THURSDAY, MARCH 24, 1904.

DIVERS MEN AND MATTERS.

Essays and Addresses, 1900–1903. By the Right Hon. Lord Avebury, P.C. Pp. 296. (London: Macmillan and Co., Ltd., 1903.) Price 7*s.* 6*d.* net.

INCLUDED in this volume are short studies of the life and work of Huxley, Ruskin, Richard Jefferies, and Macaulay; speeches on the institution of Bank Holidays, and the Early Closing Bill for Shop Assistants; three papers on trade and commerce; three addresses on education; and three other papers.

The first paper gains in interest from Lord Avebury's personal acquaintance with Huxley. The author gives an appreciation of the man as well as of his work. They were associated in the foundation of the Anthropological Institute, on commissions on scientific instruction, in the Metaphysical Society, and as members of the X Club, which included also Hooker, Spencer and Tyndall. Lord Avebury deals with Huxley's work in natural science, in education, and in metaphysics. Huxley was foremost in showing the fascination of scientific study. As Sir Michael Foster says, "Whatever bit of life Huxley touched—and there were few living things he did not touch—he shed light on it and left his mark." As to education, Huxley was a member of the first London School Board, where he made valuable suggestions as to the moral, physical and domestic, as well as to the intellectual and scientific training of the young. His attitude is well illustrated by his saying, "Teach a child what is wise—that is morality; teach him what is wise and beautiful—that is religion." In the Metaphysical Society, Huxley had difficulty in ranking himself. "Most of my colleagues were 'ists' of one sort or another; and, however kind and friendly they might be, I, the man without a rag to cover himself with, could not fail to have . . . . uneasy feelings. . . . So I took thought, and invented what I conceived to be the appropriate title of agnostic." He described his position as being "Not among fatalists, for I take the conception of necessity to have a logical, and not a physical, foundation; not among materialists, for I am utterly incapable of conceiving the existence of matter if there is no mind in which to picture that existence; not among atheists, for the problem of the ultimate cause of existence is one which seems to me to be hopelessly out of reach of my poor powers."

It may not have been possible to deal fairly with the work and personality of so many-sided a genius as Ruskin in one short lecture, but it was surely unnecessary to have spent so much care in showing the inconsistencies and paradoxes with which Ruskin delighted to adorn his writings, to the exclusion of his positive and essential teaching; and Lord Avebury himself asserts that the spirit of the critic, always of more importance than the letter, is true and noble. Fortunately, Ruskin's attitude towards art is not dealt with, but the paper is completed with some of Ruskin's exquisite descriptions of plants, animals, water and mountains.

The paper on Richard Jefferies is appreciative and interesting, and it is a happy conjunction that he is placed after Huxley and Ruskin. While Huxley compelled Nature to yield her secrets to his analysis, and Ruskin depicted her with his marvellous skill as a word-painter, Jefferies approached her with the passionate rapture of a lover, and lived with her in intimate study of all her secret moods.

But perhaps Lord Avebury is more interesting in his capacity of social reformer than as literary critic. He gives the history of the initiation of Bank Holidays, and dwells on the advantage of the uniformity which allows members of one family scattered in different occupations a possibility of periodic reunion. The plea for legislation for early closing, which follows, is forcible and convincing; the general need and demand for shorter hours is evident, and so is the impossibility of any sufficient reform on voluntary lines.

In the paper on British commerce, written before the fiscal controversy became acute, Lord Avebury supports the optimistic view that we have made rapid progress, and that there is no "reason for despondency or discouragement" as to the future, if we improve our national education, practise economy in national expenditure, and improve the relations between capital and labour. As regards the last, however, he does not get beyond the somewhat obvious remark that "In the interests alike of employers and employed it will be well if wiser and more conciliatory counsels prevail in the future." In dealing with fiscal policy, Lord Avebury has many telling illustrations of the advantages of free trade, and gives some very important evidence as to the difficulties which Germany finds in the Kartell system; but his paper will not be in any way convincing to the advocates of an Imperial fiscal policy, for he does not come to close quarters with their ideas and arguments. The paper is loose both in style and logic; what are we to think of a writer who holds that Canada's preference to us is a dominant cause of the migration from the United States to the North-West Provinces. "I am very pleased to see that Canada has herself benefited by the reduction. Our trade has increased 3,000,000*l.* with Canada, and the result to Canada has been that her people have got an increased supply of cheap goods, her agriculture has benefited, farmers are flocking in from the United States."

