gill: H. H. Turner.—Occultation of Jupiter and his Satellites, 1900, September 29: John Tebbutt.—Cape Double Star Results, 1900: Royal Observatory, Cape of Good Hope.—The Nearest Approach of Two Planets: C. T. Whitmell.—Observations of Leonids, 1900 November 15, 16: Royal Alfred Observatory, Mauritius.—Description of a Floating Photographic Zenith Telescope, and some Results obtained with it: Bryan Cookson.—Note on Mr. Cookson's Paper on the Accuracy of Eye Observations of Meteors: H. C. Plummer.—The Variable Star R Centauri: A. W. Roberts.—On the New Star in Perseus: A. Stanley Williams.—*Probable papers*: Photographic Positions of Nova Persei and Neighbouring Stars: University Observatory, Oxford.—Spectrum of Nova Persei: H. F. Newall.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Sewage Treatment: C. Johnston.

PHYSICAL SOCIETY, at 5.—A Theory of Colloidal Solutions: Dr. F. G. Donnan.—Exhibition of Apparatus: R. Appleyard.—On the Production of a Bright Line Spectrum by Anomalous Dispersion and its Application the "Flash Spectrum": Prof. R. W. Wood.

MALACOLOGICAL SOCIETY, at 8.—Note on the Anatomy of *Thersites* (*Hadra*) *bipartita*, Fer.: S. Pace.—New Marine Shells from "the Kowie" of South Africa: G. B. Sowerby.—New Marine Shells from the Philippines, &c.: G. B. Sowerby.

SATURDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

MONDAY, MARCH 11.

SOCIETY OF ARTS, at 8.—Electric Railways: Major Philip Cardew.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geography of the North-West Frontier of India: Col. Sir Thomas H. Holdich, K.C.I.E., C.B.

TUESDAY, MARCH 12.

ROYAL INSTITUTION, at 3.—The Cell as the Unit of Life: Dr. A. Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Æsthetic Treatment of Bridge Structures: J. Husband.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Apochromatic Collinear Lens: Dr. Harting.

WEDNESDAY, MARCH 13.

SOCIETY OF ARTS, at 8.—The Proposed High-Speed "Monorail" between Liverpool and Manchester: F. B. Behr.

THURSDAY, MARCH 14.

ROYAL SOCIETY, at 4.30.

ROYAL INSTITUTION, at 3.—Greek and Roman Portrait Sculpture: Prof. Percy Gardner.

MATHEMATICAL SOCIETY, at 5.30.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Growth and Trend of Indian Trade—a Forty Years' Survey: H. J. Tozer.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Notes on Polyphase Substation Machinery: A. C. Eborall.

FRIDAY, MARCH 15.

ROYAL INSTITUTION, at 9.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Combined Trolley and Conduit Tramway Systems: A. N. Connett.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Enteric Fever Mortality in Copenhagen from 1828–1898: Dr. N. P. Schierbeck.—The Effect of Sewerage and Water Supply upon the Behaviour of Enteric Fever in Buenos Ayres: Dr. J. T. R. Davison.

SATURDAY, MARCH 16.

ROYAL INSTITUTION, at 3.—Sound and Vibrations: Lord Rayleigh, F.R.S.

CONTENTS.