THURSDAY, MAY 12, 1892.

BRACHIOPODS OF THE ALPINE TRIAS.

Brachiopoden der Alpinen Trias. Von A. Bittner. *Abhandl. d. k. k. geologischen Reichsanstalt*, Bd. xiv. 4to, 325 pages, 41 plates, and numerous zincotypes in the text. (Vienna: A. Hölder, 1890.)

BOOKS on Triassic fossils, helping as they do to bridge over the gap in our knowledge of those life-forms that led from the ancient times to the middle ages of earth-history, will always be welcomed by both geologist and biologist, especially when, as in the fine work before us, they show signs of wide learning and elaborate research, and are accompanied by such figures and diagrams as place their stores of information within easy reach of all.

The Triassic rocks and Brachiopods best known to English collectors, and indeed to geologists in general, through the writings of Münster, v. Klipstein, and Laube on the one hand, and Suess and Zugmayer on the other, are those of the St. Cassian argillaceous beds and of the Hallstatt limestone. Besides these, the Brachiopods of the Alpine Muschelkalk have been largely worked out by Schauroth and Boeckh. In addition to those from these well-known horizons, Mr. Bittner surveys the Brachiopod faunas from a large number of other beds, including the Rhætic, few of which beds have been systematically worked before, but all of which may be compared with those of the above-mentioned better-known types.

Mr. Bittner has divided his work into two parts: the first, of 287 pages, being devoted to the description of species and the comparison of faunas; the second dealing with the morphology and distribution of the several genera. It will be convenient to follow a similar order in this article.

Part I. follows primarily a stratigraphical, and secondarily a topographical arrangement, so that the species are described under various faunas. In one place, however, the author stops to give us two interesting essays, one on his new genus *Halorella*, the other on the Triassic species of *Rhynchonella*, both of which should by rights have come in the second part of his work.

The descriptions are based chiefly on materials in the Museum of the Geologische Reichsanstalt and the Hofmuseum in Vienna, although a very large number of other collections—private and public—have been consulted by the author. Among these, however, we fail to notice the British Museum, which contains many of v. Klipstein's types. Mr. Bittner, it should be mentioned, invites collectors and others to send him all their material, and promises to determine the species carefully and to describe any new ones. The present volume is sufficient guarantee that the work will be carefully done.

It may well be imagined that the task set before our author was no light one. There appear to be 398 species of Brachiopods in the Trias of the Alps, and of these 216 are named for the first time in this work. But we wish that Mr. Bittner had made his book a little more of what one expects it to be from its size and scope—namely, a monograph of the Brachiopods of the Alpine Trias. Such a monograph would have included a diagnosis, if not a figure, of every species of Brachiopod known to occur in these beds; it would have summarized the literature of the subject, and it would have shown at a glance under each species in what beds and at what localities it occurred. Such a work, which need not have been a page longer than the present, would have been worth a library to students of these fossils. The author, however, has elected merely to crowd our shelves with one more book, and not even a book in the highest sense of the word. He has unfortunately not thought it necessary to give even descriptions of previously named species, unless he has something new to say about them, while his whole volume is innocent of any serious attempt at a diagnosis. Here is an example—no unfavourable one—of his method:—

"*Rhynchonella Attilina*, nov. sp."

"A small *Rhynchonella* occurring in numbers, which at first sight reminds one of the above-described *Rh. trinodosi m.* The simplest examples are very near that species and easily confused with it."

He then goes on to contrast *R. Attilina* with *R. trinodosi*, point by point, for twenty-seven lines, and so ends without any independent description of his new species, and with nothing to say how it differs from the ninety other Triassic species of the genus, not to mention the rest. And there are many worse instances than this.

We are aware that Mr. Bittner is by no means the only offender in this respect; were he so, our complaints would be unnecessary. He is merely an example of a body of writers, far too numerous in our own country, who seem to have the notion that this sort of thing is science. It is what science has to put up with, and if possible to make science out of; but there is generally about as much science in it as in an auctioneer's catalogue. The writers in question seem never to have heard of Linnæus. Had they studied his writings, they would understand that, for systematic purposes, the diagnosis is everything, that every new species described often necessitates a re-diagnosing of all other species in the genus, and in many cases involves a fresh diagnosis of the genus itself. Were this appreciated, fewer synonyms would disgrace our lists.

To return to Mr. Bittner, whose work is after all more scientific than that of most of these name-mongers. It is noticeable that he, as a rule, gives no measurements, leaving it to readers to gather these from the plates. The task of calculating average measurements is of course irksome; still it is often possible to compare species more accurately by their means than by any other.

Neither does our author ever take the trouble to inform us of the meanings of his trivial, or even generic names. "Why *R. trinodosi?*" we ask, and infer—though from nothing under the head of the species itself—that it is due to the association of the species with *Ceratites trinodosus*. But there are many names that still remain to the present writer unsolved enigmas: such are *S. pia*, *S. avarica* (unless this means *avaricensis*), and *R. generosa*. It is also rather difficult to understand why three species of Rhynchonella, all from the same district, should be called *R. cimbrica*, *R. teutonica*, and *R. venetiana*. We venture to think, however, that the climax of nomenclatural aberration is reached in such a name as "*Ko-*

ninckina Leopoldi Austriæ nov. spec." Here the author is following the bad example of "*Spiriferina Maximiliani Leuchtenbergensis* Klipstein *sp.*," and similar preciosities of the older writer. If emperors and dukes need such distinctive appellations, what must be done for ordinary mortals? Some day we shall see "*Robinsonia Gulielmi-Smithi-South-Kensingtonensis* Jones *sp.*" Seriously, no amount of snobbishness can make these names binomial. Mr. Bittner will need no apology for these remarks, for he has written:—

"Es wäre nur zu wünschen, dass man sich auch gegen andere . . . Uebelstände und Missbräuche in der Nomenclatur . . . in so eifriger Weise aussprechen . . . möchte."

In his investigations into the internal structure of some of these Brachiopods the author has received much help from the researches of Mr. H. Zugmayer, many of which are here published for the first time. Like the Rev. Norman Glass, Mr. Zugmayer has devoted much attention to the shape of the lophophoral support. While Mr. Glass, however, works his specimens out by careful dissection, Mr. Zugmayer adopts the fashionable method of cutting a series of sections. Morphologists, as we know, look down on palæontologists, and their real reason is that the latter cannot use the Caldwell microtome; but the figures here published will go far to remove that reproach. One could wish, however, for more diagrams elucidating the results obtained by the sections.

The author has made a large number of new subgenera and a few new genera, the details of which are too technical for reproduction here. The following forms may be noted as strictly characteristic of the Trias:—The Koninckinidæ, especially *Koninckina* and *Amphiclina;* the Thecospiridæ; certain Rhynchonellidæ, viz. *Halorella*, *Dimerella*, and the subgenera *Austriella* and *Norella;* *Camerothyris* and *Cruratula*, which are two subgenera of *Waldheimia;* *Nucleatula* and *Juvavella*, two new genera of the Centronelline type of Terebratulidæ; long-beaked forms of *Retzia;* most of the diplospire *Spirigeræ;* the septate *Spirigeræ* (*Amphitomella*); *Mentzelia*, a subgenus of *Spiriferina;* the doubtful *Badiotella;* and some peculiar *Cyrtinæ*.

Turning now to Part II. of the work, we may note the following details concerning some of the above forms.

The numerous groups of *Spiriferina*, though convenient, are of uncertain value; for it is uncertain whether, in determining affinities, more weight should be attached to the structure of the beak or to the ribbing. Ribbing varies greatly in forms with the same beak-structure, *e.g.* the *Hirsuta* group. This is an instructive instance of the difficulty of classifying on other grounds than those of phylogenesis.

The *Cyrtinæ* are interesting. *C. Fritschii* is a new species in which the pseudo-deltidium, which in other Brachiopods is a single plate closing in the peduncular aperture, consists of two rows of separate scale-like plates alternating with one another. *C. Buchii* and *C. Zittelii* appear to have been attached, at least in youth, by the apex of the larger valve, which is often curiously distorted. This fact may explain the pseudo-deltidium of *C. Fritschii*, for it may have been flexible to allow of the passage of a short peduncle or byssus. These forms lead up to *Cyrtotheca*, which was attached by one of the broad surfaces supporting the beak of the larger valve. The unique original of this genus has unfortunately been lost.

The genus *Spirigera* is divided into numerous groups, many of which have a secondary lamella running alongside of the main lamella that supports the spires of the lophophore; they are therefore said to be "diplospire." This structure is extremely rare in Palæozoic species of the genus.

The Koninckinidæ form the most widely distributed family of the Upper Alpine Trias; and of it, as well as of the four genera belonging to it, a complete description is given. In Mr. Bittner's opinion this family has been shown by the researches of Mr. Zugmayer to be closely allied to the Spiriferidæ. The lophophore support is diplospire. *Amphiclinodonta*, a new genus of this family, has an extremely complicated hinge and teeth.

Badiotella is a remarkable genus founded on a single unsymmetrical large valve. Its resemblance to *Streptorhynchus* suggests that it is probably a relic of the Strophomenidæ.

Juvavella and *Nucleatula* are two new genera of the Centronellinæ found in the Hallstatt limestone. This group has not hitherto been found in rocks of so late an age.

The general relations of the Triassic Brachiopods of the Alps may be summarized as follows:—

In the Lower Trias there are only two species, a *Lingula* and a *Discina*.

In the Muschelkalk there are forty-two species, referable to *Lingula*, *Discina*, *Terebratula*, *Waldheimia*, *Rhynchonella*, *Spirigera*, *Retzia*, *Spiriferina*, and *Mentzelia*. All these, in closely allied or even identical forms, appear again in the Upper Trias.

The Upper Trias contains over 300 species, including all the types already mentioned. This, therefore, is a truer representation of the Brachiopod fauna of the Triassic period. The faunas of the Lower and Middle Trias are less, merely because the conditions were no so favourable in the Alpine area.

In the Triassic fauna hingeless genera are very rare.

Among the hinged genera two families, each containing over 100 species, are noticeable: the Spiriferidæ for the large number of genera, subgenera, and minor groups, combined with a paucity of individuals; the Rhynchonellidæ for the large number of individuals, with few well-marked genera or subgenera. The philosophic naturalist is tempted to suggest that the few divisions recognized in the latter family may be due to the very richness of the material.

The spire-bearers almost exactly equal the non-spire-bearers in the number of species. The latter, however, exceed in individuals, and, from this period onwards, increase in importance, while the spire-bearers soon disappear from the rock record. It is, therefore, very noteworthy that, just before their extinction, the spire-bearers should not only develop new branches—the Koninckinidæ and (?) Thecospiridæ—but should also break up into so many genera, subgenera, and minor groups. A similar efflorescence, as Mr. Bittner observes, marked the later history of the Terebratulidæ, a family now almost extinct.

These facts are certainly opposed to the statement of Hyatt that stems give off numerous forms in their early youth, when the field is free, but not in old age, when they begin to be crowded out by the struggle for existence. Possibly, however, the opposition is more apparent than real, and will disappear when the Brachiopoda shall have been studied under the guidance of modern principles of evolution. Such a study has begun in America, but we regret to see little sign of it in the present work. No doubt Mr. Bittner is only waiting to complete his knowledge, before entering on a field where he will meet with worse obstacles than hard rocks and battered specimens—with illusion and ignorance, prejudice and envy, obstinacy and superstition. When he does start, we shall be the first to wish him good speed.

F. A. BATHER.

A TEXT-BOOK OF POLITICAL ECONOMY.

Elements of Economics of Industry. Being the first volume of "Elements of Economics." By Prof. Alfred Marshall. (London: Macmillan and Co., 1892.)

THE nomenclature of this work reminds us of the ancient custom according to which the alternate generations of a family were named alike. As the son of Hipponicus was called, not after Hipponicus, but after Hipponicus' father, Callias; so the "Economics of Industry," though sprung from the "Principles of Economics," of which it is a miniature, yet does not derive its title from that work, but from the predecessor of that work, the well-known text-book which saw the light some thirteen years ago. The first and the second "Economics of Industry" are unlike in form; but a general family resemblance may be traced between the two generations. A sort of reversion is presented by the circumstance that trades unions are discussed in the latest as in the earliest of our author's books; but not in the intermediate "Principles of Economics." The character of the "Economics of Industry" the younger, and its position in the family group, may best be indicated if, comparing it with its immediate predecessor, the second edition of the "Principles of Economics," we notice what has been retained what has been omitted, and what has been added.

The fundamental principles of political economy as enounced by Prof. Marshall in his *magnum opus*, have been transferred to the pages before us without alteration. The conception of economics as he science of measurable—not necessarily selfish—motives is again the starting-point. Thence we are led to the construction of demand-curves, and that construction by which the benefit which the consumer derives from fall in price is represented. Corresponding to demand-curves and "consumer's rent" are, on the other side of the counter, so to speak, supply-curves and rent proper. But the correspondence is not close, and the diagrammatic representation of the conditions of supply presents peculiar difficulties. It is perplexed by the principles of "increasing" and "decreasing returns." Difficulty is caused by the distinction—first clearly indicated by Prof. Marshall—between "long periods" and "short periods." An effort is required to realize the idea of supply, as it were, projected through time—the vast conception of skilled work put upon a future labour-market by parental providence for vicarious remuneration. The forces of demand and supply determine price, acting simultaneously, in the sense in which equations are called simultaneous. "Just in the same way, when several balls are lying in a bowl, they mutually determine one another's position." The law of demand and supply—the gravitation of the economic system—governs widely distant spheres; not only exchange in the proper narrow sense, but also distribution. Prof. Marshall was, we believe, the first clearly to discern this identity. But, while contemplating the unity of the genus, he has not lost sight of the diversity of the species. No one else has so fully enumerated and allowed for what may be called the *propria* of the different markets; such as the circumstance that many of the disadvantages in bargaining to which the workman is subject are *cumulative*. It is this union of wide general views with minute knowledge of concrete details which imparts peculiar weight to Prof. Marshall's recommendations respecting questions of practical moment, such as the limitation of the hours of labour.

These lessons have now been made easier by the omission of much that is accessory and abstruse in the original volume; in particular, the literary criticisms and the mathematical demonstrations. Among the latter class of omissions two seem conspicuous: the difficult formula for discounting future pleasure, and what may be called the higher theory of the supply-curve, including its possible plural intersection with the demand-curve. Difficult, the present writer may well call these theories, for he has to confess that he was mistaken in some strictures passed upon them in a review of the first edition of the "Principles of Economics" (NATURE, August 14, 1890). The fuller statements about those subjects contained in the second edition made it evident that there had occurred what more frequently occurs than is acknowledged: the author was right, and the critic was wrong. The little incident may be referred to as justifying the plan of abridgment which has been adopted—by omission rather than compression of difficult demonstrations. "It seemed that the difficulty of an argument would be increased rather than diminished by curtailing it and leaving out some of its steps." There results a text-book eminently fitted for the purpose of education, embodying the result of original reflections in a shape adapted to the needs of beginners; complete in itself, yet capable of being supplemented by the judicious teacher who, referring to the "Principles of Economics," may point to that higher world of thought and lead the way.

Practical exigencies have induced Prof. Marshall to forestall the discussion of trade unionism which may be expected in the second volume of the "Principles of Economics." In the work before us he thus states the claim of unions to make economic friction act in favour of the workman:—

"A viscous fluid in a vessel tends to form a level surface; but, if from time to time an artificial force pushes down the left side, which we may take to correspond to wages, it may reasonably be maintained that the average position of the left side is lower than it would have been without such interference, in spite of the in-

disputable fact that the force of gravitation is constantly tending to reinstate the position of equilibrium. What unions claim to be able to do corresponds to applying frequent and stronger pressure on the right-hand side, thus causing profits to yield the higher level to wages."

To this argument there is opposed a preliminary objection, that friction is not strong in the labour-market, that competition is much more effective than unionists assume. There is wanting, indeed, an exact measure of this friction, as in the case of so many economic forces; one must be content with a rough mean between the divergent statements of experienced persons. The claim on behalf of the unions may now be considered under two heads—with reference to a single trade, and where the union is supposed to be extended to all the trades of a country. But we cannot here follow the subtle argument into all the intricacies of the subject. We shall refer only, or chiefly, to the latter case—which, in view of the developments of the new unionism, cannot be regarded as imaginary—the case of a supposed universal union. The main argument against this sort of unionism is that a rise of wages obtained at the expense of profits tends to cause a diminution, or at least a check to the growth, of those accumulations from which the remuneration of the labourer is derived. "This old argument has both gained and lost strength in recent times." Upon a balance of considerations, it still appears weighty; it is even cumulative, the diminution of the national dividend being progressive from year to year. Two counter-arguments are urged by unionists. First, they claim that through their policy the machinery of the labour-market works more smoothly; thus it saves the employer trouble and anxiety to be able to buy his labour—just as it does to buy his raw material—at wholesale prices (a fixed minimum rate of wage). After a detailed consideration of the policy of trade unions, Prof. Marshall concludes that in some cases—especially where the invigorating effect of foreign competition is felt—"trade unions, on the whole, facilitate business." It is sometimes otherwise with trades which have a monopoly of some special skill. A second great argument in favour of trades unions is that they have increased the efficiency of workmen, thereby increasing the total produce. The beneficial effect on the standard of life is to be admitted in cases like that of the London Docks. "But this answer is not open to those unions or branches of unions that in effect foster dull and unenergetic habits of work." Where reasons are so conflicting, it were to be wished that direct observation were available. But here, as elsewhere in economics, history is difficult to interpret. There is, indeed, the patent fact that those occupations in which wages have risen most in England are those in which there are no unions—namely, the kinds of domestic service and the employments of women for which there has been an increase of demand and a check of supply. On the other hand are urged cases in which higher wages have attended stronger unions. But we cannot be quite certain that the gain of one trade is not obtained at the expense of a greater loss to some other trade. Also prosperity may be rather a cause than a consequence of the prevalence of trades unions. The general conclusion appears to be that unions are not to be condemned or extolled in the abstract, but only after attending to the particular character of each, and considering whether its policy complies with the conditions of success. Where the consequences for good or evil are so widespread, and the issues are to a large extent moral—whether unionists are procuring a small good immediately and for themselves at the expense of a greater loss in the future or to other classes—it is natural to appeal to public sympathy and criticism. "Public opinion, based on sound economics and just morality, will, it may be hoped, become ever more and more the arbiter of the conditions of industry." Among the means of educating public opinion we should place high the study of the "Economics of Industry." F. Y. E.

OUR BOOK SHELF.

Elements of Materia Medica and Therapeutics; including the whole of the Remedies of the British Pharmacopœia of 1885 *and its Appendix of* 1890. By C. E. Armand Semple, B.A., M.B. (Cantab.), M.R.C.P. Pp. 480. (London: Longmans, Green, and Co., 1892.)

WHEN a knowledge of medical botany was absolutely necessary to the student of materia medica, such works as Pereira's "Elements" and Bentley's "Text-book of Organic Materia Medica" supplied a real want in this direction. But with the altered ideas of modern teaching there is a growing tendency among examiners to demand rather a thorough knowledge of the chemistry and intimate action of the active principles of drugs than of their botanical sources. This being the case, it is a little difficult to understand why the work at present under notice has been written. Mr. Semple thinks that by the aid of his book and of the illustrations contained therein, the student will be able to master the subject, and will have the facts impressed upon him more vividly by the pictures. We think, however, that most will agree with us that one of the already well-known text-books, such as the excellent one by Mitchell Bruce, or the larger and more comprehensive one by Brunton—used in connection with a materia medica museum—will make the subject at least equally interesting, and enable the worker to pass a far better examination. Since the 440 illustrations included in the text appear to be brought forward as the strong point of Mr. Semple's cram-book, we must draw attention to a few of their peculiarities noticeable at a glance. In the first place, non-officinal parts of plants are sometimes illustrated, and not the officinal parts. Again, some of the plates, though good enough in themselves, such as those illustrating the extraction of tar and the collection of asafœtida, narrowly escape being ludicrous in a work on materia medica. Others, such as that showing a sulphuric acid factory, give the student no idea of the principles involved in the processes of preparation, and it is these alone which are of importance to him. Many sketches are evidently inserted simply because the blocks were at hand. Lastly, in the inorganic portion we regret to notice the complete absence of chemical equations and formulæ, without a knowledge of which the student's knowledge is indeed rudimentary.