The eleventh paper is an attack on municipal trading. It is not possible to deal with so highly controversial a subject in our present space. The most is made of the difficulties, risks, dangers and possible loss when municipalities undertake work which private enterprise could do as well, and these will be admitted by most unprejudiced students; but no real help is given to the very real difficulty of laying down principles which should govern municipal action. Such a paragraph as follows hardly shows a scientific view of a complicated economic problem:—

"As regards the telegraphs, it is sometimes said that though we have paid dearly for it, at any rate we have a more effective system. This is, of course, a matter of opinion, but I doubt it. My belief is that competition would have given us a better system. This cannot be proved, but I may give an illustration . . . ."

The papers on education derive interest from Lord Avebury's position on three commissions and in the University of London, and form a strong and convincing argument in favour of the increased attention to science which we may hope is gradually finding place; they are marked by the aptly selected quotations for which readers of "The Pleasures of Life" are prepared.

When a writer publishes essays on so wide a range of subjects, he deliberately invites criticism; and, indeed, readers of this volume will ask in several cases whether this or that address was worth printing. But if the papers are not taken too seriously, much will be found of interest, if little that is new. The book resembles the modern daily paper in many other respects; there is a wide range of ideas, something for everybody, much hasty writing, and frequent repetition of the same items in different guises.

IN SEARCH OF TRUTH.

Humanism: Philosophical Essays. By F. C. S. Schiller, M.A. Pp. xxvii+297. (London: Macmillan and Co., Ltd.; New York: The Macmillan Company, 1903.) Price 8*s*. 6*d*. net.

Ueber die Grenzen der Gewissheit. By Dr. Ernst Dürr. Pp. vii+152. (Verlag der Dürr'schen Buchhandlung, 1903.) Price 3.50 marks.

Tat und Wahrheit. Eine Grundfrage der Geisteswissenschaft. By Hans von Lüpke. Pp. 35. (Leipzig: Verlag der Dürr'schen Buchhandlung, 1903.) Price 50 pf.

Proceedings of the Aristotelian Society. New Series. Vol. iii. (London: Williams and Norgate, 1903.) Price 10*s*. 6*d*.

THE collection of articles and addresses presented in Mr. Schiller's volume exhibits all the characteristics familiar to readers of his previous work. Paradox is, of course, not wanting; humour enlivens discussion, not shrinking from the antithesis of "comic" and "cosmic," or such a phrase as "ponderous pondering"; philosophy, literary criticism, and the Psychical Research Society are duly represented. Mr. Schiller's style incurs one great disadvantage: it sometimes leaves the reader in doubt whether the matter is really to be taken seriously; perhaps this is why Mr. Schiller has still to complain that philosophers neglect his imperatives.

The keynote to the book is pragmatism, and the essays here collected may claim the unity of this one theme. The parts vary considerably both in quality and subject. The essay in literary criticism, "Concerning Mephistopheles," may claim a first place; it is interesting, novel and lucid, in short, our author at his best. The first eight essays, dealing with some of the most vexed questions of philosophy, have common characteristics and equal value. Mr. Schiller triumphs in destructive criticism; the common-sense element of pragmatism is, in his hands, a powerful weapon against extravagances not unknown in recent philosophy; pragmatism is thus justified as a tonic; if we object that man does not live by tonics, we are again victims of a triumph, for a collection of essays is not a system and not open to a systematic criticism. The essay on "Reality and 'Idealism'" illustrates the first point; for the second, let the dialogue on "Useless Knowledge" plead its occupancy of space. One of the most satisfactory essays is "Darwinism and Design," and "Pessimism" is a subject which, directly and indirectly, inspires some of the best passages in the book. The closing sections on "Immortality" would call for no remark except that such a subject too often attracts the uncritical; even they will probably think Mr. Schiller's concept of "spirit" might have been definitely explained, while his admission that the "state after death" does not form a part of the experience of any subject in the sense that "real" and "dream" states do, might well have excused not a few of the closing pages. One thing more is also a desideratum: that concept of "purpose" on which pragmatism bases its claim to rejuvenate philosophy must be elaborated; for this we wait, not without fasting, taking the present contribution as earnest of the systematic exposition which the introduction seems to promise.

As the title denotes, Dr. Dürr's book deals with the question of boundaries, consequently it is critical rather than constructive, negative rather than positive. The central problem is, How much may be called certain? and, from the author's point of view, the immediately given is alone fully certain. The immediately given is the psychical actuality. But we cannot rest in this; problems arise which compel us to make distinctions; even consistency cannot ensure "reality," for dreams may be consistent and yet life is more than a dream.

It appears then that the necessity of the immediately given coexists with a necessity for that which is not immediately given, but that which is not immediately given has not certainty—it is the object of belief and is not justified by any formal logical proof, but by the worth which attaches to our conception of it. Realism, for example, is without proof, but it is right as against anti-realism by virtue of its superior value as a basis for science.