Elementary Lessons in Heat. By S. E. Tillman, Professor of Chemistry, U.S. Military Academy. Second Edition. (New York: John Wiley and Sons. London: Gay and Bird. 1892.)

THE "Lessons" presented in this volume were originally prepared for the use of students at the U.S. Military Academy. They are well fitted for students who can devote only a limited time to this branch of science, for

the author not only knows his subject thoroughly, but understands how to deal with it in a way that shall be readily intelligible. His main object has been to direct attention only to important facts and principles, and to bring out the various links by which they are logically connected with one another. There are eleven chapters, in which he treats of thermometry, dilation of bodies, calorimetry, production and condensation of vapour, change of state, hygrometry, conduction, radiation, thermo-dynamics, terrestrial temperatures, aërial meteors, and aqueous meteors. Few changes have been made in the present edition, but the author has introduced a collection of elementary problems, which, as he says, may be "advantageously solved in connection with the subject-matter to which they appertain."

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.*]

Aurora.

THERE was a fine aurora visible in this locality on Saturday night, April 23. It was seen at intervals, whenever the clouds broke away, until after midnight. This display is specially interesting, because it forms the continuation of a series of recurrences, at the precise interval of twenty-seven days, which began in December, the dates being as follows: December 9, January 5, February 2, February 29, March 27, and April 23. Some of these displays have been brilliant, and all of them have been well defined. In the table of auroras which I have constructed, based upon a periodicity corresponding to the time of a synodic revolution of the sun—namely, twenty-seven days, six hours, and forty minutes—there was, for several years preceding the sun spot minimum in 1889 and 1890, a return each spring of series of recurrences associated with the same part of the sun as that above described. A corresponding systematic tabulation of the records of solar conditions shows that this association bears a direct relation to reappearances at the eastern limb of an area which has been much frequented by spots and faculæ, and which has been located persistently south of the sun's equator. In like manner there are other areas located in the sun's northern hemisphere which have been much disturbed, and whose reappearances at the eastern limb have been attended year after year by series of recurrences of the aurora, in the autumn months chiefly, if not exclusively. From this it would appear that, in order that a solar disturbance may have its full magnetic effect upon the earth, it is necessary that it should be at the sun's eastern limb, and as nearly as possible in the plane of the earth's orbit. It appears, also, that the disturbances which recur upon certain parts of the sun so persistently year after year have greater magnetic effect than those of comparatively sporadic character located elsewhere.

Lyons, N.Y., April 25. M. A. VEEDER.

The White Rhinoceros.

IN my "Naturalist in the Transvaal" (p. 5), I recently deplored the supposed fact that a perfect skin or skeleton of *Rhinoceros simus* was unknown in any Museum; and I relied for my information on the interesting communication in your columns made by Dr. Sclater (vol. xlii. p. 520).

I have just received a very welcome letter from Dr. Jentink, the Director of the Leyden Museum, stating that there are two skins to be found in that collection, "one in a rather bad state, but the other a beautiful stuffed specimen, measuring more than 3½ metres."

Dr. Jentink had published this information in *Notes from the Leyden Museum* (October 1890), a communication I had not seen when I returned from the Transvaal and wrote on the matter.

This is a most gratifying fact for all zoologists, and the Leyden Museum appears to have a unique treasure.

Purley, Surrey, May 3. W. L. DISTANT.

The Line Spectra of the Elements.

IN Prof. Runge's article on the spectra of the elements in last week's issue of NATURE (p. 607) he refers to my explanation of double lines in the spectra of gases ("Cause of Double Lines in Spectra," Trans. of the Roy. Dublin Soc., vol. iv. 1891, p. 563); and says:—"I do not understand the decomposition of the arbitrary curve" [rather, of the actual motion of the electric charge within the molecules of the gas] "in a series of superposed ellipses" [rather, into a series of pendulous motions in ellipses]. "For the movement is supposed not to be periodical" [rather, is not known to be periodical], "and Fourier's theorem then would not apply, at least the periods of the superposed ellipses would not be definite, as long as there are no data except the arbitrary curve itself" [rather, no data except those furnished by the positions and intensities of the spectral lines].

Prof. Runge will pardon me if I say that this objection seems to me to be of the same kind as a doubt with respect to the value of tables of logarithms on the ground that many logarithms are incommensurable with integer numbers, and therefore cannot equal decimal fractions.

Take, for example, a simple vibratory movement of an electron within the molecules, represented by

$$x = a \sin\left(2\pi \frac{mt}{j}\right) + b \sin\left(2\pi \frac{\pi mt}{j}\right), \quad \ldots \quad (1)$$

which would give rise to two lines in the spectrum with oscillation-frequencies m and πm in each jot of time. This, Prof. Runge objects, cannot be analyzed by Fourier's theorem, because it is not periodic. But

$$x = a \sin\left(2\pi \frac{mt}{j}\right) + b \sin\left(2\pi \frac{3{\cdot}14159\ mt}{j}\right), \quad \ldots \quad (2)$$

$$x = a \sin\left(2\pi \frac{mt}{j}\right) + b \sin\left(2\pi \frac{3{\cdot}141593\ mt}{j}\right), \quad \ldots \quad (3)$$

$$x = a \sin\left(2\pi \frac{mt}{j}\right) + b \sin\left(2\pi \frac{3{\cdot}1415927\ mt}{j}\right), \quad \ldots \quad (4)$$

&c., &c., &c.,

being periodic, can be so analyzed. The motion represented by the first of these (Equation 2) approximates for a certain time to the actual motion which is represented by Equation 1. The motion represented by the next (Equation 3) approximates more closely and for a longer time; and so on. So that Fourier's theorem can be applied to motions which approximate to the non-periodic motion represented by Equation 1, in any assigned degree and for any assigned time; just as a decimal can approximate in any assigned degree to the value of log 8, although no decimal can equal that logarithm.

G. JOHNSTONE STONEY.

9 Palmerston Park, Dublin, May 1.

On a Proposition in the Kinetic Theory of Gases.

IN last month's *Philosophical Magazine* there is a paper by Lord Rayleigh criticizing a demonstration by Maxwell of the equality of the products $dp_1 \ldots dp_n, dq_1 \ldots dq_n$, and $dP_1 \ldots dP_n, dQ_1 \ldots dQ_n$, where the p's and P's are the momenta, and the q's and Q's the co-ordinates, of a system at the beginning and end of any interval of time.

Lord Rayleigh correctly points out that the assumption of E, the total Energy, as an independent variable, vitiates the proof, and he suggests the substitution of Hamilton's principal function S for the characteristic function A, with t, the time, as an independent variable.

Prof. Boltzmann took a similar objection to Maxwell's demonstration in a paper to the *Philosophical Magazine* in the year 1882, in the course of some comments on my use of the proof in a small treatise on the kinetic theory of gases, and I then privately suggested to him the substitution of S for A, with t independent, as proposed by Lord Rayleigh. But unfortunately, as I now see, the proposition $dp_1 \ldots dq_n = dP_1 \ldots dQ_n$, with t independent, although doubtless true, has no application to the particular problem in the kinetic theory of gases to which I was applying it.

My object was to abbreviate and simplify the proof of a fundamental theorem in the subject originally given by Boltzmann, and which may be fairly well illustrated by the following simple case:—

Suppose that in the plane of a projectile there are two infinite

parallel straight lines, A and B, and we introduce such a relation between x_0, y_0, x, and y as will express that when the former is a point on the line A the latter will be a point on B, each of the four quantities x, y, u, v may then be expressed as a function of x_0, y_0, u_0, v_0, and it may be proved that

$$dx\,dy\,du\,dv = \frac{V_0}{V} dx_0\,dy_0\,du_0\,dv_0 ;$$

where V_0 and V are the resolved parts of the projectile's velocity perpendicular to the two lines as it crosses A and B respectively.

For instance, let the lines be vertical $x = a$ and $x = b$, where $b - a = c$. Our equations are—

$$x - x_0 = c = u_0 t$$
$$y - y_0 = v_0 t - \frac{gt^2}{2}$$
$$v = v_0 - gt$$
$$u = u_0$$

$$\therefore t = \frac{c}{u_0},\quad v = v_0 - \frac{gc}{u_0},\quad u = u_0,\quad x = x_0 + c,\quad y = y_0 + \frac{v_0 c}{u_0} - \frac{gc^2}{2u_0^2},$$

and

$$\Delta = 1 = \frac{u}{u_0}.$$

Also here $t = \frac{c}{u_0}$ is *not* constant, as it depends upon u_0.

Next let the lines be horizontal, $y = a$, $y = b$, $b - a = c$. We then have

$$(1)\quad y - y_0 = c = v_0 t - \frac{gt^2}{2}$$
$$(2)\quad x - x_0 = u_0 t$$
$$(3)\quad u = u_0$$
$$(4)\quad v = v_0 - gt.$$

From (1)

$$t = \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g},\qquad x = x_0 + \frac{u_0}{g}\left(v_0 - \sqrt{v_0^2 - 2cg}\right),$$
$$y = y_0 + c,\qquad u = u_0,\qquad v = \sqrt{v_0^2 - 2cg},$$

and our determinant Δ is

$$\begin{vmatrix} 1, & 0, & \frac{v_0 - \sqrt{v_0^2 - 2cg}}{g}, & \frac{u_0}{g}\left\{1 - \frac{v_0}{\sqrt{v_0^2 - 2cg}}\right\} \\ 0, & 1, & 0, & 0 \\ 0, & 0, & 1, & 0 \\ 0, & 0, & 0, & \frac{v_0}{\sqrt{v_0^2 - 2cg}} \end{vmatrix}$$
$$= \frac{v_0}{v}.$$

If our lines were $y = mx$ and $y = mx + c$, our additional condition would be

$$y - y_0 = m(x - x_0) + c ;$$

and the result mentioned could be arrived at, although with a little additional work.

The actual problem proposed by Boltzmann is the same as this in principle, although of much greater complexity, and it is treated by him with the utmost generality. The important thing here is to show that the S function with t constant is of no application, inasmuch as in both of these very simple illustrations we have t a dependent variable depending upon u_0 or v_0.

I am only pointing out that the S method, with t independent, would not help to establish the particular proposition to which I am referring. It may lead to the determination of a law of permanence of distribution independently of this proposition and by a simpler treatment. The Boltzmann treatment, however, avoids the difficulty which may arise from the fact that *encounters*, whether of finite or infinitely short duration, involve the assumption of discontinuous forces, and, therefore, of a corresponding discontinuity in the form of the S function.

A little consideration shows that the condition E constant cannot lead to any determinate relation between the differential products $dp_1 \ldots dq_n$ and $dP_1 \ldots dQ_n$.

For to take again the simple case of the projectile. Here we get four equations between the nine quantities, $x_0\ y_0\ u_0\ v_0$, $x\ y\ u\ v$ and t, whence it is clear that the elimination of t does not enable us to arrive at more than three equations between the remaining eight quantities, and therefore that we cannot express x, y, u, v separately as determinate functions of $x_0\ y_0\ u_0\ v_0$. To enable us to do this we need one additional condition, and this may be supplied in an infinite number of ways. It may be one of the conditions above considered leading to the equation $dx\,dy\,du\,dv = \frac{V_0}{V} dx_0\,dy_0\,du_0\,dv_0$, or it may be the condition t constant leading to the equality of these differential products, and so forth ; but the condition E constant supplies no additional relation between the eight variables. This conclusion holds equally for n degrees of freedom, following from the two partial differential equations in $q_1 \ldots q_n$, $Q_1 \ldots Q_n$, to which the characteristic function A is subject, so that the condition E constant leads to no determinate relation between the differential products.

This conclusion is not inconsistent with Maxwell's proof. That proof takes the form—

$$dp_1 \ldots dq_n = \frac{\Delta}{\Delta'} dP_1 \ldots dQ_n,$$

where Δ is equal to Δ', but it may be proved that in this case Δ and Δ' are separately zero, and therefore that, as stated above, no relation can be established between the two differential products.

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Palæonictis in the American Lower Eocene.

PALÆONTOLOGISTS will welcome Dr. T. L. Wortman's discovery of a nearly complete skull of *Palæonictis* in the Wahsatch Lower Eocene of Wyoming. The only specimens of this form known hitherto are the two fragmentary lower jaws from the Suessonian lignites of France upon which De Blainville founded the genus in 1841. This specimen includes the facial region of the skull and the complete lower jaws in fine preservation. We owe it to the expert skill of Dr. Wortman, for the fossil was found completely dissociated ; he carried several sacks of the *débris* surrounding the fragments fifteen miles to the nearest river, and by careful washing recovered all the teeth.

The skull is about the size and form of that of the Puma (*Felis concolor*), without the long muzzle so characteristic of all the early Carnivores or Creodonts. The dental series is remarkably compressed and reduced, especially in the upper jaw, the formula being : I $\frac{3}{3}$, C $\frac{1}{1}$, P $\frac{4}{4}$, M $\frac{2}{2}$. The third upper molar has entirely disappeared, the second is as small as the little tubercular in the modern cats, the first is smaller than the fourth premolar. The latter tooth, in conjunction with the first true lower molar, is in course of transformation into a *sectorial*. This and many other features point to the conclusion that *Palæonictis* is closely related to the Eocene ancestors of the Felidæ—which have hitherto been considered a gap in the fossil series.

The type, which we may call *P. occidentalis*, will soon be fully figured and described. HENRY F. OSBORN.

American Museum of Natural History, April 19.

WATERSTON'S THEORY OF GASES.

ON the 11th of December, 1845, a paper by Mr. J. J. Waterston, entitled "On the Physics of Media that are composed of Free and Perfectly Elastic Molecules in a State of Motion," was communicated by Captain Beaufort, R.N., to the Royal Society.

This paper was not published at the time, but was relegated to the Archives. It now, however, has just been issued as a part of the current volume of Philosophical Transactions.

It is preceded by an introduction by Lord Rayleigh, one of the Secretaries of the Royal Society, and we cannot do better—in order to call attention to this remarkable paper, which anticipates the present theories in many respects, and to explain how it is that it now appears—than print Lord Rayleigh's introduction as it stands, and also the introduction to the memoir itself.

"*Introduction by Lord Rayleigh, Sec.R.S.*

"The publication of this paper after nearly half a century demands a word of explanation ; and the opportunity may be taken to point out in what respects the received theory of gases had been anticipated by Waterston, and to offer some suggestions as to the origin of certain errors and deficiencies in his views.

"So far as I am aware, the paper, though always accessible in the Archives of the Royal Society, has remained absolutely unnoticed. Most unfortunately the abstract printed at the time (Roy. Soc. Proc., 1846, vol. v. p. 604 ; . . .) gave no adequate idea of the scope of the memoir, and still less of the nature of the results arrived at. The deficiency was in some degree supplied by a short account in the Report of the British Association for 1851 (. . .), where is distinctly stated the law, which was afterwards to become so famous, of the equality of the kinetic energies of different molecules at the same temperature.

"My own attention was attracted in the first instance to Waterston's work upon the connection between molecular forces and the latent heat of evaporation, and thence to a paper in the *Philosophical Magazine* for 1858, 'On the Theory of Sound.' He there alludes to the theory of gases under consideration as having been started by Herapath in 1821, and he proceeds :—

"'Mr. Herapath unfortunately assumed heat or temperature to be represented by the simple ratio of the velocity instead of the square of the velocity—being in this apparently led astray by the definition of motion generally received—and thus was baffled in his attempts to reconcile his theory with observation. If we make this change in Mr. Herapath's definition of heat or temperature, viz. that it is proportional to the *vis viva*, or square velocity of the moving particle, not to the momentum, or simple ratio of the velocity, we can without much difficulty deduce, not only the primary laws of elastic fluids, but also the other physical properties of gases enumerated above in the third objection to Newton's hypothesis. In the Archives of the Royal Society for 1845-46, there is a paper "On the Physics of Media that consist of Perfectly Elastic Molecules in a State of Motion," which contains the synthetical reasoning upon which the demonstration of these matters rests. The velocity of sound is therein deduced to be equal to the velocity acquired in falling through three-fourths of a uniform atmosphere. This theory does not take account of the size of the molecules. It assumes that no time is lost at the impact, and that if the impact produce rotatory motion, the *vis viva* thus invested bears a constant ratio to the rectilineal *vis viva*, so as not to require separate consideration. It also does not take account of the probable internal motion of composite molecules ; yet the results so closely accord with observation in every part of the subject as to leave no doubt that Mr. Herapath's idea of the physical constitution of gases appproximates closely to the truth. M. Krönig appears to have entered upon the subject in an independent manner, and arrives at the same result ; M. Clausius, too, as we learn from his paper "On the Nature of the Motion we call Heat" (*Phil. Mag.*, vol. xiv., 1857, p. 108).'

"Impressed with the above passage and with the general ingenuity and soundness of Waterston's views, I took the first opportunity of consulting the Archives, and saw at once that the memoir justified the large claims made for it, and that it marks an immense advance in the direction of the now generally received theory. The omission to publish it at the time was a misfortune, which probably retarded the development of the subject by ten or fifteen years. It is singular that Waterston appears to have advanced no claim for subsequent publication, whether in the Transactions of the Society, or through some other channel. At any time since 1860 reference would naturally have been made to Maxwell, and it cannot be doubted that he would have at once recommended that everything possible should be done to atone for the original failure of appreciation.

"It is difficult to put oneself in imagination into the position of the reader of 1845, and one can understand that the substance of the memoir should have appeared speculative, and that its mathematical style should have failed to attract. But it is startling to find a referee expressing the opinion that 'the paper is nothing but nonsense, unfit even for reading before the Society.' Another remarks 'that the whole investigation is confessedly founded on a principle entirely hypothetical, from which it is the object to deduce a mathematical representation of the phenomena of elastic media. It exhibits much skill and many remarkable accordances with the general facts, as well as numerical values furnished by observation. . . . The original principle itself involves an assumption which seems to me very difficult to admit, and by no means a satisfactory basis for a mathematical theory, viz. that the elasticity of a medium is to be measured by supposing its molecules in vertical motion, and making a succession of impacts against an elastic gravitating plane.' These remarks are not here quoted with the idea of reflecting upon the judgment of the referee, who was one of the best qualified authorities of the day, and evidently devoted to a most difficult task his careful attention ; but rather with the view of throwing light upon the attitude then assumed by men of science in regard to this question, and in order to point a moral. The history of this paper suggests that highly speculative investigations, especially by an unknown author, are best brought before the world through some other channel than a scientific Society, which naturally hesitates to admit into its printed records matter of uncertain value. Perhaps one may go further, and say that a young author who believes himself capable of great things would usually do well to secure the favourable recognition of the scientific world by work whose scope is limited, and whose value is easily judged, before embarking upon higher flights.

"One circumstance which may have told unfavourably upon the reception of Waterston's paper is that he mentions no predecessors. Had he put forward his investigation as a development of the theory of D. Bernoulli, a referee might have hesitated to call it nonsense. It is probable, however, that Waterston was unacquainted with Bernoulli's work, and doubtful whether at that time he knew that Herapath had to some extent foreshadowed similar views.

"At the present time the interest of Waterston's paper can, of course, be little more than historical. What strikes one most is the marvellous courage with which he attacked questions, some of which even now present serious difficulties. To say that he was not always successful is only to deny his claim to rank among the very foremost theorists of all ages. The character of the advance to be dated from this paper will be at once understood when it is realized that Waterston was the first to introduce into the theory the conception that heat and temperature are to be measured by *vis viva*. This enabled him at a stroke to complete Bernoulli's explanation of pressure by showing the accordance of the hypothetical medium with the law of Dalton and Gay-Lussac. In the second section the great feature is the statement (VII.), that 'in mixed media the mean square molecular velocity is inversely proportional to the specific weight of the molecules.' The proof which Waterston gave is doubtless not satisfactory ; but the same may be said of that advanced by Maxwell fifteen years later. The law of Avogadro follows at once, as well as that of Graham relative to diffusion. Since the law of equal energies was actually published in 1851, there can be no hesitation, I think, in attaching Waterston's name to it. The attainment of correct results in the third section, dealing with adiabatic expansion, was only prevented by a slip of calculation.

"In a few important respects Waterston stopped short. There is no indication, so far as I can see, that he recognized any other form of motion, or energy, than the translatory motion, though this is sometimes spoken of as vibratory. In this matter the priority in a wider view rests with Clausius. According to Waterston the ratio of specific heats should be (as for mercury vapour) 1·67 in all cases. Again, although he was well aware that the molecular velocity cannot be constant, there is no anticipation of the law of distribution of velocities established by Maxwell.

"A large part of the paper deals with chemistry, and shows that his views upon that subject also were much in advance of those generally held at the time.

"The following extract from a letter by Prof. McLeod will put the reader into possession of the main facts of the case:—

"'It seems a misfortune that the paper was not printed when it was written, for it shadows forth many of the ideas of modern chemistry which have been adopted since 1845, and it might have been the means of hastening their reception by chemists.

"'The author compares the masses of equal volumes of gaseous and volatile elements and compounds, and taking the mass of a unit volume of hydrogen as unity, he regards the masses of the same volume of other volatile bodies as representing their molecular weight, and in the case of the elements he employs their symbols to indicate the molecules.

"'In water he considers that the molecule of hydrogen is combined with half a molecule of oxygen, forming one of steam, and he therefore represents the compound as $HO_{\frac{1}{2}}$. He does not make use of the term "atom" (although he speaks of atomic weight on p. 18, but thinks it divisible), and if he had called the smallest proportion of an element which enters into combination an atom, he would probably have been led to believe that the molecules of some of the simple bodies contain two atoms, and he might have adopted two volumes to represent the molecule, as is done at the present time. The author calls one volume or molecule of chlorine Cl, one volume or molecule of hydrogen H, and one volume or molecule of hydrochloric acid $H_{\frac{1}{2}}Cl_{\frac{1}{2}}$. If he had regarded the molecules as containing two indivisible atoms, these bodies would have been represented, as now, by the formulæ Cl_2, H_2, and HCl respectively, all occupying two volumes. § 15 shows how near he was to this conception. Gerhardt, in the fourth part of his "Traité de Chimie Organique," published in 1856, points out the uniformity introduced into chemical theory by the adoption of this system.

"'For carbon he makes C = 12, as now accepted, although I do not find how he arrives at this number. He seems to have anticipated one of Ramsay's recent discoveries, that nitrous anhydride (hyponitrous acid, $ON_{\frac{2}{3}}$, No. 26 in the table) dissociates on evaporation into nitric oxide (binoxide of nitrogen, No. 23) and nitric peroxide (nitrous acid, No. 25).

"'The values for the symbols for sulphur, phosphorus, and arsenic, taken from the vapour densities (and which are multiples of what are believed to be the true atomic weights), cause some complexity in the formulæ of their compounds.

"'There seem to be errors in the formulæ of alcohol and ether on p. 49, for they do not agree with those in the table. They ought probably to be written

$$2(HC_{\frac{1}{2}}) + O_{\frac{1}{2}}2H_{\frac{1}{2}} \text{ and } 4(HC_{\frac{1}{2}}) + O_{\frac{1}{2}}2H_{\frac{1}{2}}.$$

"'Considering how nearly Waterston approached what is now believed to be the true theory, it is disappointing to read his controversy with Odling in 1863 and 1864 (*Phil. Mag.*, vols. xxvi. and xxvii.), where he seems to oppose the new formulæ then being introduced. He is very dogmatic about the constitution of hydrate of potash: he very properly insists that we can only obtain a knowledge of the molecular weight of bodies that can be volatilized, and of which the vapour densities can be determined, but he does not see the analogy between the hydrate and oxide of potassium with alcohol and ether, probably because he regards these latter bodies as combinations of water with different quantities of olefiant gas. He writes water $HO_{\frac{1}{2}} = 9$, alcohol $CH_2HO_{\frac{1}{2}} = 23$, and ether $C_2H_4 . HO_{\frac{1}{2}} = 37$, whilst he considers potassic hydrate $KO_{\frac{1}{2}} . HO_{\frac{1}{2}} = 56$, and oxide of potassium $KO_{\frac{1}{2}} = 47$, the hydrate having a higher molecular weight than the oxide. If we regard these compounds as derived from water by the replacement of hydrogen by ethyl and potassium respectively, the analogy between the two series is complete (ethyl was discovered in 1849, and is mentioned by Waterston).

$H_2O = 18$	$H_2O = 18.$
$(C_2H_5)HO = 46$	$KHO = 56.$
$(C_2H_5)_2O = 74$	$K_2O = 94.$

"'From a remark in the *Phil. Mag.* (vol. xxvi. p. 520), I imagined that Waterston had arrived at the double atomic weights of many of the metals now adopted, for he gives that of iron as 56 and that of aluminium as 27, calculated from their specific heats, but there is an error in his arithmetic, for 3·3 divided by the specific heat of iron ·1138 gives 28·998, and 3·3 divided by the specific heat of aluminium ·2143 gives 15·399.'

"With the exception of some corrections relating merely to stops and spelling, the paper is here reproduced exactly as it stands in the author's manuscript.—December 1891."

The author's own introduction to his memoir, which occupies eighty pages of the Philosophical Transactions as now printed, runs as follows:—

"Of the physical theories of heat that have claimed attention since the time of Bacon, that which ascribes its cause to the intense vibrations of the elementary parts of bodies has received a considerable accession of probability from the recent experiments of Forbes and Melloni. It is admitted that these have been the means of demonstrating that the mode of its radiation is identical with that of light in the quantities of refraction and polarization. The evidence that has been accumulated in favour of the undulatory theory of light has thus been made to support with a great portion of its weight a like theory of the phenomena of heat; and we are, perhaps, justified in expecting that the complete development of this theory will have a much more important influence on the progress of science, because of its more obvious connection and intimate blending with almost every appearance of Nature. Heat is not only the subject of direct sensation and the vivifier of organic life, but it is manifested as the accompaniment of mechanical force. It is related to it both as cause and effect, and submits itself readily to measurement by means of the mechanical changes that are among the most prominent indications of its change of intensity. The undulatory theory at once leads us to the conclusion that, inasmuch as the temperature of a body is a persistent quality due to the motion of its molecules, its internal constitution must admit of it retaining a vast amount of living force. Indeed, it seems to be almost impossible now to escape from the inference that heat is essentially molecular *vis viva*. In solids, the molecular oscillations may be viewed as being restrained by the intense forces of aggregation. In vapours and gases these seem to be overcome; vibrations can no longer be produced by the inherent *vis insita* of the molecules struggling with attractive and repellent forces; the struggle is over and the molecules are free; but they, nevertheless, continue to maintain a certain temperature; they are capable of heating and being heated; they are endowed with the

quality heat, which, being of itself motion, compels us to infer that a molecule in motion without any force to restrain or qualify it, is in every respect to be considered as a free projectile. Allow such free projectiles to be endowed with perfect elasticity, and likewise extend the same property to the elementary parts of all bodies that they strike against, and we immediately introduce the principle of the conservation of *vis viva* to regulate the general effects of their fortuitous encounters. Whether gases do consist of such minute elastic projectiles or not, it seems worth while to inquire into the physical attributes of media so constituted, and to see what analogy they bear to the elegant and symmetrical laws of aëriform bodies.

"Some years ago I made an attempt to do so, proceeding synthetically from this fundamental hypothesis, and have lately obtained demonstration of one or two points where the proof was then deficient. The results have appeared so encouraging, although derived from very humble applications of mathematics, that I have been led to hope a popular account of the train of reasoning may not prove unacceptable to the Royal Society.—September 1, 1845."

REPORT OF THE ROYAL SOCIETY'S COMMITTEE ON COLOUR VISION.

A COMMITTEE, consisting of Lord Rayleigh as Chairman, Lord Kelvin, Mr. Brudenell Carter, Prof. Church, Mr. J. Evans, Dr. Farquharson, M.P., Prof. Michael Foster, Mr. Galton, Dr. Pole, Sir G. Stokes, and Captain Abney, as Secretary, was appointed by the Council of the Royal Society in March 1890, to consider the question of testing for defective colour vision. Their report has just been presented to the Royal Society, and it possesses great practical interest for all classes, considering that on the average one male out of every twenty-five suffers more or less from this form of blindness.

The Committee have taken evidence as to the tests in general use on the railways, and also as to those which have been for some time adopted by the Board of Trade for the mercantile marine service, and have supplemented it by carrying on practical examinations on their own account. Experts have also given evidence as to the different forms of colour-blindness to be found, and the fact that it may be induced by disease as well as be congenital has been brought prominently forward by Dr. Priestley Smith, of Birmingham, and Mr. Nettleship, of St. Thomas's Hospital, and we have it on their authority that this type is not a negligible one. As an outcome of their investigations, the Committee have unanimously agreed to the following recommendations:—

(1) That the Board of Trade, or some other central authority, should schedule certain employments in the mercantile marine and on railways, the filling of which by persons whose vision is defective either for colour or form, or who are ignorant of the names of colours, would involve danger to life and property.

(2) That the proper testing, both for colour and form, of all candidates for such employments should be compulsory.

(3) That the testing should be intrusted to examiners certificated by the central authority.

(4) That the test for colour vision should be that of Holmgren, the sets of wools being approved by the central authority before use, especially as to the correctness of the three test colours, and also of the confusion colours. If the test be satisfactorily passed, it should be followed by the candidate being required to name without hesitation the colours which are employed as signals or lights, and also white light.

(5) That the tests for form should be those of Snellen, and that they should be carried out as laid down in Appendix VI. It would probably, in most cases, suffice if half normal vision in each eye were required.

(6) That a candidate rejected for any of the specified employments should have a right of appeal to an expert approved by the central authority, whose decision should be final.

(7) That a candidate who is rejected for naming colours wrongly, but who has been proved to possess normal colour vision, should be allowed to be re-examined after a proper interval of time.

(8) That a certificate of the candidate's colour vision and form vision according to the appointed tests, and his capacity for naming the signal colours, should be given by the examiner; and that a schedule of persons examined, showing the results, together with the nature of the employments for which examinations were held, should be sent annually to the central authority.

(9) That every third year, or oftener, persons filling the scheduled employments should be examined for form vision.

(10) That the tests in use, and the mode of conducting examinations at the different testing stations, should be inspected periodically by a scientific expert, appointed for that purpose by the central authority.

(11) That the colours used for lights on board ship, and for lamp signals on railways, should, so far as possible, be uniform, and that glasses of the same colour as the green and red sealed pattern glasses of the Royal Navy, should be generally adopted.

(12) That in case of judicial inquiries as to collisions or accidents, witnesses giving evidence as to the nature or position of coloured signals or lights should be themselves tested for colour and form vision.

These recommendations have been framed after duly weighing all the evidence they have collected, and from the results of the experiments they have carried out during the last two years; and the reasons for adopting them are set forth at some length in the report. The Committee have, perhaps wisely, refused to endorse any particular hypothesis of colour vision, though they have described two, those of Young and Hering, in some detail, no doubt considering that everything which might be debatable had better be avoided when practical recommendations alone were in question. It is, however, a matter of some regret that this should be the case, as a Committee so strongly constituted should have been able, if not to convince every one, at least to lead opinion into proper channels. What little they have said in the notes to the report leads one to suspect that they are not satisfied that either Young or Hering has given a theory which will satisfy all requirements. Leaving, however, the question of theory, we may point out that the practical necessity of insisting, on the grounds of public safety, that certain posts on railways and on board ship should only be filled by persons possessing normal colour vision, no sane man would call in question. The peril that must arise, for instance, if an engine-driver could by any possibility mistake a red signal of danger for a green signal of safety, or if a look-out man on board ship should be liable to make a similar error, is self-evident; and it is to prevent any such risks being run that the Committee buckled to the task of recommending tests which should be efficient and perfectly trustworthy. There has been for a long time a suspicion, if not more than a suspicion, that the examinations carried on for colour vision by the Board of Trade in the mercantile marine were inadequate in both respects; and what little was known regarding the tests employed by the various railway companies engendered the same feeling of distrust, in those who had considered the subject in a scientific spirit. The evidence shows that the Board of Trade examiners have passed on a second

or third examination candidates who have been rejected on their first trial. This is a proof of one of two things: (1) either that the tests employed were bad, or else that colour-blindness had been cured or mitigated. There is no evidence to show that congenital colour-blindness is curable; in fact, what there is is in exactly the contrary direction. For although it is true that reds and greens may be correctly named by a colour-blind person, by making him notice certain slight difference in the intensity or purity of the one colour which represents both of these to him, yet no amount of education or coaching would enable him to distinguish between them under the varying atmospheric conditions under which the signals are seen. The Committee had practical trials of various tests made before them at Swindon and elsewhere, with the result that the Board of Trade tests for the mercantile marine allowed several individuals to be passed as possessing normal colour vision whom other tests distinctly proved to be markedly and probably dangerously colour-blind. Under these circumstances it is not surprising that they have condemned such a system of testing, more especially as it is one which necessitates the naming of colours, and recommend those of Holmgren, which have long given practical proof of their ability to discriminate between normal and even slightly defective colour-perception.

The Holmgren test consists in requiring a candidate to select from a large assortment of wools those colours which appear to him to match a skein of pale yellowish green, a pale pink, and a bright crimson. These pale colours are sure to be matched by the colour-blind with colours which are totally different in hue, and the nature of the mistakes made infallibly indicate the character and danger of the blindness.

The evidence shows that some railways have been under the impression that they were using the Holmgren test, but when the colours were examined critically it was found that the hues of the test-skeins of wool were perfectly different from those determined by the distinguished Swedish investigator. If the two trial test-colours of Holmgren were more brilliant and of rather different hues, it is quite possible that persons with defective colour sense might make correct matches, and pass an examination which they really never should do. It is for this reason that the Committee recommend that the standard test-colours should be officially passed by an expert attached to the Board of Trade, as also those colours with which the colour-blind would most probably match them.

There are several of the recommendations which are especially valuable; for instance, that one by which the test should only be intrusted to examiners certified as competent to conduct the examinations. It is obvious that to have an efficient examination, not only should the test be efficient, but also the examiner. We have heard of a railway foreman being armed with a variegated bunch of wools, and insisting on candidates for employment naming them, and rejecting those who failed to give the name which he considered should be given. Such a test by such an examiner is evidently useless and cruel. The right of appeal by the rejected candidates is also wholesome, though it will probably be very rarely exercised; and as the tribunal to whom such an appeal can be carried is an expert, we may be certain that substantial justice will be meted out.

The whole report is valuable, but the labour will be thrown away unless legislative measures are taken to render it effective. It is no use telling railways what they ought to do, but only what they *must* do, in such examinations as are in question. The subject of colour vision is one which is so open to fads that the public require to be safeguarded from faddists who might happen to have ear of Boards of Directors or general managers; for this reason we hope that reasonable legislative action may be taken within a reasonable time.

THE GREAT EARTHQUAKE IN JAPAN, 1891.[1]

WHILE the occurrence of a great earthquake in a district intersected by railways, and traversed by telegraph wires, brings forcibly before the mind—even of the most casual reader of newspaper reports—the awful and destructive results of such a catastrophe, the scientific man cannot fail to note that it is under such conditions as these the best opportunities will be found for obtaining the necessary data upon which to reason concerning these terrible and still little understood movements of the earth's crust. In connection with the Seismological Society of Japan, a system of reporting the times and chief features of earthquake-shocks has been for some years in successful operation, and all station-masters and Post Office agents are required to transmit their records to a central office; the electrical control of the clocks of course giving these reports a value which they would not otherwise possess.

Two considerable earthquakes in recent years have occurred in areas where it was possible to obtain a great mass of accurate time and other observations, and these can scarcely fail to be of great value to the seismologist. The terrible earthquake of Charleston, on August 31, 1886, was felt over a great part of the United States; and at the railway stations, post offices, and other places where the accurate time was kept, many valuable observations were made. The vast mass of material collected has been dealt with by Prof. Simon Newcomb and Captain C. E. Dutton; and from the Report published by the United States Geological Survey, some remarkable and striking conclusions regarding the rate of movement of earthquake waves would appear to have been established. The Gifu or Ai-Gi earthquake of October 1891 has yielded data which the able seismologists of Japan may be trusted to make the fullest use of, when sufficient time has elapsed for the comparison and discussion of the reports.

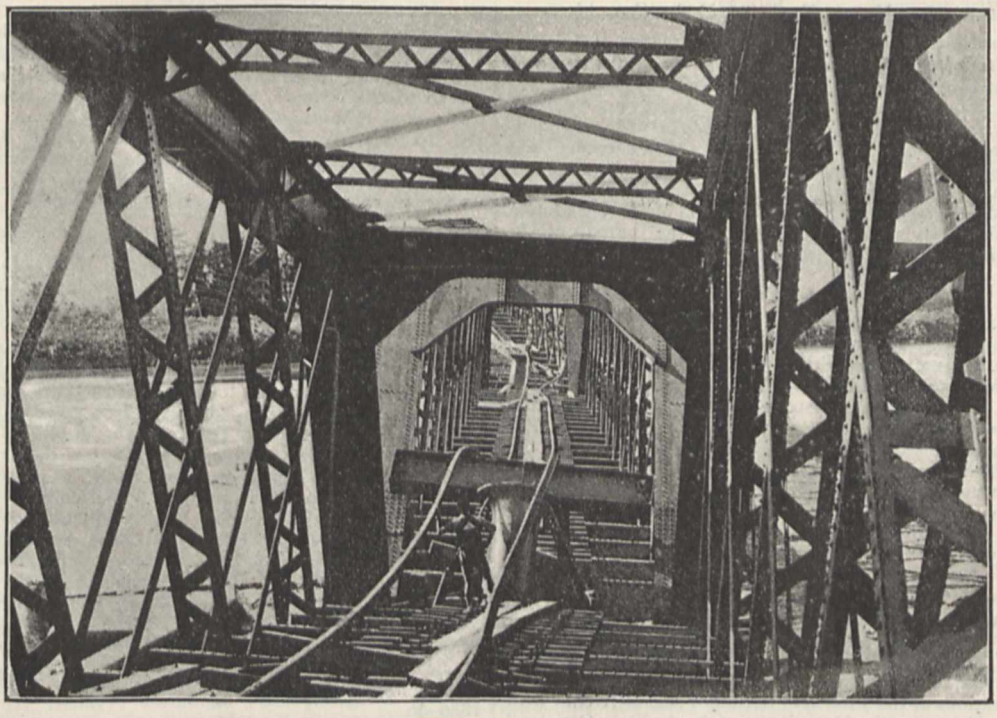
As a preliminary notice and striking memorial of the catastrophe, the beautiful volume now before us will be gladly welcomed. The book consists of twenty-nine permanent photographic plates, printed on excellent paper, and forty-six pages of letterpress. The energetic authors of the book were on the scene of the earthquake immediately after its occurrence, and all the plates, except three, are reproductions of photographs taken by Prof. Burton for the Imperial University. It is difficult to realize that the collection of the materials for this handsome book, with the execution of its luxurious typography, illustrations, and binding have been all completed within the short space of two months, and it says much for the enterprise and activity of the Japanese publishers, as well as of the authors, that such a result should have been possible.

One of the most striking effects of the Charleston earthquake, as described in Captain Dutton's report, was the twisting laterally of the permanent way on railway lines. On Plate x. of the work before us a similar serpentine twisting of the railway, suggesting a permanent compression in the line of the rails, is shown to have been effected, and the photograph constitutes a beautiful permanent record of the result. Still more striking are the phenomena displayed at some of the railway bridges, especially that of Nagara Gawa, which is very fully illustrated in Plates xxii., xxiii., xxiv., xxv., and xxvi. Our illustration is a reproduction of one of these plates. Not only have the lattice-work sections of the bridge been snapped asunder, but the great tubular piers have been thrust through the floor on which the railway lines are laid, these latter being forced up in

[1] "The Great Earthquake in Japan." By John Milne, F.R.S., Professor of Mining and Geology, and W. K. Burton, C.E., Professor of Sanitary Engineering, Imperial University of Japan. With Plates by K. Ogawa. (Yokohama, Japan: Crawford and Co. London: E. Stanford, 1892.)

great curves. Many of these photographs tell, incidentally, a very sad story of the loss and suffering endured by the people of the district.