Having thus found belief at the very roots of science we may consider some belief to have some certainty; we may further show that other beliefs, ethical and metaphysical, are not less certain than this scientific belief, and with that the limit of our author's work is reached. The result is a defence of belief against some, and only some, attacks. It might be objected that the ethical belief cannot be defended by proving it not less valuable than the scientific belief without giving the concept of value an ambiguous significance. The preliminary discussions on "Erkenntnistheorie" and the question of a "Kriterium" contain much interesting criticism; but the subsequent justification of belief seems built on inadequate foundations.

The subject of Herr Lüpke's little book is the significance of genius; the basis from which the subject is developed is the work of Eugen Kühnemann. The exposition of Kühnemann's importance is combined with original suggestions, but the author admits that no exact distinction between these parts can be made. The point selected for emphasis is the method adopted by Kühnemann of studying thought in a concrete way; to understand a thinker we must study the life-history of his thought, exposing the soil and climate of its growth. This scientific analysis has been applied by Kühnemann in his works on Socrates and Herder. The result is a more adequate recognition of personality as the object of Geisteswissenschaft and a clearer idea of the meaning of personality. From this certain deductions follow. Genius means the ability adequately to express oneself; it implies a penetration into the very depths of our own being—and, consequently, a power to reach the depths common to all humanity. In both aspects, whether of the method by which we interpret the thought or of the manner in which the thought expresses the being of the thinker, it is equally true to say that thus the word becomes flesh.

The author is here very much in touch with the significance which recent writers in Germany give to the term "Geisteswissenschaft." He has a further interest in relating this movement to theology and the progress of scientific theology. The point that in the life of genius the word becomes flesh, indicates the direction in which we are to look for the expected development. The author makes the noteworthy remark that the battle for a God is not to be fought in the sphere of natural science, but in this study of personality. Though brief, the essay is singularly suggestive.

The published proceedings of the Aristotelian Society are always of considerable interest. If comparison is permitted, the contributions to this number seem more than usually interesting, while the whole series is pervaded with an atmosphere of life and activity. The first paper is an able criticism of "Mr. Bradley's Theory of Judgment" by Prof. Stout, whose work Dr. Bosanquet rightly says is "always thorough and of the highest scientific quality." The essay on "The Logic of Pragmatism" (Henry Sturt) is a timely contribution on a subject that at present stands in some need of complete exposition. Prof. Latta's treatment of "The Significance of the Sub-conscious" is a distinctly helpful contribution, marked by a lucidity too rarely associated with his subject; a little infusion of this same quality would have achieved something toward making the contribution of another writer ("Experience and Empiricism") more intelligible.

In all there are eight papers, and all are worth reading. In view of the quality of the work, it seems a pity that the Society should have to record a decrease in membership. This is certainly "matter for regret," and however much the spirit of the times is opposed to the speculative life, there must be many students of philosophy who do not support the Society; to such this volume should be an eloquent proof of the advantages of cooperation in the search after truth. G. S. B.

PEAKS AND PASSES OF GREECE.

Vacation Days in Greece. By Rufus B. Richardson, formerly Director of the American School of Archæology, Athens. Pp. xiii+240; illustrated. (London: Smith, Elder and Co., 1903.) Price 7*s*. 6*d*.

THE genial personality of the late director of the American School at Athens is known to everyone who has made any long stay in the capital of Greece during the past five years and more. No foreign resident, except, perhaps, Dr. Dörpfeld, had wider personal knowledge of the Hellenic peninsula than Mr. Richardson. Certainly none had pushed a bicycle over so many stony passes, or scaled half as many storied peaks. He made mountain-climbing a speciality of the American School, so much so that climbing of all kinds became a passion of the students; and while one risked life and limb on the Acropolis precipice to rediscover inscriptions once read by Wordsworth in the face of the Kimonian walls, another swung himself over the eastern pediment of the Parthenon to decipher by the print of the nails the dedication whereby a Roman emperor had aspired to appropriate the credit of the temple. In the pleasant volume before us Mr. Richardson describes two ascents, those of the highest peaks of Taygetus and Kióna, the less known twin of Parnassus, which overtops by about two hundred feet all other summits on Greek soil. But he alludes to many others, *e.g.* those of Parnassus itself and Aroania, and probably, with the exception of Tsumerka and the Pindus peaks, which are as much in Turkey as Greece, he has stood on every one of the mountain giants of free Hellas.

Despite Mr. Richardson's enthusiasm for the bicycle, few visitors, we suspect, will be convinced that it is the best vehicle for touring about Greece. A comparatively freshly laid road in the Hellenic kingdom is good enough, but very few are freshly laid, and an old road can be appalling. Then there are the dogs, and the impossibility of obtaining skilled surgery for the wheel outside Athens itself, and the chance of an occasional row with some rustic, whose dog you have had to stone, or whose mule has stampeded at sight of you. Nevertheless, given a light and inexpensive American machine, one may certainly get over most unpromising ground with it, and cover great distances in the day, freed from the intolerable irksomeness of sitting a Greek baggage-animal. Mr. Richardson's account of his three days' run from Athens to Thessaly is exhilarating reading; but did he really see Olympus from Cithaeron? Was it not rather some snowy part of Othrys or Pindus? The interval, from the point on which he was standing, to the seat of the gods, is not less than one hundred and fifty miles as the crow flies, and there are many intervening heights.