In the short descriptive remarks which accompany the plates, Prof. Milne has succeeded in giving us much valuable information concerning the earthquake. The Gifu plain is situated about the centre of the Japanese Empire, and consists of a thick alluvial deposit resting on metamorphic rocks, the district being highly cultivated and thickly populated. The severely shaken district, in which complete destruction of buildings and engineering works occurred, measured 4200 square miles, but the effects were felt over an area of 92,000 square miles; and ten thousand people lost their lives, while fifteen thousand



were wounded. The earthquake is believed to have originated in the Mino Mountains; but it was in the soft alluvial plain adjoining that the earth-movements were most severely felt. The district thus violently affected supported a population of about 800 to the square mile. Earthquakes have been recorded as occurring in this area, which lies quite away from any volcanic centres, in 1826, in 1827, in 1859, and in 1880; and during the last ten centuries there have been many terrible catastrophes affecting this area which are noticed in the Japanese records.

We look forward with much interest to the publication of the full account of this destructive, and in many respects remarkable, display of seismic energy, which is promised to us by the Professors of the Imperial University of Japan. J. W. J.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following fifteen candidates were selected on Thursday last (May 5) by the Council of the Royal Society to be recommended for election into the Society. The ballot will take place on June 2, at 4 p.m. We print with the name of each candidate the statement of his qualifications.

ROBERT YOUNG ARMSTRONG, Lieut.-Colonel R.E.,

From 1870 to 1875 was Assistant Instructor in Submarine Mining and Electricity, and from 1875 to 1882 was Instructor. From 1884 to the present date, Inspector of Submarine Defences of the United Kingdom, Military Ports, and Coaling Stations. From June 1883 to December 1888, adviser to the Board of Trade in electrical matters connected with the Electric Lighting Acts. Was connected with the development of the present apparatus and electrical and mechanical processes employed in submarine mining, and with the compilation of the army instructional books and methods on electricity and submarine mining since 1870. Distinguished as an electrical engineer. It may be said that the present satisfactory state of defensive torpedo warfare in this country is very largely due to his ability and energy.

FRANK EVERS BEDDARD, M.A. (Oxon.),

Lecturer on Comparative Anatomy, Guy's Hospital. Prosector to the Zoological Society. Author of the following papers:—"Report on the Isopoda, collected by H.M.S. *Challenger*" (Parts xxxiii., xlviii.); "Nephridia of Acanthodrilus and of Perichæta" (Proc. Roy. Soc., 1886-87); "Structure of Megascolea" (Trans. Roy. Soc. Edin., 1883); "Minute Anatomy of the Ovary of Echidna"; "Subdivision of the Cœlom in Birds and Reptiles" (Proc. Zool. Soc., 1886-88); "Visceral and Muscular Anatomy of Scopus" (*ibid.*, 1885); "Anatomy of various little-known Types of Birds" (*ibid.*) With other papers on Comparative Anatomy in *Ann. and Mag. Nat. Hist.*, *Ibis*, and *Quart. Journ. Micros. Sci.*

JOHN AMBROSE FLEMING, M.A. (Camb.),

D.Sc. (Lond.). Professor of Electrical Engineering in University College, London. Late Fellow of St. John's College, Cambridge. Fellow of University College, London. Some time Demonstrator in Applied Mechanics in the University of Cambridge. Author of the following papers, among others:—"The Polarisation of Electrodes in Water free from Air" (Proc. Phys. Soc., 1874); "A New Form of Resistance

Balance" (Proc. Phys. Soc., 1880); "On the Characteristic Curves and Surfaces of Incandescent Lamps"; "On Molecular Shadows in Incandescent Lamps"; "On the Use of Daniell's Cell as a Standard of Electromotive Force"; and "Problems in the Distribution of Electric Currents in Networks of Conductors" (Proc. Phys. Soc., 1885); "On the Necessity for a National Standardising Laboratory for Electrical Instruments" (Proc. Inst. Elect. Engs., 1885); "A Design for a Standard of Electrical Resistance" (Proc. Phys. Soc., 1889); "On Electric Discharge between Electrodes at different Temperatures in Air and in High Vacua" (Proc. Roy. Soc., 1889); "On Some Effects of Alternating Current Flow in Circuits having Capacity and Self-induction" (Proc. Inst. Elect. Engs., 1891). Delivered Friday Evening Discourses at the Royal Institution in 1890-91. Author of "Short Lectures to Electrical Artisans," four editions; and of "The Alternate Current Transformer in Theory and Practice."

CLEMENT LE NEVE FOSTER, D.Sc. (Lond.),

F.G.S., Professor of Mining in the Royal College of Science, and H.M. Inspector of Mines. A.R.S.M. He is distinguished for his knowledge of mining in its various scientific aspects; and is the author of numerous papers bearing on Geology, Mineralogy, and Mine-engineering. He has carried on explorations and mining works in Italy, Egypt, and Venezuela, and was for some years a Member of the Geological Survey of England and Wales, in connection with which he made important discoveries bearing on the question of the denudation of the Weald. His papers are published in the Journals of the Geological and Statistical Societies, and other journals.

HANS GADOW, Ph.D. (Jena),

Hon. M.A. Cantab. Strickland Curator and Lecturer on the Advanced Morphology of Vertebrata in the University of Cambridge. A naturalized British subject, engaged in research in Animal Morphology. Author of "Versuch einer vergleichenden Anatomie des Verdauungssystemes der Vögel" (Inaugural Dissertation, *Jenaische Zeitschr.*, xiii., 1879); "Zur vergleichenden Anatomie der Musculatur der Beckens und der hinteren Gliedmasse der Ratitæ" (4to, Jena, 1880, 5 plates); "Untersuchungen über die Bauchmuskeln der Krokodile, Eidechsen und Schildkröten" (*Morphol. Jahrb.*, vii., p. 57); "Beiträge zur Myologie der hinteren Extremität der Reptilien" (*ibid.*, p. 329); "Observations on Comparative Myology" (*Journ. of Anat.*, 1882, p. 493); "Catalogue of Birds in the British Museum" (vols. viii. and ix.); "On the Colours of Feathers as affected by their Structure" (Zool. Soc. Proc., 1882, p. 409); "On the Reproduction of the Carapace in Tortoises" (*Journ. of Anat.*, 1886, p. 220); "On the Cloaca and Copulatory Organs of Amniota" (Phil. Trans., 1887); "On the Modifications of the First and Second Visceral Arches, with Especial Reference to the Homologies of the Auditory Ossicles" (Phil. Trans., 1888); Volume "Aves" in Bronn's "Klassen und Ordnungen des Theirreichs" (in publication). Conjointly with Dr. Gaskell:—"On the Anatomy of the Cardiac Nerves in certain Cold-blooded Vertebrates" (*Journ. of Physiol.*, v.); "Suctorial Apparatus of the Tenuirostres (1883); "On the Anatomical Differences in the Three Kinds of Rhea" (1885); "On some Points in the Anatomy of *Pterocles arenarius*, with remarks on its Systematic Position (1882). "Introduction to the Osteology of the Mammalia," by W. H. Flower, F.R.S., third edition revised with the assistance of Hans Gadow (1885).

ROBERT GIFFEN, LL.D. (Glasc.),

Assistant Secretary (Commercial Department) Board of Trade. Author of "Stock Exchange Securities: an Essay on General Causes of Fluctuation of their Price" (1878); "Essays in Finance," 1st series (1879), 2nd series (1885); "The Growth of Capital" (1889); also of numerous papers communicated to the British Association, Statistical Society, Bankers' Institute, &c. As head of the Statistical Department of the Board of Trade (since incorporated with the Commercial Department) has been examined by Royal Commissions and Parliamentary or Treasury Committees on the following subjects (among others): Depreciation of Silver (1876); Hall Marking; Wine Duties; Agricultural Depression; Trade Depression; Stock Exchange; Gold and Silver; Channel Tunnel; Emigration and Immigration; Corn Averages, &c. Has given great attention to the theory and practice of the use of Index Numbers in the study of Prices and their history, and first invented and used the plan of an Index Number of a purely objective and not an arbitrary character, especially one based on the actual proportion of the different articles of Import and Export to the total. Has explained with regard to numerous branches of statistics, such as imports and exports, the condition and nature of the data, and the way in which they can be used in public discussions. Has also explained in numerous papers the way in which common statistics can be used in stating and solving problems for the politician, *e.g.* statistics of the growth of population, of the growth of incomes and capital. Has also given attention to the problems relating to the incidence of taxation, upon which several papers are included in the "Essays in Finance." Author of numerous official reports, including reports on wages, prices of imports and exports, emigration, &c.

FRANCIS GOTCH, M.R.C.S.,

B.A., B.Sc. (Lond.), Hon. M.A. (Oxon.). Has made researches of value into the physiology of the nervous system, and is the author of the following papers:—"On the Electromotive Properties of the Electrical Organ of Torpedo" (Phil. Trans., 1887, B., p. 487, and 1888, B., p. 329); "On the Electrical Organ of the Skate," with Dr. Burdon Sanderson, F.R.S. (*Journ. of Physiol.*, vol. ix., p. 137, and vol. x., p. 259); "On the Electromotive Changes in the Mammalian Spinal Cord following Electrical Excitation of the Cortex Cerebri," with Prof. Horsley, F.R.S. (Roy. Soc. Proc., vol. xlv., p. 18); as well as of other shorter papers on similar subjects.

WILLIAM ABBOTT HERDMAN, D.Sc.,

F.R.S.E., F.L.S. Professor of Natural History in University College, Liverpool. Distinguished as a Zoologist, and especially for researches into the structure and relations of the Tunicata. Author of the following, amongst other papers:—"Report on the Tunicata of the *Challenger* Expedition," Parts I., II., and III. (*Challenger* Rept., Zool., vol. vi., 1892; vol. xiv., 1886; vol. xxvii., 1888); "On the Invertebrate Fauna of Lamlash Bay" (Roy. Phys. Soc. Edin. Proc., vol. v., 1879, and vol. vi., 1880); "On the Olfactory Tubercle, &c., in Simple Ascidians" (*ibid.*, 1881); "On Individual Variations in the Branchial Sac of Ascidians" (Linn. Soc. Journ., vol. xv., 1881); "The Hypophysis Cerebri in Tunicata and Vertebrata" (Roy. Soc. Edin. Proc., 1883); "Report on the Tunicata of the *Triton* Expedition" (Roy. Soc. Edin. Trans., vol. xxxii., 1883); "Report on the Tunicata of the *Lightning* and *Porcupine* Expeditions" (*ibid.*, 1884); "On the Phylogeny of the Tunicata" (Roy. Soc. Edin. Proc., 1885-86); "On the Structure of Sarcodictyon" (Roy. Phys. Soc. Edin. Proc., 1884); "On the Structure and Functions of the Cerata or Dorsal Papillæ in some Nudibranchiate Mollusca" (*Quart. Journ. Micros. Sci.*, 1890); and of important Reports on the Fauna of Liverpool Bay, 1886-90.

FREDERICK WOLLASTON HUTTON, Captain, R.E.,

Professor of Geology in Canterbury College. F.G.S., C.M.Z.S., Cor. du Mus. d'Hist. Nat. Paris, Cor. Mem. Roy. Soc. Tas., Hon. Mem. Roy. Soc. N.S.W., Cor. Acad. Nat. Sci. Philad., Cor. Ornith. Ver. Wien., Cor. K. K. Geol. Reichsanst. Wien. Author of numerous reports, papers, &c., published by the New Zealand Government, the Geological and Zoological Societies, the New Zealand Institute, &c., and in the *Phil. Mag.* Amongst them are:—"Fishes of New Zealand," 1872; "Geology of the Thames Gold Field (Government Report, 1868-69); "Sketch of the Geology of New Zealand" (Quart. Journ. Geol. Soc.); "Birds inhabiting the Southern Ocean" (*Ibis*, 1865); "On *Peripatus N. Zealandiæ*"; "On the Structure of *Amphibola avellana*"; "Origin of the Fauna and Flora of New Zealand" (*Ann. and Mag. Nat. Hist.*); "Eruptive Rocks of New Zealand," Oscillations of the Earth's Surface (Aust. Assoc. Advt. Sci., 1889); "On Dimensions of Dinornis Bones" (Trans. N. Z. Inst.); "New Zealand Land Shells"; "Revision of the Land Mollusca of New Zealand" (*ibid.*, vol. xvi.). Author of a Class-book of Geology, and of Zoological Exercises for Students in New Zealand. Author of eleven papers in Proc. Linn. Soc. N.S.W. Has done much valuable work in other ways for the advancement of science in New Zealand.

JOHN JOLY, M.A.,

Assistant to the Professor of Civil Engineering in the University of Dublin. Has discovered (*a*) by direct measurement a

variation of specific heat at constant volume of various gases with density; (*b*) Iolite in the Granites of Leinster; (*c*) a heterogeneous Beryl Felspar mineral; (*d*) the reversal of *Oldhamia antiqua* and *radiata* impressions in the Slates of Bray Head. Is the author, amongst other papers, of the following:—"On the direct experimental determination of Specific Heats of Gases at Constant Volume" (Proc. Roy. Soc., vol. xlviii., in abstract, recommended for Phil. Trans.); "On the Method of Condensation in Calorimetry" (Proc. Roy. Soc., vols. xlv. and xlvii.); "On the Specific Heats of Minerals" (*ibid.*, vol. xli.); "Observations of Spark Discharge over Surfaces of Dielectrics" (*ibid.* vol. xlvii.); "On the Volcanic Ash of Krakatoa" (Proc. Roy. Dubl. Soc., vol. iv.). Has invented (*a*) the Method of Steam Calorimetry (Trans. and Proc. Roy. Soc., as above); (*b*) a Diffusion Photometer (*Phil. Mag.*, July 1888); (*c*) a Hydrostatic Balance (*ibid.*, Sept. 1888); (*d*) an Instrument for measuring Melting and Boiling Points of Solids, &c., up to a very high temperature (NATURE, vol. xxxiii., and *Industries*, vol. vi.); (*e*) a Method of measuring the Density of a Gas (*Phil. Mag.*, vol. xxx.); (*f*) a Method of reading Distant Meteorological Instruments (Proc. Roy. Dubl. Soc., vol. iv.); (*g*) a Method of measuring Specific Gravities of Minute Quantities of Porous and other Solids (*Phil. Mag.*, July 1888.

JOSEPH LARMOR, M.A.,

D.Sc. Fellow of St. John's College, Cambridge. University and College Lecturer in Mathematics. Senior Wrangler, 1880. Formerly Professor of Mathematics Queen's College, Galway. Fellow of the Royal University of Ireland. Examiner in Mathematics at the University of London. Author of the following papers:—"Application of Generalized Space Co-ordinates, Potentials, and Isotropic Elasticity" (Trans. Camb. Phil. Soc., vol. xiv.); "Least Action" (Proc. Lond. Math. Soc., vol. xv.); "Flow of Electricity in Linear Conductors" (*ibid.*, vol. xvi.); "Characteristics of an Asymmetric Optical Combination" (*ibid.*, vol. xx.); "Electro-magnetic Induction in Conducting Sheets and Solid Bodies" (*Phil. Mag.*, 1884); and other papers on Pure and Applied Mathematics.

LOUIS C. MIALL,

Professor of Biology in the Yorkshire College. Prof. Miall has published the following papers and books:—Reports on Labyrinthodonts (Rep. Brit. Assoc., 1873-74): the first translated as introduction to S. Anton Fritsch's "Fauna der Permformation Böhmens"; Fossil Teeth of Ceratodus (Palæont. Indica); Sirenoid and Crassopterygian Ganoids, Part I. (Palæont. Soc.); papers on Labyrinthodonts, Rhizodus, Ctenodus, and Megalichthys (Quart. Journ. Geol. Soc.): Studies in Comparative Anatomy: I. Skull of Crocodile, II. Anatomy of the Indian Elephant (jointly with F. Greenwood), III. The Cockroach (jointly with H. Denny); Vertebrate Palæontology in Geol. Record (Sub-editor). In 1875 received the Wollaston Donation from the Geological Society.

BENJAMIN NEVE PEACH,

F.R.S.E., F.G.S. District Surveyor of the Geological Survey of Scotland. Past President of the Physical Society of Edinburgh. Recipient of the Wollaston Donation Fund of the Geological Society in 1887. For thirty years actively engaged on the Geological Survey, during which time he has mapped many of the most complicated districts of Scotland. Has charge of the surveying of the North-West Highlands, and has taken the leading part in unravelling the remarkable structural complications of that region. Author of various papers on palæontological subjects:—"On some New Crustaceans from the Lower Carboniferous Rocks of Eskdale and Liddesdale" (Trans. Roy. Soc. Edin., vol. xxx., p. 73); "On some new species of Fossil Scorpions from the Carboniferous Rocks of Scotland" (*ibid.*, p. 399); "Further Researches among the Crustacea and Arachnida of the Carboniferous Rocks of the Scottish Border" (*ibid.*, p. 511); "On some Fossil Myriapods from the Lower Old Red Sandstone of Forfarshire" (Proc. Roy. Phys. Soc. Edin., vol. vii. p. 179). Joint author with Mr. J. Horne of many papers on stratigraphical and physical geology, including:—"The Glaciation of the Shetland Isles" (Quart. Journ. Geol. Soc., vol. xxxv. p. 778); "The Glaciation of the Orkney Islands" (*ibid.*, vol. xxxvi. p. 648); "The Old Red Sandstone of Shetland" (Proc. Roy. Phys. Soc. Edin., vol. v. p. 30); "The Glaciation of Caithness" (*ibid.*, vol. vi. p. 316); "Report on the Geology of the North-West of Sutherland" (NATURE, vol. xxxi. p. 31); "The Old Red Sandstone Volcanic Rocks of Shetland" (Trans. Roy. Soc. Edin., vol. xxxii. p. 539); "Report on the Recent Work of the Geological Survey in the North-West Highlands of Scotland, based on the Field Maps of B. N. Peach, J. Horne, W. Gunn, C. T. Clough, L. Hinxman, and H. M. Cadell" (Quart. Journ. Geol. Soc., vol. xliv. p. 378).

ALEXANDER PEDLER,

F.C.S., F.I.C., Fellow of the University of Calcutta; Professor of Chemistry, Presidency College, Calcutta; Meteorological Reporter to the Government of Bengal; and Curator of the Bengal Government Museum at Calcutta. Author of papers on "An Isomeric Modification of Valeric Acid," "Calcutta Coal Gas," "The Use of the Radiometer as a Photometer," "Cobra Poison," "The Past and Present Water Supplies of Calcutta," "Technical Education for Bengal," "The Faln Point Cyclone of September 22, 1885," published in the Proc. Roy. Soc., the Journ. Chem. Soc., the Journ. Asiat. Soc. Beng., and elsewhere.

AUGUSTUS D. WALLER, M.D.,

Lecturer on Physiology at St. Mary's Hospital Medical School. Distinguished as a Physiologist. Lauréat de l'Institut de France (Prix de Physiologie Expérimentale). Contributions to the Royal Society:—"On the Influence of the Galvanic Current on the Excitability of the Motor Nerves of Man" (with Dr. de Watteville, Phil. Trans., 1882); "On the Influence of the Galvanic Current on the Excitability of the Sensory Nerves of Man" (Roy. Soc. Proc., 1882); "On the Action of the Excised Mammalian Heart" (with Dr. Reid, Phil. Trans., 1887); "On the Electromotive Changes connected with the Beat of the Mammalian Heart" (Phil. Trans., 1889). Contributions to the *Journal of Physiology*:—"On the Rate of Propagation of the Arterial Pulse Wave" (vol. iii., 1880); "A Demonstration in Man of Electromotive Changes accompanying the Heart's Beat" (vol. viii., 1887) Contributions to other journals, English and foreign:—"Die Spannungen in den Vorhöfen des Herzens" (*Arch. f. Anat. u. Physiol.*, 1878); "On Muscular Spasms known as Tendon Reflex" (*Brain*, 1880); "Nouvelles Expériences sur les Phénomènes nommés Réflexes tendineux" (with Dr. Prévost, *Rev. Méd. de la Suisse Romande*, 1881); "Sur la Contraction de l'Ouverture" (*Journ. de Physiol.*, 1882), &c.

NOTES.

THE Council of the British Association for the Advancement of Science have nominated Dr. J. S. Burdon Sanderson, F.R.S., Waynflete Professor of Physiology in the University of Oxford, President for the meeting of the Association which will be held next year at Nottingham. Dr. Sanderson has accepted the nomination.

THE Gold Medal of the Linnean Society has this year been awarded by the Council to Dr. Alfred Russel Wallace for his important contributions to the literature of zoology. The medal will be presented at the forthcoming anniversary meeting of the Linnean Society, to be held at Burlington House on the 24th inst.

WE regret to have to record the death of the illustrious chemist, August Wilhelm Hofmann. He died on May 5. Prof. Hofmann was well known in England, where he spent many of his best years. On Liebig's recommendation he was appointed in 1848 Superintendent of the Royal College of Chemistry, in London. This institution, which made great progress under his care, was in 1853 merged in the Royal School of Mines as the Chemical Section. He became a Warden of the Royal Mint in 1855. In 1864 he accepted the chair of chemistry at Bonn, and in the following year he was called to Berlin, where he spent the rest of his life as Professor of Chemistry. He made many contributions to the *Annalen der Chemie*, to the Transactions of the Chemical Society, and to the Philosophical Transactions of the Royal Society, of

which latter institution he was made a Fellow in 1851, in recognition of his services to science. In 1854 he was awarded a Royal Medal for his "Memoirs on the Molecular Constitution of the Organic Bases." Some of his discoveries led to industrial results of the highest importance. The high respect in which Prof. Hofmann was held in Germany was shown at his funeral, which took place on Monday. It was very largely attended, and, according to the Berlin correspondent of the *Standard*, "was in all respects worthy of a prince of science." The correspondent says:—"The Empress Frederick, immediately on receiving the news of the Professor's death, telegraphed to his widow, 'My deepest sympathy in your great, your irreparable loss. I am deeply shocked by the quite unexpected news of your dear husband's death.' Her Imperial Majesty sent a splendid laurel wreath bearing her initials, to be placed on the coffin, and a Court Chamberlain represented Her Majesty at the funeral. The Minister of Education and numerous officials of his Department, all the members of the Berlin Academy, and almost all the professors and students of the University, accompanied the funeral procession to the cemetery."

WE regret also to have to announce the death of Dr. James Thomson, F.R.S., Emeritus Professor of Civil Engineering in the University of Glasgow, Lord Kelvin's brother. Dr. Thomson died on Sunday last. He was seventy years of age.

THERE are vacancies for zoological students at the Cambridge University's tables in the Zoological Station at Naples, and in the Marine Biological Society's Laboratory at Plymouth. Applications are to be sent to Prof. Newton, Chairman of the Special Board for Biology and Geology, by May 30.

GENERAL ISAAC T. WISTER, President of the Philadelphia Academy of Sciences, has placed in the hands of trustees for the benefit of the University of Pennsylvania, 100,000 dollars for the erection of a Museum with laboratories, to contain the Wister and Horner Museum of Human and Comparative Anatomy. He has also given an endowment of 3000 dollars a year for the maintenance of a curator, whose occupation shall consist largely of original research.

WE referred lately to the interesting Horticultural Exhibition for which preparations were being made at Earl's Court. The Exhibition was formally opened on Saturday last by the Duke of Connaught, and promises to be a great success.

A GERMAN scientific expedition under Dr. Erich von Drygalski started from Copenhagen for West Greenland on May 1. Dr. von Drygalski is accompanied by Dr. H. Stade, the meteorologist, and Dr. E. Vanhöffen, the zoologist. They were to make in the first instance for Umanak Fjord. They do not intend to return until the autumn of 1893.

WE are glad to welcome a third edition of Clerk Maxwell's great "Treatise on Electricity and Magnetism" (Clarendon Press). The task of seeing the proofs through the press could not be undertaken by Mr. W. D. Niven, who had charge of the second edition; so the duty has been fulfilled by Prof. J. J. Thomson, who, we need scarcely say, has done his work admirably. Twenty years have passed since the work was written, and during that time the sciences of electricity and magnetism—thanks in part to the influence exerted by this treatise—have made rapid progress. Prof. Thomson explains that when he began to prepare the present edition he intended to give in foot-notes some account of the advances made since the publication of the first edition, not only because he thought it might be of service to students, but because all recent investigations have tended to confirm in the most remarkable way Maxwell's views. He soon found, however, that if this intention were carried out the book would be disfigured by a disproportionate quantity of foot-notes. His notes have accordingly been thrown into a slightly more consecutive form, and will be published separately. A few foot-notes relating to isolated points which could be dealt with briefly are given. Prof. Thomson has added something in explanation of the argument in those passages in which he has found from his experience as a teacher that nearly all students find considerable difficulties. He has also attempted to verify the results which Maxwell gives without proof. He has not in all instances succeeded in arriving at Maxwell's results, and in such cases he has indicated the difference in a foot-note. Maxwell's method of determining the self-induction of a coil is reprinted from his paper on the dynamical theory of the electro-magnetic field.

AT the time of our last issue, an anticyclone lay over the whole of the British Islands and part of the Atlantic, with north and north-east winds of some force, under the influence of a depression existing over North Germany. Daily temperatures were, generally, considerably below the normal values; slight snow fell on the south coast on the morning of the 6th, and the grass thermometer fell as low as 18° on that night in London. The anticyclone afterwards moved southwards, while a depression, which had set in at the northern stations, spread towards the North Sea, the winds shifted to west and north-west, and temperatures gradually increased; the maxima exceeded 60° over the inland parts of England on Sunday, and even reached 70° at several stations on Monday, with fine weather generally. The amount of rainfall is considerably below the average. The Weekly Weather Report for Saturday last shows that the deficiency, since January 3, amounts to 7·7 inches in the west of Scotland and to 5·3 inches in the south-west of England. During the last few days this country has again been under the influence of an anticyclone, with fine, warm weather generally.

THE Pilot Chart of the North Atlantic Ocean, in its review of weather during April, says that the storms on the Atlantic, like those of the preceding month, were confined almost entirely to the American coast and the western part of the ocean, and they again followed somewhat abnormal northerly tracks. Two of the most severe storms whose tracks are plotted on the chart, occurred during the last few days of March. During the first week of April, pleasant anticyclonic weather prevailed along the American coast south of Hatteras, but two severe storms moved eastward over Labrador on the 3rd and 6th respectively, the first of which was followed by a storm of slight energy that formed south of Cape Race on the 4th, and the second by one that reached Hatteras from inland the morning of the 8th, but neither of these, nor those of the 9th to 11th, and 15th to 16th, along the Nova Scotia coast, were at all severe. The only remaining storms of any noteworthy severity, so far as indicated by data received at the office of the Pilot Chart up to date of publication, were those that originated between the Grand Banks and Bermuda on the 13th and 18th respectively. The track of a depression of considerable energy is indicated near the Azores on the 6th, 7th, and 8th, and another, but of slight energy only, in the English Channel on the 15th and 16th. The persistent anticyclonic weather over the British Isles and Central Europe during the last week of March and the first half of April, may be said to have turned to the northward the storms that formed over the ocean, and it seems probable that the persistent northerly winds thus caused off Labrador and Newfoundland helped along the ice that is now working its way southward off the Grand Banks. Fog has been reported in increasing quantities, also, and it will continue to increase until midsummer.

WE note the publication of two new monthly meteorological bulletins for Russia, which are issued nearly closely up to date, viz. by Prof. A. Klossovski, Odessa, with Russian and German

next, and by Prof. P. Brounof, Kieff, in Russian, with a few notes in French. Both bulletins contain observations taken three times daily, with daily and monthly means, while the Odessa publication contains monthly rainfall values, and maximum and minimum temperatures for about a hundred stations in South-West Russia. The Kieff observations are preceded by some remarks (in Russian only) on the temperature and density of snow at various depths.

A REMARKABLE aurora borealis was seen at Moscow during the night of April 26–27. It began at 11.50 p.m. with a dark segment fringed by a bright border, the summit of which stood a few degrees to the west of the meridian. Bright rays were projected to the constellations of Auriga, Perseus, and Cassiopœia, while the longest rays reached the Pole star. It attained its maximum at 11.56, but four minutes later it began to die away, no traces of it being seen at 12.15 a.m. At 2 a.m. three beams of light appeared again for a few seconds. It is worthy of note that on April 26 a large accumulation of sun-spots was observed at Moscow; it consisted of ten groups of spots. It may also be added that another aurora borealis, much brighter than the above, was seen at Moscow on March 12, at 4 a.m. It lasted for nearly half an hour.

ALL who have occasion to use the magic lantern will be interested in the fact that a lantern may now be seen at the Crystal Palace finely illuminated by the arc-light. This instrument was designed by Mr. T. C. Hepworth, F.C.S., who uses it to illustrate lecture entertainments in connection with the Crystal Palace Electrical Exhibition. The lamp employed is the Brockie-Pell, which has been modified by Messrs. Newton to make it more suitable for the particular work required. It gives a pure white light, and its brilliance is said to be several times that of the lime-light. The electric arc-light has before been applied to lantern projection, but it is claimed that the Crystal Palace lantern is on quite an unprecedented scale.

M. MESDRAN, of Paris, sends us a prospectus, in which he sets forth the merits of a machine he has invented for the proper boiling of eggs. Hitherto, it seems, mankind have boiled eggs on a wholly false principle. M. Mesdran claims that he has solved the problem, and that his invention is nothing short of "a revelation both from the hygienic and the gastronomic point of view." The invention has been patented in England.

AN interesting trace of Palæolithic man has lately been discovered in Hermann's Cave in the Harz. Excavations were being carried on in the cave, under the superintendence of Herr Grabowsky, when a flint which had all the appearance of having been fashioned into the form of a knife was found among the remains of reindeer and other glacial or Arctic animals. The object could not have been brought into the cave by non-human means, as flint is not found anywhere in the neighbourhood. A paragraph on the subject appears in the current number of *Globus*, the editor of which appends a note to the effect that the flint (which lay before him as he wrote) has undoubtedly been artificially worked into its present shape.

DR. DANIEL G. BRINTON has issued an interesting pamphlet, in which he urges the claims of anthropology as a branch of University education. He gives an account of the aims and methods of the science, and then sketches a general scheme of anthropological instruction. Dr. Brinton would begin with lectures on somatology, including internal somatology, external somatology, psychology, and developmental and comparative somatology. Then would come ethnology, in connection with which he would deal with sociology, technology, religion, linguistics, and folk-lore. Under ethnography he would discuss the origin and subdivisions of races; and archæology he would divide into "general" and "special." Laboratory work would include (in the physical laboratory) such tasks as the comparing and identifying of bones, the measuring of skulls, &c.; and (in the technological laboratory) the study of stone and metal implements, textile materials, &c. There would also be library work and field work. Students who might wish to obtain an adequate notion of the science would have to attend a course of thirty or forty lectures, and give twice as many hours to laboratory work. That would be the minimum amount of study. Those who might desire to instruct others, or to prepare for independent research, would devote to the science the greater part of their time during two or three years.

THE structure of the cells of Bacteria continues to occupy the attention of biologists, and a communication on the subject to the St. Petersburg Society of Naturalists (*Memoirs*, vol. xxi., Botany), by W. K. Wahrlich, is worthy of notice. Careful study of several species of Bacteria has led the author to the conclusion that only two substances are to be detected in the cell—chromatin, and linin, which surrounds the former. The leading part in the formation of spores belongs to chromatin, which is used entirely for this purpose, while the linin substance is used for the formation of the exosporium. As to the involutional forms, the author can only confirm the opinions of De Bary, Nägeli, and Büchner as to their being representative of a pathological state, or of a degeneration of the cell; chromatin disappears in such cells, and two or three vacuoles appear in their linin part. The bacterial cells thus appear to be simple nuclei, surrounded by membranes, but devoid of cytoplasm; chromatin is their most important part, and when it disappears the cell can no longer reproduce itself or continue an independent life.

A REPORT was lately spread in the United States to the effect that the Government intended to introduce the mongoose in the West to exterminate the rodents which annoy farmers there. The editors of the *Naturalist* wrote to the Department of Agriculture for information on the subject, and received in reply a letter to the effect that no such "rash act" had ever been contemplated, the introduction of exotic species being contrary to the Department's policy. The *Naturalist* expresses cordial approval of this answer, evil having, it maintains, "invariably resulted from the introduction of exotic animals into countries when no adequate natural restriction to their increase exists."

MR. F. W. WARD was commissioned last year by the Hon. Sydney Smith, then Minister of Agriculture in New South Wales, to report upon the relations of fruit production in that colony to the English market. The report was presented some time ago, and is printed in the February number of the *Agricultural Gazette of New South Wales*. Mr. Ward is convinced that London offers an attractive market for the fruit products of Australasia in their green, dried, and canned forms. All testimony, and most emphatically that of the European growers, is, he says, to the effect that London is, and always will be, the great fruit market of the world. There is also, he adds, a consensus of opinion to the effect that Australasia will gain the largest share of the advantage in regard to this market, consequent upon the reversal of the seasons. Other territories in the southern hemisphere will dispute the market with Australasia; but Mr. Ward anticipates that the energy and intelligence of Anglo-Saxon communities, operating upon good and cheap soil, an unsurpassed, if not an unrivalled, climate for fruit production, and splendid facilities of over-sea carriage, will fully or more than compensate for the one great disadvantage of geographical distance. The London market for Australasian fruit resolves itself, for the most part, into a question of carriage. What needs to be done is to minimize the cost of conveying

green fruit from (say) Sydney to London, and to solve the chemical problems attaching to the attempt to utilize the cool chambers of swift steam-ships in such a way as to preserve the appearance and flavour of so perishable a commodity as fruit through the unavoidable space of time and varying latitudes of the journey. Mr. Ward is of opinion that there are sound reasons for expecting that "these problems will be solved and that the market will be captured."

THE Echinoderm fauna of Kingston Harbour, Jamaica, seems to be remarkably numerous and varied. Mr. George W. Field, who has been investigating it, contributes some notes on the subject to the April number of the "Johns Hopkins University Circulars." About twenty-eight species of Echinoderms were found in Kingston Harbour and about the cays at its mouth, and a longer residence and dredging in the deeper waters would probably, Mr. Field thinks, have increased the number considerably. The difficulties of dredging were very considerable, arising in part from the nature of the bottom, from the unmanageableness of the boat, and chiefly from the wind. There always seemed to be a perfect calm or a gale; the calm periods between exceedingly short. However, considerable dredging was done by various members of his party. The surface tow-net showed a wonderful richness of the larval Echinoderms in the pelagic fauna, chiefly however, during their stay, confined to Ophiurid, Echinid, and Spatangid plutei, the relative abundance being in the order named. During the month of June they were abundant, and in early July they were extremely numerous. They were found in greatest numbers in tows made about sunrise. In the evening towing they were invariably absent. These larvæ, says Mr. Field, appear to come to and remain at the surface from midnight until about sunrise; after that to gradually disappear until three hours after sunrise, when they are rarely found at the surface. Their appearance seemed to be little or not at all influenced by the tide, but did depend very much upon the quantity of flood water poured into the harbour by the various rivers. In its general aspect the Echinoderm fauna shows no very considerable variation from that of the Bahamas and Southern Florida, though apparently richer in species and in individuals.

ACCORDING to an official report published in the *Deutsches Kolonialblatt* for April, the Germans have every reason to be satisfied with the way in which the resources of Cameroon are being developed. The industry and trade of the colony are said to be in a flourishing condition. The chief products are palm oil and palm kernels. There are many elephants in the territory, and ivory is still exported. Caoutchouc is also obtained in considerable quantities, and ebony fetches good prices. In 1891 there were in Cameroon 166 Europeans, of whom 10 were women. There were 109 Germans and 31 Englishmen. The exact number of natives is not yet known, but it is calculated that there are 20,000 Dualla on the Cameroon river, 25,000 Bakwiri in the Cameroon Highlands, and 20,000 Bamboko towards the west of the hilly district.

A VALUABLE paper presenting a revision of the American species of Rumex occurring north of Mexico, by William Trelease, appears in the third annual report of the Missouri Botanical Gardens, and has also been issued separately. Rumex is a genus which has been held to include from 100 to about 130 species, the greater part of which belong to the north temperate region of both continents. "Of the twenty-one species," says Mr. Trelease, "recognized by me as occurring within our flora, eleven were characterized and named by Linnæus in the first edition of the 'Species Plantarum,' and only five have been named by American botanists." The biological interest of the genus arises chiefly, as he points out, from the protective acidity of the sorrels and some docks, and the occurrence of tannin and a bitter principle in others; their protandry and exclusive adaptation to wind pollination; and the adaptation of the greater number of species to wind dissemination, by the enlargement of the inner segments of the perianth during ripening, although some of those with fimbriate valves may profit by attachment to animals.

IN the latest instalment of the Proceedings of the Academy of Natural Sciences, Philadelphia, Messrs. H. Skinner and L. W. Mengel give an account of some of the insects taken by the expedition which the Academy sent to Greenland in 1891. The insects captured were divided among the different orders as follows:—Hymenoptera 25 specimens, Coleoptera 4 specimens, Lepidoptera Rhopalocera 143 specimens, and Heterocera 143. They were captured by Mr. L. W. Mengel, entomologist to the expedition, and Dr. W. E. Hughes, ornithologist. The specimens are all from the West Coast, and were taken at three principal localities, McCormick Bay, Herbert Island, and Disco.

ACETYL FLUORIDE, CH_3COF, has been prepared by M. Maurice Meslans, and is described by him in the current number of the *Comptes rendus*. As was to be expected, it is a substance considerably more volatile than acetyl chloride. Its boiling-point is 19°·5, very near that of hydrofluoric acid itself, and hence upon a warm day it takes the form of a gas, while at temperatures below 19°·5 it assumes the liquid state. It has been prepared by M. Meslans by causing various inorganic fluorides to react upon acetyl chloride. Thus when silver fluoride and acetyl chloride are heated together in a sealed tube to 260°, a small quantity of acetyl fluoride is formed. The acetyl chloride, however, is much more completely converted to fluoride when it is passed in the state of vapour through a long silver tube filled with dry silver fluoride and heated to 300°. Upon allowing the issuing vapour to pass into a strongly cooled receiver, acetyl fluoride condenses in the liquid form. Another mode of preparation consists in allowing arsenic fluoride to fall drop by drop upon acetyl chloride contained in a copper vessel, when energetic action at once occurs in the cold. The exit tube is attached to a spiral of leaden tubing, arranged as an inverted condenser, in order to retain either of the liquid reacting substances, and the last traces of acetyl chloride are removed by subsequently allowing the escaping vapour to pass through a copper U-tube filled with fragments of silver fluoride and heated in a bath of nitrates to 300°. The acetyl fluoride may then be condensed in a strongly cooled receiver. Instead of arsenic fluoride the solid trifluoride of antimony may be employed, and the operation performed in a glass flask, an ordinary inverted glass condenser being used to retain any escaping acetyl chloride. By far the most advantageous mode of preparation, however, consists in reacting with acetyl chloride upon zinc fluoride. One hundred grams of zinc fluoride are introduced in successive portions of ten grams each into a strong glass flask cooled by a freezing mixture and containing a hundred and fifty grams of acetyl chloride. The flask is then sealed, warmed to 40°, and again cooled. It is subsequently opened, while surrounded by the freezing mixture, and placed in connection with a leaden worm whose extremity passes down into a second flask surrounded by ice and containing a little dry zinc fluoride. The acetyl fluoride is then distilled over into the second flask, and upon redistillation over the zinc fluoride contained in the flask it is obtained in an almost pure condition. The liquid may be preserved unchanged in a dry glass vessel, but if moisture obtains access the glass is rapidly attacked. If the vessel containing the liquid is placed in connection with a tube standing over mercury, and the liquid warmed by holding the vessel in the hand, the new fluoride may be collected in the gaseous state, and preserved as a gas, provided the temperature of the room is superior to 19°·5. Both the liquid and the gas are colourless.