Mr. Richardson is careful to suppress archæological "shop," and to preserve the holiday atmosphere. Therefore, although he gives a glimpse of M. Kabbadias at work at Epidaurus, and alludes to the French excavations at Delphi, his own at Corinth, and others, his book is to be read, not for its information about these, nor, indeed, for scientific information of any sort, but for its revelation of the matchless mountain and marine scenery of Greece, Sicily, and the Adriatic coast, for its breaths of an intoxicating air, and for the side-lights it throws on Greek peasant interiors and a rural life, which few foreigners have seen as often, and known as intimately, as our author. He shows himself typically American, restless, strenuous, adventurous, claiming the right to go everywhere and do everything, within the physical capacity of a man, but at the same time in singular sympathy with a land and people so little like his own. The book is very pleasant reading for all who know Greece, and should serve to excite many, who do not, to visit one of the loveliest lands on earth. D. G. H.

OUR BOOK SHELF.

Ueber verschiedene Wege phylogenetischer Entwickelung. By Prof. O. Jaekel, Berlin. Pp. 60; 28 figures. (Jena: Gustav Fischer, 1902.) Price 1.50 marks.

THERE are three dominant ideas in this notable essay, each requiring for the exposition it merits more space than our limits admit of.

(1) Besides the gradual changes with which we are all familiar, there have been what Galton called "transilient" transformations ("saltatory variations," "sprungweise Umbildungen"). By individual variation within one generation or within a few generations, certain animal organisms have undergone profound transformations, comparable to the "mutations" described in plants by Korschinsky and de Vries. This is an important conclusion, the evidence for which is palæontological. Prof. Jaekel distinguishes what may be called three grades of variation:—(*a*) the so-called normal range of variation, changes in the proportions and correlations of the structural architecture, limited in final result by the conditions of inter-crossing; (*b*) abrupt deviations which transcend the limits of structural correlation and cannot be harmonised with the organic unity, which are therefore called "anomalies" or pathological aberrations from the evolutionary trend of the species; (*c*) transilient deviations or mutations which bring about a new system of correlations, what others have called "a new position of organic equilibrium," and lead to the origin of a new "form" in various degrees removed from the original type.

(2) Prof. Jaekel endeavours to draw a sharper distinction than has hitherto been made out between the origin of a species and the emergence of a new structural "form." The origin of a species is a consequence of some form of reproductive isolation (Kreuzungsausgleich)—of a restriction in inter-crossing, of an alteration in the radius in mutual fertility; but the structural differentiation which leads up to a new "form" is a very different, and it may be much more important matter.

(3) The third, and perhaps the most essentially new contribution which Jaekel makes to the interpretation of structural transformations, is that he does not regard these changes as arising by the summation of the qualities of adult forms, but as due to inhibitions or accelerations of development in the juvenile plastic stages. Each individual ontogeny is a re-creation of the inherited "Stammform," with a plastic period in which new adjustments may arise.

While we have indicated the three most conspicuous ideas in this essay, we have done it scant justice. It expresses the views of an expert palæontologist in regard to the mechanism of evolution, and is full of originality and suggestiveness. The illustrations in evidence are chiefly drawn from crinoids, brachiopods, and trilobites. We venture to express the hope that the author will expand his essay into a book, in which he may condescend to be a little less terse. J. A. T.

Ausgewählte Methoden der analytischen Chemie. By Prof. Dr. A. Classen and H. Cloeren. Pp. xvi+831. (Brunswick: Vieweg und Sohn, 1903.) Price 20 marks.

THIS is just the kind of book to which an analyst will turn with pleasure. It is well bound, well printed, and really beautifully illustrated. It contains, moreover, a good account of recent methods or improvements in old ones, with the necessary details and manipulative *Kunstgriffe* which in analysis often means the difference between failure and success.

The subjects which are included in the volume are the estimation of the common gases, water analysis, which is fully treated, the analysis of hydrogen peroxide, ozone, explosives, the common compounds of carbon, sulphur, phosphorus, boron and silicon, the cyanides, concluding with a chapter on organic analysis.

It would seem ungenerous to try to discover omissions or to offer criticisms when the authors have given so much, and with such evident care and thoroughness. But the book has one weak point which is common to many books of this class. The authors have not submitted all the methods they describe to personal revision (indeed, it would be difficult to do so without the expenditure of a good deal of labour), but there is no doubt that such a critical examination, which would help the reader to a choice of his method, would greatly add to the value of the volume.