They burn with a blue flame upon ignition, producing water vapour, carbon dioxide, and hydrofluoric acid. They possess an odour somewhat resembling that of carbonyl chloride. Water dissolves about twenty times its volume of the gas, but the liquid does not mix with water, a very small proportion only being dissolved, and suffering slow decomposition. Alcohol, ether, benzene, and chloroform dissolve it in all proportions.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. C. Drew; a Grivet Monkey (*Cercopithecus griseo-viridis* ♀) from North-east Africa, presented by Mr. George Conquest; a Grey Ichneumon (*Herpestes griseus*), from India, presented by Mr. J. E. Barber; a Common Fox (*Canis vulpes* ♀), British, presented by Miss Nora Dunn; a Song Thrush (*Turdus musicus*), British, presented by Mr. Baldwin M. Smith; an Alexandrine Parakeet (*Palæornis alexandri* ♂) from India, presented by Mr. E. Bond; two Cerastes Vipers (*Vipera cerastes*) from Egypt, presented by Colonel Holled Smith; a —— Lizard (*Amphibolurus* sp. inc., from Australia, presented by Mr. Herbert E. Swayne; a Guinea Baboon (*Cynocephalus sphinx* ♀) from West Africa, a Rhesus Monkey (*Macacus rhesus* ♂), a Grey Ichneumon (*Herpestes griseus*) from India, two Punctated Agoutis (*Dasyprocta punctata*), a King Vulture (*Gypagus papa*) from Central America, a White-eyebrowed Guan (*Penelope superciliaris*) from South-east Brazil, deposited; a White-faced Heron (*Ardea novæ-hollandiæ*) from Australia, eight Ruffs (*Machetes pugnax* 4 ♂ 4 ♀), British, purchased; a Reindeer (*Rangifer tarandus* ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHIC AND VISUAL MAGNITUDES OF STARS.—At the Amsterdam Academy of Sciences on April 2, Prof. J. C. Kapteyn communicated the results of an investigation on the systematic differences between the photographic and visual magnitudes of stars in different regions of the sky. The comparison of the photographic diameters of stars of equal visual magnitude (according to Gould and Schonfeld's estimations) on 370 plates of the southern sky, shows that the actinic effect of stars in or near the Milky Way is much greater than that of stars in high galactic latitudes. Prof. Kapteyn has examined the different causes which lead to this variation. There is, first of all, the influence of different meteorological conditions; next, systematic errors in the catalogue of visual magnitudes used for comparison; and thirdly, peculiarities in the light of the stars. The discussion leads to the conclusion that the difference of magnitude is not appreciably affected by the first of these causes. And since, taking everything into consideration, the errors of estimated visual magnitudes could not possibly exceed 0·3 magnitude, there is no doubt that the difference of half a magnitude or more, indicated by the photographs, is due to the quality of light emitted. It is said that Prof. Pickering's idea that the Milky Way ought to be considered as an aggregation of stars of the first type is only sufficient to account for a difference of about 0·1 magnitude. Thus it appears that the light of stars in or near the Milky Way, like those of Group IV., is richer in violet rays than that of other stars.

PHOTOGRAPHS OF THE LYRA RING NEBULA.—In addition to the work on the Carte du Ciel, Prof. Denza, of the Vatican Observatory, has taken up the photography of nebulæ. Beginning with the Ring Nebula in Lyra, he has made five exposures on this object, from half an hour up to nearly two hours' duration. To bring out the fine detail, development has been carried on for about twenty minutes in each case. The negative which had received the longest exposure was presented to the Paris Academy on April 25. Viewed microscopically, the star at the centre of the nebula is seen to be joined to a smaller one near the nebulosity, and each of them can be broken up into other more or less brilliant points. A large number of condensed regions are well visible in the nebula. The location of these leads Prof. Denza to agree with Secchi that "L'anneau se prolonge dans le sens du plus grand axe, et que les parties les plus denses sont dans la direction du petit axe."

DETERMINATION OF THE CONSTANT OF ABERRATION.—Prof. G. C. Comstock contributes the provisional results of a determination of the constant of aberration to the *Astronomical Journal*, No. 261. The method adopted in the investigation is a modified form of that used by M. Lœwy, three reflecting surfaces being placed in front of the objective of the telescope instead of two. Images of stars in different portions of the heavens are thus simultaneously produced in the focal plane of the objective, and a micrometer is used to measure the distance between those of two given stars, when each pair of surfaces is successively employed. Then, if d represent the distance between the images of two stars as measured with the micrometer, Δ the angle subtended at the earth by the stars, R the effect of refraction in changing the true Δ into an apparent Δ', and K a correction depending upon the squares of the errors of adjustment of the mirrors, we have—

$$\Delta = 120^{\circ} + K + d + R.$$

The provisional value of the aberration constant derived from Prof. Comstock's observations is—

$$20''{\cdot}494 \pm 0''{\cdot}017.$$

An investigation of the refraction has also been made, resulting in the detection of a real variation. The refraction is at a maximum near the time of the winter solstice and a minimum near the summer solstice, but the exact epoch and amplitude have not yet been determined.

STAR MAGNITUDES.—"The Estimation of Star Magnitudes by Extinction with the Wedge," was the subject of an interesting paper by Captain Abney before the Royal Astronomical Society, many of the experiments from which his conclusions were drawn being made from a paper which he and General Festing communicated to the Royal Society on colour photometry. In the experiment for determining the amount by which the intensity of any ray of the spectrum would have to be reduced before it became invisible, the absolute intensity of the D line was fixed upon for the basis, from which all the other intensities could be directly calculated. With the arrangement he described, the D line was reduced to the 350 ten-millionths part of a standard amyl lamp, while under the same conditions the green light E had to be reduced to 65, F to 150, G to 3000, and the red to 110,000 ten-millionths part. By making the rays equal to one amyl lamp the numbers obtained were for D 350, E 35, F 17, G 15, and for C 22,000 ten-millionths part.

These numbers showed that to produce extinction for two lights of equal luminosity, say of colours C and G respectively, the latter was nearly 1500 times greater than that required for the other. He then referred to the extreme persistency of the violet sensations, they being 1500 times more persistent than the red and about 25 times more than the green, pointing out that the violet sensation would be the last to be extinguished. The function of the wedge, then, was not to obliterate the spectrum but to eliminate the violet sensation contained in its light. By determining star magnitudes by this method of extinction, the results obtained, he says, "should agree better with those obtained by photography than those obtained by eye estimation," the first being obtained by estimation of the E light, the second of the light between G and F, and the third from that near D.

Referring to colour extinction he mentions that although most of the faint stars are known to be of a bluish colour it does not follow that "they are not red." The blue tint is brought about by the faintness of the light, which makes all colours appear grey, and "as the violet sensation disappears last, it frequently happens that you get the red and green sensations as grey, and the violet just above the colour limit, thus giving a grey blue." He suggests that with telescopes of large aperture these stars might be seen in colours.

THE INSTITUTION OF MECHANICAL ENGINEERS.

AN ordinary general meeting of the Institution of Mechanical Engineers was held on the evenings of Thursday and Friday of last week. There were two items of exceptional interest on the programme, the first being the inaugural address.

of the new President, Dr. William Anderson, F.R.S. ; and the second the report of the Committee appointed by the Institution to make trials on marine engines. The President in his address gave a brief review of the progress of the Institution since its foundation in 1847. For the first thirty years of its existence the Institution was a provincial Society, having its head-quarters in Birmingham. In 1877 it was determined to remove to London, as it was thought that the wealth and influence that had been acquired was sufficient to give a position of national importance which could hardly be held by a Society having its head-quarters in any other city than the metropolis. There was naturally a strong opposition to the migration, but the change was made, and since then the importance of the Institution has gone on steadily increasing, until at the present day it is second only to the Institution of Civil Engineers. The Institution was started in 1847 with 107 members, the annual income being £515. During the first thirty years the membership increased about tenfold, but at the end of the fourteen years that the head-quarters have been in London it has increased to twenty-fold ; that is to say, in 1877, when the migration was made, the numbers were about one thousand, whilst last year they were over two thousand—actually 2077. The annual income was last year £7212, and the accumulated investments of the Institution are now £22,536.

A somewhat acrimonious correspondence has been published lately in the pages of a weekly journal, and the President, somewhat unnecessarily perhaps, thought fit to reply to this. A complaint had been made that the papers were few and poor. Dr. Anderson referred to the large number of scientific Societies now existing, and the difficulty of providing good papers. "We have been spoiled and cloyed," he says, "by the rapid progress of mechanical engineering ; so that papers which are not revelations of something new are condemned as unworthy of the Institution. Is there any form of steam-engine, for example, which it would be worth while now to describe, unless it be some monster of exceptional proportions, the details of which we should like to see in our Transactions? Who would like to read a paper on a bridge of even 800 feet span, and to illustrate it with all the type and plates which characterized the two accounts of the Britannia Bridge, when the Forth Bridge, a structure of more than double that opening, has recently become familiar to us? I am afraid that, in consequence of the state at which we have arrived, and, in respect of originality, the untoward age in which we live, we must be content with many papers that may justly be termed poor so far as novelty alone is concerned. We must, therefore, rely for excellence on a more scientific treatment of our subjects, and on the care with which the details of construction are worked out and presented in the illustrative drawings. Our critics should remember also that originality is not our only quest—that we are not all veterans to whom design comes almost by instinct : we have a large body of younger and less experienced members, and to them I feel sure, from my past experience, that our proceedings offer practical examples and guidance which are appreciated all over the world, and the desire to possess which is, I take it, the main cause of the ever-increasing strength of the Institution."

The President next referred to the work done by the different Research Committees of the Institution which have been engaged for some years past in investigating engineering subjects upon which information appeared most desirable. There have been Committees on riveting, on friction, on steam-jacketing engine cylinders, and other matters, including marine-engine trials, the last report of the Committee on the latter subject having been presented at the meeting now under notice. It would be difficult to imagine a more useful and legitimate purpose upon which the funds of the Institution could be spent. The work that is over and over again done, generally in a partial and imperfect manner, by private firms, in getting information on many points of engineering practice, represents a sad loss of time and money. The work of the Research Committees of the Institution should put an end to a great deal of this, and will so help the advance of engineering practice, to the benefit not only of engineers, but of the whole civilized world. The President made another suggestion which would tend to the same end, and which it is hoped may be carried out. "There is," he said, "another sphere of usefulness in which our abundant means would enable us to do good service ; it is in the compilation of a brief reference index to all mechanical matters at home and abroad. Were we to establish a staff—and it might be a very modest one—whose duty it would be to index under proper heads every important article relating to mechanical science which comes out week by week, we should in time, and at moderate cost, form an invaluable record, from which an inquirer would be able to find in a few minutes where to look for complete information on any subject connected with our special branch of engineering." The Royal Society is doing a similar work for scientific papers generally ; and in the United States Messrs. Haferkorn and Heise have compiled a most useful index of books printed in English relating to technical matters, but the work stops at 1888, and does not contain references to the isolated letters and papers which appear in English and foreign journals.

Dr. Anderson, as every one knows, holds the important post of Director-General of Ordnance Factories, and it was natural he should make some reference to the various establishments—the chief of which, of course, is Woolwich Arsenal—under his control. Here, again, public criticism has been exercised of late, not altogether favourably, and a good part of the address was taken up with an apology for Woolwich. Taking the side of the case selected by Dr. Anderson for discussion, there is no doubt he made out a very good case. It is perfectly impossible that all inventions should be adopted, and therefore it is evident the authorities with whom these matters rest must reckon with a great many hostile critics. The address gave some interesting details of the way in which the Ordnance departments are managed, but into this question we need not now enter. The difficulty of finding subjects for papers which were altogether novel had been previously referred to in the address ; but, notwithstanding that there is little scope for originality, Dr. Anderson pointed out that some problems still remain to be solved. Among them is one which is of the greatest practical importance to mechanical engineers, while at the same time it is of extraordinary theoretical interest. This was the question of the nature and composition of steel, and alloys generally. Since the year 1879 the Institution had been engaged in trying to unravel the mystery which surrounds the behaviour of steel in connection with its chemical and molecular composition, combined with changes of temperature. The researches of Sir Frederick Abel, Dr. Sorby, Mr. Osmond, Mr. Hadfield, and Prof. Roberts-Austen, aided by the Le Chatelier pyrometer, have given the inquiry new life. Dr. Anderson expressed great hope that the active measures taken by the Institution, through the Alloys Research Committee, would result, at no distant time, in the solution of the enigma, and in the establishment of definite laws. The problem, however, is excessively involved. It amounts, in fact, to a consideration of the number of permutations or combinations possible among some ten variables, the relations of which to each other are also dependent, not only on actual temperature, but also on the rate of its changes, and on the uniformity of these changes, throughout the mass. The address next made reference to the fact that pure iron is allotropic, and exists in both the hard and soft state. Carbon also exists in two forms in steel, either combined or suspended in the mass ; and there are other ingredients necessary to take into account. In consequence of changes due to temperature also, the chemist is impotent to pronounce from mere analysis what the quality of steel may be. On the other hand, the ordinary mechanical tests are not of much avail, because the specimens are not and cannot be in the same condition of internal stress—on which again the molecular arrangement appears to depend—as the masses from which they are cut. Moreover, specimens for mechanical testing cannot always be taken from the central parts of the huge forgings and castings now in use for many purposes. Under these circumstances Dr. Anderson considered that the method of noting the rate of cooling by curves automatically traced—as now so ingeniously worked out by Roberts-Austen—affords the best promise of placing in the hands of the mechanic a means of judging at any rate of the uniformity in composition of the material, and even perhaps of its actual chemical nature, so far as this affects his wants. As additional advantages the thermo-electric autographic apparatus is cheap ; it occupies but little space, it can be employed in an ordinary room, and the results sought can be obtained in a few minutes.

The use of petroleum or mineral oil next occupied a place in the address, the author being of opinion that as a source of power it would rapidly gain ground. In 1888, Priestman Bros. brought out their engine, working with a heavy oil having a high flashing temperature. That engine was tested by the present Lord Kelvin (then Sir William Thomson) and the author independently, and gave an efficiency of one brake horse-power

to 1·73 lb. of oil. At the next year's show the consumption fell to 1·42 lb.; in 1890, to 1·243 lb., and Prof. Unwin this year reports that a brake horse-power has been obtained by the combustion of 0·946 lb. Much yet remains to be done. The useful work on the brake is under 14 per cent. of the energy latent in the fuel, while the heat carried off by the water jacket round the cylinder, and by the exhaust is equivalent to 75 per cent. of the total thermal capacity of the fuel. Dr. Anderson was of opinion that a combination of the direct combustion engine with the spirit-engine of the Yarrow type would give the best results, especially if a more advantageous cycle than that of the Otto gas-engine can be adopted.

The address next proceeded to deal with the question of the capacity of the earth to supply the ever-increasing demand for petroleum, and to enquire whether it would be possible to substitute it largely for coal as a source of heat, owing to the fact that we should have to go deeper and deeper in the future to reach workable coal measures. In connection with this problem the address gave particulars of the researches of Mendeleeff, and described his theory of the continuous formation of petroleum by the action of water on the molten rocks in the interior of the earth. The speculation is one of great interest, but has already been dealt with in these pages.

The vote of thanks to the President for his address was moved by Sir Frederick Bramwell and carried with acclamation.

After the reading of the address the Report of the Marine Engine Trials Research Committee, which had been prepared by the Chairman of the Committee, Prof. Alexander B. W. Kennedy, was read. This report dealt with the trials of the Belgian channel steamer *Ville de Douvres*, which had been generously placed at the disposal of the Committee by the Belgian Government. This vessel is one of the line which carries the mails between Ostend and Dover, and was built and engined by the Société Cockerill, of Seraing, Belgium, and is a comparatively new vessel, having been delivered in the year 1890. The propelling machinery consists of a pair of compound surface-condensing paddle engines. Vessels of this class are mainly designed with a view to speed, as the chief object desired is to carry passengers and mails quickly from port to port. As the run is only of three hours' duration, it would obviously not pay to enter into any refinements with a view of economizing fuel. The time under way is comparatively small when considered in relation to the time spent in raising steam and cooling down again. This is a point which should be borne in mind, but which some critics appeared to forget during the discussion. Perhaps engineers are apt to base their estimates of efficiency, especially in marine practice, too much on an economy basis. It is a good thing to save fuel if it can be done without too much sacrifice. An examination of the details of the various trials of steamships made by the Research Committee illustrates this important point. We hardly know how to deal with this paper. It is full of information of the most valuable description, but its very fullness renders it extremely difficult to make an abstract, and we have not space to give all the details in full. Perhaps the best plan will be to give some of the leading facts; and, although these may appear somewhat bald standing alone, they will enable our readers to form an estimate of the scope of the trials, and those who are especially interested will go to the original, in the Transactions of the Institution, for fuller details. The *Ville de Douvres* is 271 feet long, 29 feet broad, and 15·5 feet deep, moulded. Her registered tonnage is 855 gross; and her displacement 1090 tons. She was run for nine hours especially for the trial in the North Sea. The engines are of the compound, inclined, surface-condensing type, with cylinders 50·12 inches and 97·12 inches in diameter, with 72 inches stroke. Neither cylinder is steam-jacketed, but there is an intermediate receiver encircling the high-pressure cylinder; an arrangement which certainly does not tend towards efficiency. The air, feed, and bilge pumps are driven from the main engines. The circulating pump is separate, and is estimated to develop 47 indicated horse-power. The surface condenser contains 6540 square feet of tube surface, and it is so arranged that the circulating water passes three times through the condenser. The course of the water is such that the coldest water meets the hottest steam. This is naturally not the best arrangement, for the circulating water would still be efficient for taking heat from the hottest steam, even after it had been somewhat raised in temperature by the coldest steam. On the other hand, circulating water having been heated by the steam at highest temperature, will be comparatively inefficient to further cool down steam already cooled to a great extent. In any case, if a good vacuum be ultimately obtained, the refrigerating surface will be far less effective. The paddle-wheels are 22 feet 10 inches over the floats, the latter being 10 feet broad and 4 feet 4 inches deep. The immersion on trial was 17 inches. There are four single-ended return-tube boilers, 13 feet by 10 feet. The grate area is 236 square feet, and the total heating surface 7340 square feet. There is forced draught on the closed stokehold system. The total weight of all machinery, exclusive of paddle-wheels, and all water is 361 tons. Block fuel was used throughout the trial. The calorific value, calculated from analyses made, was 14,390 thermal units per pound. This corresponds to an evaporation of 14·90 pounds of water from and at 212° F. A number of samples of furnace gases were collected and analyzed, with the following mean results:—

	Carbonic Acid.	Carbonic Oxide.	Oxygen.	Nitrogen.
By volume per cent. ...	11·55	0·00	7·95	80·50
By weight per cent. ...	16·84	0·00	8·44	74·72

There was a little uncertainty about the temperature of the chimney gases, but the mean temperature was assumed to be 910° F. The mean draught was equal to a pressure of from 0·92 to 1·22 inches on the water-gauge. A notable feature about these trials was that the feed measurement was made by meters. This is a vast improvement, in one respect at least, and that of great importance, on the measuring tank system. Measuring tanks are always cumbersome and difficult to fit; so much so that they generally prove the greatest bar to proper trials being made of the efficiency of marine machinery. The meters used were of the Kennedy type, and appear to have answered the purpose admirably. There is no trouble in taking a meter reading, whilst the measuring tanks require constant attention. We look on the introduction of the water meter for this purpose as a most important step in advance, and one which will lead to engineers obtaining more frequent information on the efficiency of marine engines. It is most desirable that the performance of the boiler should be separated from that of the engine. The indicated horse-power and coal consumption give the economy of the whole machine; but when results are not satisfactory it is often difficult to say whether the fault rests in the boiler compartment or the engine-room. Another step in advance is the effort made to measure the amount of priming water. In the present day we do not have so much trouble from priming as in past times, when lower pressures were in use and the steam space was practically what it is now. Still, there are yet large quantities of unevaporated water often carried over to the engines by the rush of steam. It is obviously useless to exercise great care in measuring the feed if a considerable part of it is carried from the boiler to the condenser simply as water. In such a case the boiler is credited with a high evaporative efficiency by reason of its very fault; and the engine is debited with steam which it never receives, but on the contrary is having its action impaired by the presence of water in the cylinders. The method of testing for priming is as follows:—A quantity of steam from the main steam-pipe is condensed in a special surface-condensing apparatus, and collected, and at the same time a sample of water is taken separately from the boilers. Both of these samples are carefully analyzed to determine the quantity of salt present in each. As the whole of the salt found in the sample from the steam-pipe must have come over from the boiler in conjunction with priming water, and not with steam, a simple calculation will show how much boiler water corresponds with the quantity of salt, if any, found in the steam-pipe sample. From this it is easy to determine what percentage of the whole feed-water has passed from the boilers in the form of water, or, in other words, what percentage there is of priming. The chemical determination for salt is a very simple one, and is capable of being carried with ease to an exceptional degree of certainty. The observed and calculated data of the trial are given in a full table appended to the report. The mean boiler pressure was 105·8 lbs. above atmosphere, the vacuum 10·12 lbs. below atmosphere, the revolutions 36·82 per minute, the mean indicated horse-power 2977, the fuel per square foot of grate per hour 31·3 lbs., and the feed-water per indicated horse-power per hour 20·77 lbs., allowing for auxiliary engines. The efficiency of the boiler was 66·1 per cent., and of the engines 11·7 per cent. The combined efficiency of engine and boilers was 7·7 per cent.

A very interesting discussion followed the reading of the report, but a great part of this it would be useless to give, as many details of the trial have necessarily been omitted from our brief abstract.

A paper was next read "On Condensation in Steam-Engine Cylinders during admission." This was a contribution by Lieutenant-Colonel English, of Jarrow. In former papers on this subject the author had given experimental data, but it was objected that he had left out of account the range of temperature in the cylinder. In order to show that this was not the case, he submitted the following formulæ, which, he claimed, proved his case. The former papers, a study of which is necessary to a proper understanding of the facts, may be found in the Transactions of the Institution for the years 1887 and 1889.

In jacketed cylinders the weight of steam condensed per stroke and not re-evaporated at cut-off is represented by the expression

$$\frac{56}{\sqrt{\text{revs. per second}}} \times \frac{(S_c - S_1)\rho_1}{L},$$

where S_c is the unjacketed clearance surface in square feet, S_1 the fresh surface exposed during admission up to cut-off, ρ_1 the initial density of the steam in pounds per cubic foot, and L the latent heat of evaporation in thermal units. If d be the diameter of the cylinder in feet, l the length of stroke in feet, m the proportion of stroke up to cut-off, $\mu = \frac{S_c}{2 \times \text{area of cylinder}}$, and N the number of revolutions per minute; then S_c = unjacketed clearance surface $= \frac{\mu\pi d^2}{2}$; $S_1 = \pi dml$; $\sqrt{\text{revs. per second}} = \frac{\sqrt{N}}{7{\cdot}75}$; and the foregoing expression may be written

$$\text{Weight condensed} = \frac{56 \times 7{\cdot}75}{L \times \sqrt{N}}\left(\frac{\mu\pi d^2}{2} - \pi dml\right)\rho_1$$

$$= \frac{868}{L \times \sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right)\frac{\pi d^2 ml}{4}\rho_1.$$

But $\frac{\pi d^2 ml}{4}\rho_1$ is the weight of steam per stroke uncondensed at cut-off, and 868 may be taken as an approximate value for L; therefore for jacketed cylinders;

$$y = \frac{\text{weight condensed}}{\text{weight uncondensed}} = \frac{1}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

For unjacketed cylinders a similar approximate expression is

$$y = \frac{1{\cdot}5}{\sqrt{N}}\left(\frac{\mu}{ml} - \frac{2}{d}\right).$$

The author supported his views by means of a voluminous table, in which he gathered together the observed data on a number of steam-engine trials made by various well-known authorities, to which he attached the results obtained by calculation on his system.

A short discussion followed the reading of this paper, and the meeting was then brought to a conclusion by the usual votes of thanks.

The summer meeting of the Institution will be held at Portsmouth, on July 26 to 29.

THE ROYAL SOCIETY SOIRÉE.

THE annual *soirée* of the Royal Society, which took place on Wednesday, May 4, may be said to have been the most successful that has been held for many years. All the necessary arrangements, which were by no means few in number, were carried out without a hitch, while the exhibits were of a most attractive nature. As regards the latter, the following are a few notes of the most novel and important objects displayed:—

Prof. T. E. Thorpe exhibited a model to illustrate the general phenomena of explosions as brought about by the presence of dust particles, in explanation of the causes of colliery explosions. This apparatus consisted of two long narrow boxes, fitted together in the form of a cross. On the bottom of these boxes was thinly strewn a quantity of fine Lycopodium powder, while at one end of the longer box there was a small chamber in which a blank cartridge was fired. The firing of this cartridge corresponded to the direct action of a "blow-out shot," while the dust raised by the concussion, which carried the flame throughout the entire apparatus, took the place of the fine coal dust. The apparatus also showed that the progress of such an explosion was always accompanied with increase of violence.

Prof. Clowes showed an ordinary miner's safety-lamp which had, by a very simple contrivance, been converted into a delicate instrument for detecting minute proportions of fire-damp. To the ordinary burner an additional tube is made to pass through the oil reservoir, one end of it being connected, by means of a flexible tube, with a small portable bottle of compressed hydrogen. The hydrogen when turned on becomes ignited close to the oil burner, the flame of which is extinguished by turning down the wick; by adjusting the flame of hydrogen to the standard height, a luminous column of light is seen vertically over it, from the behaviour of which the amount of inflammable gas can be directly estimated. At the conclusion of the experiment the wick is simply turned up, and ignited from the hydrogen flame; the latter is then disconnected from the bottle. From 0·25 to 3 per cent. of fire-damp has in this way been estimated, while greater quantities than these have been measured by reducing the size of the flame.

Vacuum tubes without electrodes, exhibited by Dr. Bottomley. These tubes, which were of a variety of shapes and kinds, illustrated very beautifully all the phenomena of stratification. They were sensitive also to magnetic and electro-dynamic influence, and showed the phenomena of molecular bombardment. The brilliant illumination of a piece of Iceland spar contained in a glass sphere afforded an excellent means of displaying the electrical excitements. [For an account of experiments with vacuum tubes, see a letter by Mr. Bottomley in NATURE, January 6, 1881, vol. xxiii. p. 218.]

Mr. Cecil Carus-Wilson exhibited some natural and artificial sands, from which he was able to produce many musical notes. These notes, as he explained, were the results of the rubbing together of the surfaces of the grains of sand, but he had met with several sands from which he could not obtain a vestige of a note. One special artificial sand sang only when rubbed in some sort of vessel.

Apparatus for measuring degrees of incompleteness of colour vision, exhibited by Mr. Brudenell Carter. The object used for the tests is a group of various colours, which were such that they could be seen by either reflected or transmitted light. The amount of illumination that was required to recognize the colours distinctly was a measure of the "degree of incompleteness." In order to control this amount of illumination, light of known intensity had to pass through a variable aperture before it fell on the test object, the size of this aperture being read off in square millimetres.

Captain Weir's azimuth diagram was exhibited by Mr. J. D. Potter. It is claimed for this diagram that besides being most ingenious, it furnishes one of the most successful modes of graphic solution of a mathematical problem that has ever been invented. It is used for finding the true azimuth of a heavenly body, taking into account the ever-changing errors of the compass, which in our days of iron ships have to be so carefully watched and recorded. The errors as usually determined are obtained from observations made of the compass-bearing of a heavenly body (the sun generally being taken) with its true bearing, and it is for the simplification of this method that this azimuth diagram has been found to be practically useful.

Prof. Oliver Lodge had three exhibits. The first was the projection of interference bands on a screen, being produced by a modified method of Michelson. Very striking also were the electric sparks in and to water, illustrating lightning effects and multiple flashes. In a shower, with too great spark-length for a strong discharge, a multitude of violet streams or spurts filled the air, resembling somewhat lightning flashes. The spark to water spread itself out over the surface, showing that the surface layer was a feeble dielectric, while the spark under water was brief but very violent, treating the water as a dielectric, and producing concussion. The electric retina, illustrating the possible meaning of the rod-and-cone structure, was very interesting; radiation from spheres which were in a suddenly disturbed and oscillatory electrical condition falling upon a graduated series of end-on cylinders, which responded by vibrating transversely.

Mr. W. Crookes repeated many of those beautiful experiments of electric currents of high potential and extreme frequency that were first carried out by Tesla. The discharges from a battery of Leyden jars were sent through the primary

wire of an oil induction coil. The frequence of alternation amounted to no less than 1,000,000 a second, while the electromotive force reached the enormous amount of 100,000 volts. Perhaps it was as well that this frequency was great, otherwise the physiological action might have been rather surprising to those who trusted implicitly in Mr. Crookes. The resistance offered by the sheet of vulcanite to the strong current produced some fine flashes, while very pretty were the examples of brush discharges, St. Elmo's fires, &c., at the secondary poles of the oil induction coil.

The electrical apparatus shown by Captain Holden, R.A., consisted of some very important new instruments, among which we may mention the high-speed chronographic pen for taking a number of successive records of short intervals of time, the pen being automatically reset after each record; an improved simple compensated voltmeter on the hot wire system, and the dead-beat alternating current ammeter worked by a heated metal strip and free from self-induction.

Prof. Roberts-Austen exhibited a new electrical method for the exact determination of very high temperatures, which has rendered possible the construction of a very simple instrument, devised by Prof. H. Le Chatelier, that can be placed in the hands of any workman. The latter depends on the comparison of the intensity of the radiation emitted by a glowing body (the temperature of which has to be determined) with that of a standard source of light. To use the instrument it is pointed in such a direction as to have the light from the heated mass of metal in its field of view, so that the colour can be distinctly observed; in the same field of view a series of standard colours can also be made apparent (situated side by side with the heated metal), by turning a milled head screw which carries a pointer over a graduated scale. By matching the colours a direct reading of the position of the pointer gives the required temperature.

The Rev. F. J. Smith exhibited an electric tram chronograph which he had devised for measuring small periods of time, varying from one-fourth to one-twenty-thousanth part of a second. This instrument consists of a metal girder furnished with a T-shaped end, carries two steel rails, and is supported on a V-groove, hole, and plane system. The carriage, on which is fixed a slightly smoked glass plate, runs on these rails, driven either by a weight or by a coiled spring. A metal pillar, carried on a V-groove, hole, and plane system, is placed in front of the moving surface, and supports electro-magnetic styli which can be brought into contact with the smoked surface; a tuning-fork also is so placed that the traces are found to be recorded on the smoked plate so as to afford a means of measuring the time intervals. The two motions of the pillar, of rotation and vertical translation, allow a large number of observations to be made on the same plate. There are also continuous contact-breakers, whereby, when a photographic plate is fixed in the carriage, spark photographs of moving objects may be obtained. This instrument has been applied to the measurement of the velocity of projectiles, and small periods of time in physiological research, and to the photography of insects and falling drops of liquids.

Perhaps the most unique exhibit of the evening was the series of photographs of flying bullets which Mr. Boys had obtained by a modification of an old method. The photographs showed beautifully the waves in the air caused by the rapid flight of the bullet analogous to those produced by a fast-going steamer. In one slide the small pieces of paper through which the bullet had passed were also seen ploughing their way through the air, producing quite as definite waves as the projectile itself, only of not such large dimensions. The passage of a bullet through a piece of wire was also very curious, the piece of wire that was cut off not having time to fall before it was seized by the lightning eye of the camera. The photograph showing a magazine rifle bullet piercing a glass plate brought out some very interesting facts. The glass appeared to be thoroughly scattered in a direction opposite to that in which the bullet was proceeding, the greatest scattering taking place on the side which the projectile touched first. The waves set up on the glass plate gave measures of the wave, length of the tremor caused, and the velocity of travel. The bullets used for these pictures were of various kinds, and the velocities varied from 750 to as much as 3000 feet per second, the former from a pistol and the latter from a magazine rifle, the bullet being composed of aluminium to obtain this great velocity.

The Committee of the Kew Observatory exhibited a testing camera for photographic objectives that had been designed by Major L. Darwin. With this instrument all the most important features of a lens can be accurately and swiftly determined. We may mention here that arrangements are being made that any lens sent to them will be thoroughly examined in all respects under the superintendence of Mr. G. M. Whipple, certificates of examination being made out, as is at present done in the case of other instruments.

We must now pass on to the photographs.

Astronomy was well to the fore with the exhibits of Messrs. Lockyer and Roberts. The former showed a fine spectrum of Nova Aurigæ, that had been enlarged twenty-five times from a negative taken with only a 6-inch object-glass and prism by the Brothers Henry and Hilger respectively; several fine photographs of stellar spectra illustrating the main evolutionary types according to the meteoritic hypothesis, and photographs of the 3-foot reflector at Kensington that is now near completion. Mr. Roberts showed some photographs of celestial objects; the original negative of Nova Cygni, taken with a 20-inch reflector with a two-hours' exposure, showing the Nova as a star of the thirteenth magnitude. An enlargement of the region in which Nova Aurigæ was situated when the star was of the fourth magnitude was also displayed, together with the original photograph taken with the instrument before mentioned, but with an exposure of three hours.

The photographs showing the great sun-spot of February last, exhibited by the Solar Physics Committee, may be said to be the best series that has ever been obtained. The series included nine days, and showed the remarkable changes that occurred during the interval from February 5 to February 17.

Mr. W. Saville-Kent exhibited a series of photographs, over a hundred, taken by himself, enlargements of the same, and water-colour sketches, illustrating coral reefs, coral animals, and the marine fauna generally of the Great Barrier district of Australia. A lantern exhibition illustrating the same subject was also included in the evening's programme. The reef views, which portrayed extensive areas of growing corals of innumerable varieties, were, as explained by the exhibitor, taken at abnormally low spring tides, and are as a matter of fact very rarely visible to the extent depicted. Among the more important points associated with this exhibit were the facts that in a large number of instances accurate measurements had been taken of the individual corals that composed the reefs photographed, such reefs being in easily accessible positions, where their subsequent amount and rate of growth could be periodically determined. This exhibit, more particularly with relation to the illustrations of living coral polyps—those of the mushroom corals, genus *Fungia*, being particularly noteworthy—represented the first occasion in which photography has been systematically applied to this highly interesting biological subject. A second novelty exhibited by Mr. Saville-Kent was a pearl of fine quality and considerable size that the exhibitor had caused the mother-of-pearl shell animal, *Meleagrina margaritifera*, to produce by means of a delicately-manipulated operation on the living animal.

From the Zimbabwe ruins, Mashonaland, some very valuable finds in the shape of pottery, gold crucibles, weapons, ingot moulds, &c., were exhibited by Mr. Theodore Bent and the Royal Geographical Society; while by the same exhibitors were shown a model of the circular temple at Zimbabwe, built of small blocks of granite without mortar; and several plans of ruins in Mashonaland. No less interesting also were the photographs of ancient Central American monuments and buildings from the ruins at Chichén Itzá (Yucatan), Palenque (Chiapas), &c., exhibited by Mr. Alfred P. Maudslay; and a selection from the proof-plates to the first memoir of the archæological survey of Egypt that is being undertaken by Mr. Percy E. Newberry. One of these proof-plates showed all the successive stages of a wrestling match between a black and a white man, more than a hundred different positions being recorded; the white man, we are sorry to say, seemed to be getting the worst of it in many of them.

Several important discoveries were made during the Royal Dublin Society's survey of the fishing grounds on the west coast of Ireland; specimens of several fish then obtained were exhibited by Prof. A. C. Haddon and Mr. E. W. L. Holt. Many new to British waters were found, while one quite new to science (*Nettophichthys retropinnatus*, Holt) was caught.

Some very curious worms composed Mr. F. E. Beddard's exhibit. They were specimens of *Branchiura Sowerbii*, and were found in a tank in the Regent's Park Botanical Gardens.

They possess a dorsal and ventral series of contractile gills, which make them differ from all other known fresh-water worms.

To summarize shortly a few of the other exhibits, we may mention Messrs. Pike and Harris's high tension apparatus; Mr. H. L. Callendar's platinum resistance pyrometers; the original specimen of *Asteropecten Orion* (Forbes), and a specimen of a slab of mountain limestone Bolland showing the passage of a foraminiferal ooze into crystalline calcite, by Prof. W. C. Williamson; Prof. Percy Frankland's crystals of active calcium glycerate (lævorotatory); and the two exhibits of turacin, one by Dr. C. A. MacMunn, showing the very remarkable spectrum it produces; the other by Prof. A. H. Church, who discovered this red pigment in the wing-feathers of certain plantain-eaters or Touracos. A very ingenious process of so-called colour photography was explained by Mr. F. Ives, of Philadelphia, who showed several pictures by means of a special optical lantern.

THE SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY.

THE annual Exhibition of this Society was held on the 5th and 6th inst., at "The Bridge House," London Bridge, S.E. The President, Mr. C. G. Barrett, F.E.S., in opening the Exhibition, gave a short account of the history of the Society from its formation by eleven South London entomologists in 1872; and he referred to the work done by members in rendering popular the study of biological science.

The exhibits were arranged in four rooms, and were very varied, including examples of nearly every order of the animal and vegetable kingdoms.

In the first room Mr. C. S. Cooper exhibited an almost perfect collection of British wild flowers and leaves; the Lambeth Field Club, Mollusca; Mr. J. T. Carrington, land shells from the Riviera, arranged so as to show variation; Mr. C. H. Collings and Mr. D. W. Collings, British and Australian birds' eggs and British birds; Mr. H. J. Turner and Mr. Rice, nests and eggs of British birds, the latter having a double nest of the great titmouse (*Parus major*). The tables around this room were set apart for the exhibition of objects by aid of the microscope, and among so many it is difficult to make a selection; but the more important objects were those of Mr. T. D. Ersser, who showed the circulation of the blood in a gold carp, a most interesting subject; Mr. J. H. Stanley, spawn of perch; Mr. H. Groves, the circulation of sap in Nitella; Mr. R. Macer, heads and eyes of various species of spider; Mr. West, fresh-water Polyzoa; Mr. E. Hinton, preparations of the Hydroids, including the beautiful sea pen, killed with the tentacles fully extended; Mr. W. B. Medland, the pulsation in the heart of a snail; Mr. J. B. Medland, a section of the jaw of a mole, with the teeth *in situ* (polarized).

In the second room Mr. J. A. Cooper's birds' nests and eggs in natural clutches occupied one end, and were much admired: one of the principal features of this collection being that it is arranged to show the variation in different clutches of the eggs in one species. This was particularly noticeable in those of the red-backed shrike. Among the eggs there were white varieties of those of the chaffinch, lapwing, and great black-backed gull; variable series of the guillemot, razorbill, lapwing, and golden plover; also a series of nests containing eggs of the cuckoo, including nests of the wagtail, tree pipit, chaffinch, greenfinch, hedge sparrow, robin, flycatcher, yellow bunting.