However, the important point for the analyst is that he has in his possession the most recent information from a variety of sources which has been collected and sifted by a discriminating authority on analytical matters.

In looking through the volume it is evident that the analytical work of recent years has lain rather in the perfecting of existing methods than in the discovery of new ones. This seems only natural; for although new technical processes are constantly coming into operation, the number of new reagents does not increase *pari passu*, and it follows, therefore, that the demands made upon rapidity and accuracy in technical analysis have to be met by the skilful adaptation of old processes to new needs.

An interesting illustration of this is Emmerton's new method for estimating phosphorus in iron, described in the appendix to this volume. Phosphorus has always been precipitated as phosphomolybdic acid, and the precipitate either measured or weighed. The drying of a precipitate always means a loss of time. By the new method the precipitate is not dried, but reduced with zinc and sulphuric acid, and the lower oxide of molybdenum which is formed is titrated and estimated with permanganate. J. B. C.

O'Gorman's Motor Pocket Book. By Mervyn O'Gorman. Pp. ix+287. (Westminster: Archibald Constable and Co., Ltd., 1904.) Price 7*s*. 6*d*. net.

IT is not surprising to find that at last a "motor" pocket book has appeared; in fact, it is a wonder such a work has not appeared sooner. Engineers have long had their "Molesworth," and now the motorist can lay claim to his "O'Gorman" when in trouble or in doubt.

This interesting and instructive book is alphabetically arranged, thus rendering easy the finding of any particular item of information required. Our author has a breezy style of expression which adds largely to the pleasure of reading the book. Take, for instance, his treatment of that all-important worry of the motorist, the "police." Mr. O'Gorman says, "to pass unchallenged at a speed in excess of the legal limit—a thing which is daily accomplished by carts, hansoms, and even by the London omnibuses on almost every run when the gradients favour them—and by almost every other vehicle everywhere—remember that by sitting upright with a calm face (on a quiet car) you produce no impression of speed except on turning a corner. If you turn a corner without being able to see down the road you are entering at over 20 miles per hour you deserve to be punished. If, however, you stoop forward (this gives the impression that you are withstanding and endeavouring to avoid a high wind pressure), jamb your hat over your eyes, screw up your face, stare intently and anxiously, do a great deal of steering with visible swinging of your body, blow your horn in such a manner as to say 'Get out of my way' frequently, instead of pressing it slowly and peaceably, you will invariably be arrested. I think a couple of good actors could safely wager to be stopped by an otherwise inoffensive constable at a pace of 10 miles per hour, especially if mounted on a machine the teeth of whose gear 'gave tongue' like a siren, after the manner of certain makes, they would as surely be fined."

The above description is quaint but true, as every motorist knows. On the other hand we find admirable descriptions and explanations of the all-important details of car management, design, &c. Our author's treatment of electric ignition is excellent, the accompanying diagrams being particularly clear. On the subject of accumulators we find much useful information, and, generally, the work contains those hundred and one wrinkles the knowledge of which goes to constitute the successful and trustworthy driver of a motor car, and we cordially recommend to all such the possession and careful perusal of this pocket-book.

N. J. L.

Weather Folk-Lore and Local Weather Signs. Prepared under the direction of Willis L. Moore, Chief U.S. Weather Bureau, by Edward B. Garriott. Pp. 153. (Washington, U.S.A.: Government Printing Office, 1903.) Price 35 cents.

THIS volume is divided practically into two parts, the first dealing solely with weather folk-lore gathered from many available sources, the second with summaries of local weather signs as based on special reports of observers to the chief of the U.S. Weather Bureau. The latter are arranged alphabetically as regards the names of the towns from which these reports are received, and deal for the most part with the prospect of fair or foul weather as indicated by the appearance of clouds, direction of wind, movements of barometer, &c. In fact, weather-folk-lore, as such, is naturally conspicuous by its absence. This portion of the work will not be of much interest to Britishers, as the signs only hold good for the particular parts of the country in question. The first portion, on the other hand, is of more general interest, as many of the quaint sayings were, so far as can be judged, the results of observation of long experience. The subject is subdivided under several different titles, according as the weather was foreshadowed by wind, barometer, clouds, humidity, temperature, &c., or by the peculiar effects of these on objects animate or inanimate. Many curious sayings, probably unfamiliar to British readers, are here collected, but one, with regard to the effects of atmospheric moisture that precedes rain, is rather gruesome. "When the locks turn damp in the scalp house surely it will rain" (American Indians).

Reference is also made to the moon as a weather prophet, to many weather proverbs of a miscellaneous kind, and to recent work on possible long-range weather forecasting.