In the class Insecta some of the more important exhibits were those of Mr. J. H. Leech, with sixteen drawers containing Palæarctic Lepidoptera. This collection attracted considerable attention. Mr. J. Jenner Weir showed exotic Rhopalocera, illustrating forms of mimicry, and fine examples of South African Ornithoptera. Mr. S. Edwards also contributed a large exhibit of exotic Rhopalocera. Adjoining these, was the Society's typical collection of Canadian Lepidoptera. Four drawers of European Neuroptera were shown by Mr. R. McLachlan. Mr. H. Moore exhibited a number of wasps' nests. Mr. T. R. Billup's exhibit comprised British Coleoptera, containing types of nearly all the known species; three drawers of Hemiptera-Heteroptera and one of Homoptera were beautifully arranged, and the adoption of a system of labelling giving the name of the species, the locality where taken, and date of capture, is much to be commended; seven drawers of Hymenoptera Aculeata, containing many rare species, also long series of Ichneumonidæ, many of the specimens being new to science, and others new to Britain; also two drawers of life-histories of Hymenopterous and Dipterous parasites, together with the larvæ and imagines of the Lepidopterous host. This last exhibit was one of the most interesting and instructive of the exhibition. Of British Lepidoptera there was a magnificent display, there being some forty exhibitors. Mr. R. South showed nearly the whole of his collection of *Pyrales*, *Crambi*, *Pterophori*, and *Tortrices*, a selection of *Noctuæ*, among which were extreme series of most of the polymorphic species in the group; a drawer of *Lycæna icarus*, showing the colour range of both sexes, one very blue female without black discoidal spots was especially interesting; a drawer of Geometræ showing that the colour and ornamentation of the female parent is transmitted to a large proportion of her offspring; Mr. C. G. Barrett, *Pieris napi*, one female of a light canary-yellow colour from Norfolk, others suffused with grey from South Wales, others with black spots and tips and dark nervures from the north of Ireland; varieties of *Anthocharis cardamines*; long series of *Odonestis potatoria*, showing extreme variation, the colour in the males ranging from chocolate to a pale buff; also extensive series of varieties of *Agrotis cursoria* and *A. tritici*, from the east coast of England. Mr. Barrett also exhibited a drawer of varieties of Rhopalocera lent to him for the purpose of figuring in his book on the British Lepidoptera, by the Rev. Joseph Greene, the Rev. O. Pickard Cambridge, Dr. Wheeler, Mr. J. E. Robson, Mr. E. Sabine, and Mr. Sydney Webb. It is doubtful whether such a collection of varieties has been seen before, and those Lepidopterists who pay special attention to the question of variation were much interested in the extraordinary varieties shown. Mr. F. Merrifield, examples of *Selenia illustraria*, *S. illunaria*, *S. lunaria*, *Eugonia alniaria*, *Vanessa urticæ*, *Platypteryx falcataria*, *Arctia caia*, *Bombyx quercus* and var. *callunæ*, bred by him in his experiments on the effect of temperature on the pupæ of certain species in causing variation. Labels were attached to each specimen showing the conditions to which the pupæ had been subjected, and the results obtained from these. It appeared that a lower temperature produced examples which were darker and more intense in colour than those subjected to higher temperatures. A third drawer of *S. illustraria* and *S. illunaria* was shown, as illustrations of the effect of temperature applied for a very few days to pupæ at a sensitive stage, *i.e.* just before they began to show the colour, the forcing temperature was about 77°; the natural temperature about 40° to 50°; a range of 15° or less (at a point which it appeared was not yet actually ascertained between 57° and 73°) was sufficient to produce the full temperature effects shown in the first two cases, but a range of much less than 13°, if at the right part of the thermometric scale, produced substantial difference of colouring. Mr. W. Farren contributed examples from Cambridge including fine yellow specimens of *Bryophila perla*, and extensive series of *B. muralis* and *B. impar* of Warren; these gave rise to considerable discussion among visitors as to whether *impar* was a true species or only a variety of *muralis*. Mr. R. S. Standen, a small box showing extreme varieties of *Argynnidæ*. Mr. Tugwell, a selection from his cabinet, including long series of *Eugonia alniaria*, Esp., melanic forms of *Phigalia pedaria*, *Boarmia repandata*, *Tephrosia biundularia*, &c., and striking varieties of *Abraxas grossulariata*. Mr. C. G. Gregson also put in a magnificent series of varieties of this last-named species, some of the specimens being entirely suffused with the black markings, in others the yellow-coloured markings were wanting, and many were very pale forms, the black markings being absent; Mr. Gregson also showed *Dianthœcia conspersa*, from various localities, to illustrate the local variation in that species—many of the forms were so extreme that he had given them varietal names. Mr. J. R. Wellman, his collection of Dianthœcia and Acidalia, also a drawer of *Cidaria russata*, bred and captured from various parts of Great Britain, a most interesting drawer as showing local variation. Mr. F. W. Hawes, Rhopalocera, reared in 1890 and 1891, chiefly from ova obtained by searching or from the captured female, thus enabling Mr. Hawes to ascertain the early life-histories of this group; among them were examples of *Hesperia lineola*, the species recently added to the British list by Mr. Hawes. Variation in *Arctia caia* was shown by Mr. Goldthwait, Mr. T. W. Hall, and Mr. A. Mera. Mr. C. H. Williams included in his series a gynandrous specimen of *Argynnis paphia* taken by him last summer in the New Forest, and much attention was paid to this beautiful specimen. Life-histories, the larvæ being mounted on

the natural food-plant, were shown by Mr. J. A. Simes, Mr. A. Quail, and Mr. A. J. Croker, the latter gentleman's *Phoroaesma smaragdaria* being especially noticeable. Mr. R. Adkin exhibited a collection of British Sphinges and Bombyces, arranged with a view to showing local variation, such variation being well defined in some of the species of the genus *Spilosoma*. Also a collection of Macro-Lepidoptera made at Rannoch, Perthshire, in 1891, illustrating an article on the local variation prevailing in that district recently contributed to the *Entomologist*. Mr. Tutt, extremely long and variable series of Noctuæ. Mr. Machin four drawers from his cabinet; among the rarer species were *Dicranura bicuspis* and *Drepana sicula*.

In the third room there was a large exhibit of marine Mollusca, by Mr. Conisbee. Mr. Step's exhibit of living Mollusca afforded a capital opportunity for comparing the mollusks as well as their shells. Between thirty and forty species were thus shown, each in a separate glass, and ranged from the substantial *Helix pomatia* to the graceful *Clausilia rugosa* among land snails; and from the large *Anodons* to the fragile *Planorbis linentus* among the aquatic species. Pond life was shown by Mr. Perks; living newts, &c., by Mr. R. Adkin, Jun.; and living snakes, &c., by Mr. Gee. A gigantic sponge was exhibited by Mr. Kedgley.

In a fourth room Mr. Reeves exhibited and explained an original set of diagrams, showing the correct positions of horses' legs while walking, trotting, and galloping, and to demonstrate their correctness the diagrams were transferred to a zoëtrope.

A large room was set apart for lectures, and during each evening crowded audiences listened to Mr. F. Enock, who lectured on "The Life-history of the British Trap-door Spider." The lecture was illustrated by Mr. Enock's original micro-photographic slides, shown by means of the oxy-hydrogen lantern. Mr. E. Step's "Talk about Toadstools" was listened to attentively on each evening. The figures thrown on the screen were from Mr. Step's own photographs and drawings. A third lecture was given by Mr. George Day, illustrated by micro-photographic slides, entitled "Domestic Friends and Foes."

IMÈRINA, THE CENTRAL PROVINCE OF MADAGASCAR.

ON Monday evening the Rev. James Sibree read a valuable paper on Imèrina, the central province of Madagascar, before the Royal Geographical Society. After an account of the work of recent explorers, of whom the French surveyors, MM. Catat and Maistre, and the English missionary, Mr. Baron, are the most important, Mr. Sibree came to the main subject of his paper, of which the following is an abstract.

M. Grandidier, who is now completing a splendid atlas of Madagascar, published a map of Imèrina on the scale of 1 : 200,000 in 1880, and in 1883 an orographical map coloured according to the contour lines. The road from the port of Tamatave to Antananarivo, the Hova capital, in the centre of the Imèrina province remains a mere footpath, impassable either to wheeled vehicles or to beasts of burden; and now, as 300 years ago, porters are the only means of transport.

Imèrina ("the elevated") is bounded on the east by the steep ridge of forest-girdled mountain sloping to the Indian Ocean. The other boundaries are indistinct, and the total area of the province may be estimated at 7000 square miles. The general level of the province is from 4000 to 4500 feet above the sea. It is a mountainous region, abounding in peaks, which rise high above the breezy plateau, and marked also by many valleys. The most prominent summits are Angàvokèly to the east, Ambòhimiangàra in the extreme west, Ihàranandriàna to the south, Milangàna, Ambòhimanòa, and Andringitra more central, and Ambòhipanìry and Vòhilèna to the north. The south-west of the province is dominated by the central mass of Ankàratra, a denuded volcano of great size, its peaks forming the culminating points of the island, and reaching nearly 9000 feet above the sea. The mountain-peaks are usually granite or gneiss, sometimes occurring in great rounded bosses, sometimes in fantastically carved pinnacles resembling from a distance Titanic forts, castles, and cathedrals. Decomposed granite covers a great part of the country with thick deposits of clay, sometimes white but more often tinted deep red by ferric oxide. Iron is abundant, gold has recently been discovered, graphite, galena, copper, and other useful minerals are also found in Imèrina. The watershed of the island lies much nearer the east coast than the west, and the two chief rivers rising in the extreme east traverse the breadth of the province on their way to the Mozambique Channel. The Ikòpa, fed by the Sisaony, the Andròmba, the Màmba, and other streams, flows north-westward through the fertile plain of Bètsimitàtatra, and farther north is joined by the Bètsibòka, under which name the united stream runs on to the sea at the Bay of Bembatòka. Lake Itàsy is the only large body of water in Imèrina, and probably owes its origin to volcanic subsidence.

On account of its altitude Imèrina has a pleasant temperate climate, although lying within the tropics. The south-east trade-winds, blowing fresh and moist over the forest belt and the wooded plains of the east, make the atmosphere peculiarly bracing in the cooler season. The annual rainfall at Antananarivo is about 53 inches. Through the clear pure air distant landscapes stand out with remarkable sharpness of outline. Towards sunset Imèrina is seen in its most attractive aspect; the hills, range beyond range, assume the richest shades of purple, the sky flames with crimson and gold, and the long clay walls of the native compounds glow like streaks of vermilion.

The general aspect of the province is bare, except for patches of primæval forest in the northern districts. Moor-like hills, which would look utterly dreary but for the marvellous atmospheric effects, predominate. Near Antananarivo the dried-up bed of an ancient lake, known as Bètsimitàtatra, forms a great plain, covered with rice-fields, which support a dense population. The steep sides of the river valleys are terraced, like great green staircases, with rice-plots, where the grain is sown broadcast, and whence the young plants are transplanted in the larger fields along the river-plains and in the meadows left by dried-up lakes.

The political subdivisions of Imèrina are mainly tribal, and are used for purposes of taxation, and for the apportionment of military levies and forced labour. No census has been taken, but an estimate based on the number of villages and houses justifies the estimate of the population at about 1,100,000. Except Antananarivo, there are only small villages in the province, but these are clustered very closely together, especially to the north and north-west of the capital. Several of these were formerly tribal capitals, and Ambòhimànga still retains nominal equality with Antananarivo in royal speeches. The old villages were always built on hills for purposes of defence, and surrounded by double or treble lines of fosses and embankments dug out of the hard red clay. A narrow bridge of the red clay leads to the gateway, which is formed of blocks of rock, either a circular slab 10 or 12 feet in diameter, which was rolled between upright gate-posts so as to block the way, or massive upright monoliths bearing strong wooden gates. In recent times the Hovas have largely deserted these fortresses, and built themselves villages close to the rice-fields. Graves of the aboriginal Vazimba are scattered over the province, but local feeling prevents any examination of these from being made.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, May 2.—M. d'Abbadie in the chair.—The movements of minute organisms analyzed by means of chronophotography, by M. Marey. Using an arrangement described in the *Revue Générale des Sciences* in November last, and in NATURE, vol. xlv. p. 228, M. Marey has obtained photographs of the movements of blood corpuscles in the capillaries, and has analyzed the movements of zoosphores in the cells of a Cladophora. Enlargements from these negatives have been presented to the Academy. By taking a series of pictures at intervals of about one-tenth of a second, and projecting them upon a screen at about the same rate, the effect of the real motions of the object can be reproduced. The arrangement for doing this will be described in a future communication.—Observations of Swift's, Denning's, and Winnecke's comets, made at Algiers Observatory with the *coudé* equatorial, by MM. Rambaud and Sy. Observations of position are given.—On the approximation of functions of very large numbers, by M. Maurice Hamy.—On the tautochronism in a material system, by M. Paul Appell.—On the laws of electrolysis, by M. A. Chassy. When a substance having the formula M_pR_q is electrolyzed, M designating an electro-positive and R an electro-negative radicle, one equivalent of the radicle R, and $\frac{p}{q}$ equivalents of the radicle M

are disengaged when one equivalent of hydrogen is set free in a voltameter included in the circuit. Wiedemann and others have found exceptions to this law, for in the case of some salts, $\frac{q}{t}$ equivalent of the radicle R and one equivalent of the other radicle are disengaged. M. Chassy proposes to substitute the following law for those previously enunciated, all cases being included in it: "Lorsqu'on électrolyse une substance quelconque il se dégage toujours l'équivalent d'hydrogène ou la quantité correspondante du radical électropositif."—A new case of abnormal solution: saturated solutions, by M. F. Parmentier. The author finds that the solubility of ethyl bromide in ether decreases rapidly with increase of temperature.—The occurrence of fluorine in different varieties of natural phosphates, by M. Ad. Carnot. From the results of the analyses of a number of sedimentary phosphates it is concluded that in the sedimentary phosphates the proportion of fluorine is sensibly equal to that in apatites having an equal percentage of phosphorus. Phosphorites of fibrous, semi-crystalline structure have almost the same composition as crystallized apatites. Earthy or compact phosphorites contain a less proportion of fluorine. Concretionary, zoned, and mammillated phosphorites contain barely any fluorine.—Estimation of small quantities of carbon monoxide by means of cuprous chloride, by M. L. de Saint-Martin.—Thermal study of the value of the replacement of hydrogen in phenolic hydroxyl, by M. de Forcrand. C_6H_6O sol. + Na sol. = C_6H_5 . ONa sol. + H gas . . . . + 39·10 cal. This is practically the mean value for the replacement of H by Na in tertiary alcohols and acids, for $\frac{27{\cdot}89 + 50{\cdot}17}{2} = + 39{\cdot}03$.—On an ethylnitroketone and an acetylnitroketone derived from camphosulphophenols, by M. P. Cazeneuve.—Determination of the surface of ebullition of normal paraffins, by M. G. Hinrichs.—Action of pyridine bases on certain sulphites, by M. G. Denigès. Compounds of the type SO_3M'', C_5H_5N have been obtained and examined.—Preparation and physical properties of acetyl fluoride, by M. Maurice Meslans. (See Notes).—Diamidophenyl sulphone and some of its derivatives, by M. Ch. Lauth.—Colouring matters and azo and alkyl compounds derived from chrysaniline, by MM. A. Trillat and De Raczkowski.—On a soluble naphthol derivative, by M. Stackler.—Remarks on some fishes from Upper Tonkin, by M. Léon Vaillant.—On *Cerataspis petiti*, Guérin, and on the systematic position of the species *Cerataspis*, Gray (*Cryptopus*, Latreille), by MM. A. Giard and J. Bonnier.—On an embryological law for the orders *Rhabdocœlida* and *Triclada*, by M. Paul Hallez.—On the circulation of the blood in young spiders, by M. Marcel Causard.—On the discovery of *Bactryllium* in Meurthe-et-Moselle Trias, by MM. Bleicher and P. Fliche.—Applications to normal physiology and pathology of the temporary loss of the activity of tissues by local cocainisation, by M. C. A. François-Franck.—Observation of a meteor, by M. L. Simon (extract from a letter to M. Wolf). The meteor was observed on April 24, at 11h. 55m. in the evening. It moved from east to west at an altitude of about 70° or 80°.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MAY 12.

ROYAL SOCIETY, at 4.30.—Transformers: Prof. Perry, F.R.S.—On the Probable Effect of the Limitation of the Number of Ordinary Fellows elected into the Royal Society, to Fifteen in each Year, on the Eventual Total Number of Fellows: General Strachey, F.R.S.—On the Shoulder-girdle in Ichthyosauria and Sauropterygia: J. W. Hulke, F.R.S.—On the Embryology of Augiopteris evecta (Hoffm.): J. B. Farmer.—Note on Excretion in Sponges: G. Bidder.—On the Development of the Stigmata in Ascidians: W. Garstang.

MATHEMATICAL SOCIETY, at 8.—On an Operator that produces all the Co-variants and Invariants of any System of Quantics: Dr. W. E. Story.—Applications of a Theory of Permutations in Circular Procession to the Theory of Numbers: Major MacMahon, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on the Light of the Electric Arc: A. P. Trotter. (Discussion.)—On the Cause of the Changes of Electromotive Force in Secondary Batteries: Dr. J. H. Gladstone, F.R.S., and W. Hibbert.

INSTITUTION OF CIVIL ENGINEERS.—Students' Visits to the Beckton Gas Works, the Northern Outfall Sewer, the Victoria and Albert Docks, and the P. and O. s.s. *Oceana*. Leave Fenchurch Street at 9.18 a.m.

ROYAL INSTITUTION, at 3.—The Chemistry of Gases: Prof. Dewar, F.R.S.

FRIDAY, MAY 13.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—An Instrument for Drawing Parabolas: R. Inwards.—Some Electrical Instruments: F. H. Nalder.—An Instrument for Measuring Magnetic Fields: E. Edser and H. Stansfield.

INSTITUTION OF CIVIL ENGINEERS.—Students' Visits to Woolwich Arsenal, the Works of the London Electric Supply Corporation at Deptford, and the Tower Bridge. Leave Charing Cross at 9.40 a.m.——At 7.30.—Students' Annual Dinner at the Holborn Restaurant.

ROYAL INSTITUTION, at 9.—The New Star in Auriga: Dr. William Huggins, F.R.S.

AMATEUR SCIENTIFIC SOCIETY, at 7.—Exhibition of Objects of interest.——At 8.—Recent Additions to Botanical Science: L. A. Boodle.—The Copper Production of North America: W. Semmons.

SATURDAY, MAY 14.

ROYAL BOTANIC SOCIETY, at 3.45.

ROYAL INSTITUTION, at 3.—J. S. Bach's Chamber Music (with many Musical Illustrations): E. Dannreuther.

MONDAY, MAY 16.

VICTORIA INSTITUTE, at 8.—On Primitive Man: Sir W. Dawson and Rev. J. Mello.

TUESDAY, MAY 17.

ZOOLOGICAL SOCIETY, at 8.30.—On the Geographical Distribution of the Land-Mollusca of the Philippine Islands: Rev. A. H. Cooke.—Resultats des Recherches Ornithologiques faites au Pérou par M. Jean Kalinowski: Graf Hans von Berlepsch, C.M.Z.S., and M. Jean Stolzmann.—On Lucioperca marina: G. A. Boulenger.—On the Antelopes of the Genus Cephalophus: Oldfield Thomas.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Distribution and Measurement of Illumination: A. P. Trotter. (Discussion.)—The Measurement of High Temperatures: Prof. W. C. Roberts-Austen, F.R.S.

ROYAL INSTITUTION, at 3.—Photography in the Colours of Nature: Frederick E. Ives.

WEDNESDAY, MAY 18.

ROYAL METEOROLOGICAL SOCIETY, at 7.—Results of a Comparison of Richard Anémo-Cinémographe with the Standard Beckley Anemograph at the Kew Observatory: G. M. Whipple.—Rain-drops: E. J. Lowe, F.R.S.—Levels of the River Vaal at Kimberley, South Africa, with Remarks on the Rainfall of the Watershed: W. B. Tripp.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Organs of Oviposition in certain Cattle Ticks: R. T. Lewis.—The Penetrating Power of the Microscope: E. M. Nelson.—The Rings and Brushes of Crystals: E. M. Nelson.

THURSDAY, MAY 19.

ROYAL SOCIETY, at 4.30.

CHEMICAL SOCIETY, at 8.—Magnetic Rotation of some Acetyl Derivatives: W. H. Perkin, F.R.S.—Studies on Isomeric Changes, No. IV.; Halogen Derivatives of Quinone, Part I.: A. R. Ling.—Note on Diastatic Action: E. R. Moritz and T. A. Glendinning.—Formation of the Hydrocarbon $C_{18}H_{12}$ from Phenylpropionic Acid: Dr. Kipping.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

ROYAL INSTITUTION, at 3.—The Chemistry of Gases: Prof. Dewar, F.R.S.

FRIDAY, MAY 20.

ROYAL INSTITUTION, at 9.—Electro-Metallurgy: J. Wilson Swan.

SATURDAY, MAY 21.

ROYAL INSTITUTION, at 3.—J. S. Bach's Chamber Music (with many Musical Illustrations): E. Dannreuther.

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