The book concludes with a series of charts which illustrate the local weather signs as observed at regular stations of the Weather Bureau.

W. J. S. L.

The Principles of Mechanism. By Herbert A. Garratt. Pp. viii+166. (London: Edward Arnold.) Price 3*s.* 6*d.*

IN this book the author has brought together his notes of lectures delivered in connection with a course of instruction in mechanism at the Northern Polytechnic Institute, Holloway. The work is divided into two parts, dealing respectively with the kinematics and the dynamics of machines.

These notes are no doubt valuable to the compiler and useful to the students under his charge, but they seem too fragmentary to be of much service to the general reader. The descriptions of the various mechanisms are concise and to the point, but the mathematical treatment, where given, is often unsatisfactory. Moreover, there is sometimes a want of perception of the relative importance in the several items which have been introduced. Thus in the second chapter, dealing with circular and straight line motion, the fundamental subject of simple harmonic motion is not properly defined, and is dismissed with a meagre treatment extending only over one page, whilst nearly three pages are devoted to the comparatively unimportant problem of finding the crank position which corresponds with the maximum piston velocity in a steam engine, answers being given in degrees, minutes and seconds. Special constructions for velocities and accelerations such as Mohr's and Klein's are given, but these are not well explained, and the reasoning is difficult to follow; the author seems to be unaware of the fact that he is here dealing with vector quantities.

In chapter iii. the treatment of wheel teeth seems unsound. The chapter is somewhat redeemed by descriptions of gearing chains for cycles, and modern machines for cutting worm wheel teeth and bevel wheel teeth. A number of valve gears are described in chapter iv., with some applications of the Zeuner valve diagram.

Part ii. opens inauspiciously, for in the first chapter, which enunciates the general principles that are to guide the student, power and work are confused with one another, and an equation of energy is written down which involves the addition of power and kinetic energy as if they were quantities of like kind. This part includes a casual treatment of speed regulation as affected by fly wheels and governors, one or two problems on balancing, water motors, and friction. Two useful examples of axial flow turbines, with numerical data and good diagrams, are given, the information being supplied to the author by Messrs. Günther and Sons, of Oldham.

Calculating Scale, a Substitute for the Slide Rule. By W. Knowles, B.A., B.Sc. Pp. 29. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1903.) Price 1*s.* net.

IN this book the author provides and explains the use of two graduated scales, placed adjacent to each other for comparison and fixed together, on one of which numbers can be read off, and on the other the logarithms of the numbers, or *vice versâ.* This compound scale is 100 inches long, and is cut up into twenty lengths, printed in successive columns, and occupies four pages of the book. This comparatively great length enables three significant figures to be read off directly from the scale divisions and subdivisions, while a fourth figure can be estimated. The author claims that computations can be made with a degree of accuracy equal to that obtained by the use of four-figure log tables, and with less trouble. We suspect, however, that few would be found who would allow this claim, or be willing to give up their tables for the author's plan. The title of the book is somewhat misleading; instead of a "substitute for the slide rule," the proper description would be, a substitute for tables of logarithms; the "calculating scale" is only an equivalent for the slide rule in the sense that a log table may be so regarded. We fail to see any useful purpose that this scale is likely to serve.

Practical Orthochromatic Photography. Photography Bookshelf, No. 14. By Arthur Payne, F.C.S. Pp. 178. (London: Iliffe and Sons, Ltd., 1903.) Price 1s. net.

IN these pages the author gives us an excellent account of the fundamental principles governing this branch of photography. Although he does not pretend to exhaust the subject, yet the reader will find that enough of the theory has been dealt with to enable him to obtain a good ground-work of the scientific principles for his own practical use. The ten chapters into which the book is divided treat of the advantages of this kind of photography, light, the use of the spectroscope, visual and photographic brightness, light filters, their use and effects, and other important subheads.

Not only is the letterpress clear, but the numerous illustrations are well chosen, and add to the utility of the volume. Those about to take up this branch of photography, and others who are practising it, should find this book a good guide.

Tombs of the Third Egyptian Dynasty at Reqâqnah and Bêt Khallâf. Report of Excavations at Reqâqnah, 1901–2. By John Garstang, B.A., B.Litt. Pp. 70+xxxiii plates. (Westminster: Archibald Constable and Co., Ltd., 1904.) Price 21s. net.

AFTER an introductory chapter describing the site of the excavations and the nature of the results, Mr. Garstang deals with the continuity of early history and the place of the third Egyptian dynasty in ancient history. Three chapters are then devoted to stairway tombs, to their construction, special features, and objects from them, respectively. The evolution of stairway tombs is discussed in a later chapter. Other sections of the volume are devoted to the necropolis, burial customs, burials under pottery vessels, objects from the smaller tombs, and the archæology of the third dynasty. There are thirty-three full-page plates containing a large number of good illustrations.

Worked Problems in Higher Arithmetic. By W. P. Workman, M.A., B.Sc., and R. H. Chope, B.A. Pp. vii+144. (London: W. B. Clive, 1904.) Price 2s.

THIS useful little book consists of two sections; in the first many of the difficult problems in the author's "Tutorial Arithmetic" are fully solved, while the second part, which will appeal more to teachers, comprises solutions of all the problems of Section xi. of the same work. The book should prove of value to the private student particularly, who is, we notice, warned that "but little benefit will accrue to him unless he makes it a regular practice to attempt to solve the questions for himself before reading the solutions here given."

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.]*

Blondlot's *n*-Rays.

FOR the past few months I have endeavoured to repeat some of Blondlot's measurements with *n*-rays, taking every precaution and following out closely the methods and adjustments described by Blondlot in his numerous papers which have appeared during the past year in the *Comptes rendus* of the Paris Academy of Sciences.

A Nernst lamp consuming 176 watts was used, which is described by Blondlot as emitting the rays most copiously. A variety of screens of phosphorescent calcium sulphide, some brilliantly phosphorescent, others very feebly so, were employed for the detection of the rays. The experiments were carried out in an absolutely dark room to which the eye had become accustomed by a wait of fifteen or twenty minutes, the only light visible being the phosphorescent glow of the screen. Lead screens, thickness ⅛ inch and 1/16 inch, were used to intercept the rays, and occasionally a quartz lens was used to focus them on the screen.

But in no case could any certain difference in the brilliancy of the screen be shown to be due to the presence of the *n*-rays, although the experiments were repeated many times and under varied conditions. The only observed differences in brightness could be assigned to four known causes. If initially the sulphide was fairly bright, after a while it appeared less so, owing to the natural decay of the phosphorescence. If the phosphorescence was very feeble it appeared more brilliant by indirect than by direct vision, this being a well known phenomenon in physiological optics, which has been admirably discussed in the paper by O. Lummer, of which a translation appeared in NATURE of February 18 (p. 378).

The third effect was the increase of brightness due to the increasing sensitiveness of the eye during the first few minutes spent in a dark room, and the fourth is mentioned below. Several competent observers in England and Germany have likewise obtained negative results in looking for what Blondlot describes as being so simple, and it seems advisable to direct attention in the columns of NATURE to certain experimental precautions not sufficiently observed, perhaps, by Blondlot in the course of his work.

A slight rise in temperature increases the brilliancy of the screen. Using a screen which showed no appreciable brightening under the influence of the *n*-rays from a Nernst lamp, it was found that by heating it gently, perhaps 10 or 15 degrees centigrade, without using *n*-rays at all, the brightness increases very perceptibly, possibly 50 or 100 per cent. as nearly as could be estimated by simple observation; so that efforts to detect *n*-rays may be partially vitiated by the presence of heat effects, from the body of the observer, &c., unless special precautions are taken to show that this is negligible. Mr. S. G. Brown has brought this point forward very clearly in a recent letter to NATURE (January 28).

On reading a recent striking paper by Blondlot on the index of refraction and wave-length of *n*-rays (*Comptes rendus*, January 18), one cannot, considering the experimental conditions, fail to be impressed by the extraordinary experimental skill required to carry out what Blondlot describes.

In measuring the index of refraction, a comparatively wide slit (5 mm.) was used, placed 14 cm. from the filament of a Nernst lamp. After traversing the slit, the rays passed through an aluminium prism, and were dispersed, each homogeneous pencil spreading out into a constantly broadening beam. Now in measuring the angles of deviation there would be two difficulties to be overcome. The beams become so broad, being 1 cm. wide at a distance of 14 cm. from the slit, that the intensity is greatly weakened. Furthermore, it may be shown, by using Blondlot's actual values for the indices of refraction, and calculating backwards, so as to get the angles of deviation, by the well known formula for Descartes's method, that among the total number there are at least three consecutive beams the deviations of which differ by only 1·5 or 2·2 degrees, and by making an accurate geometrical diagram it will be seen that these beams never entirely separate out from each other, but continue to overlap no matter how far one passes away from the prism. Thus under the conditions of the experiment it would hardly be possible to detect the existence of separate beams at all. Blondlot does not mention the use of a lens to focus the rays, and if one were used it would be necessary to re-focus it separately for each beam, according to the different values of the indices of refraction.

In measuring wave-lengths of light by a diffraction grating, everyone knows how enormously the intensity of the incident light is reduced in the different diffracted images, yet Blondlot was able, apparently with the greatest ease, to split up a divergent pencil of *n*-rays, coming through a slit 5 mm. wide, into eight divergent homogeneous beams by passing it through a prism, then to take only as much of one single beam as would pass through a second slit 1·5 mm. wide, having perhaps 1/50 the intensity of the original beam, and after allowing this small fraction of the whole radiation to fall on a grating, to detect the existence of, and measure up accurately, a central image and no less than twenty diffracted images, the intensity of each of which must have been considerably less than 1/1000 of the original beam. All this was done with a radiation so feeble that no observer outside of France has been able to detect it at all.

But it is questionable from another point of view whether the different diffracted images could be observed at all, at least in certain cases, under the conditions of the experiment, for the slit was quite broad, 1·5 mm., and apparently no lens at all was used to bring the spectra to a focus. The central beam and the various diffracted beams would thus continue to broaden out and become more and more diffuse. Now using the ordinary formula for a plane grating and calculating back from one of Blondlot's wave-lengths, 0·0081μ, it follows that for radiation of this wave-length the distance apart of adjacent spectral images at a distance, say, of 50 cm. from the grating would be only 0·8 mm., or considerably less than half the breadth of the central beam itself. This is with the grating mentioned as having 200 lines to the millimetre. With the grating containing 50 lines to the millimetre, the distance between adjacent spectral images would be only 0·2 mm., or less than 1/8 the width of the central beam. In other words, there would be no definition, and the broad central band, together with the broad diffracted bands, would hardly separate out at all, even using as large an angle of incidence as 75 degrees.

In measuring wave-lengths by means of Newton's rings, it is well known that the rings produced by a fairly bright source of light, such as a sodium flame, are quite faint, and a dark background is necessary in order to see them at all. Yet if we accept one of Blondlot's wave-lengths, 0·0085μ, as correct, he must have succeeded in counting up no less than 70 *n*-ray rings in the space between two adjacent sodium rings, and this by the use of a source of radiation only 1/8 the intensity of the original source, as the latter must have been split up into homogeneous beams before the rings were formed. It would be interesting to know just where the phosphorescent screen was placed in this experiment, as the rings are formed in the thin air gap between the lenses, and the eye must be focused on that point to see them sharply. But of course, the screen could not be put between the lenses, as the latter could not then be brought into close contact, and if it were placed anywhere else the rings would be somewhat blurred.

C. C. SCHENCK.

McGill University, March 10.

Escape of Gases from Atmospheres.

IN a recent number of NATURE (January 14) there appears an article on the above subject by Dr. G. Johnstone Stoney, in which he corrects a statement in the literary supplement of the *Times* of December 25, 1903, in regard to the escape of helium from the earth's atmosphere. The permanence of planetary atmosphere is of so much importance to science that I trust I may be permitted through your columns to add a word to what Dr. Stoney stated in his letter of January 14.

The problem of the escape of gases from planetary atmospheres has, as Dr. Stoney remarked, been approached by two distinct methods :—

(1) The inductive method, by taking the conditions as they appear in nature and arguing upward to results concerning our atmosphere which may then be applied to other planetary atmospheres.

(2) The deductive method, by using the laws which are acknowledged to appertain to gases under known conditions, and by assuming conditions under which these laws are known to apply for the outer stratum of our atmosphere, and to apply these laws to the escape of molecules from the atmosphere.

The first of these methods was made use of by Dr. Stoney in his memoir on "Atmosphere upon Planets and Satellites" in the *Astrophysical Journal*, 1898. In this paper Dr. Stoney argues that since helium is coming into the atmosphere at a greater rate than it is being removed from the atmosphere by natural carriers, and since it has not been proved to be increasing as a constituent of the atmosphere, it must be escaping from the outer stratum of the atmosphere, and in doing so must attain a speed of 9·27 times its mean velocity at a temperature of $-66°$ C. —the velocity that would carry it beyond the earth's attraction.

In the *Astrophysical Journal*, January, 1900, I have shown by the Maxwell-Boltzmann distribution of velocity that if we assume the outer stratum of the atmosphere to be at a temperature of 5° C. with a density equal to that at the earth's surface, and to be composed entirely of helium, only $10{\cdot}34\times10^{-4}$ c.c. of helium would be favourably situated, and would attain a velocity sufficient to escape in 10^7 years—the computed age of the earth; and also that if we assume a temperature of 66° C., the number of c.c. that would attain to that velocity would be $22{\cdot}10\times10^{-24}$, or less than a single molecule in the same length of time; while if we assume a temperature of $-180°$ C., which I believe to be much more probable for the temperature of the ultimate stratum, only $91{\cdot}6\times10^{-86}$ c.c. will escape, which, of course, means that an atmosphere of helium at normal pressure and at the average yearly temperature could not escape from the earth.

If these results, deduced from the kinetic theory under conditions to which it is generally acknowledged that the kinetic theory does apply, have any value whatever, it seems to me that they completely refute the assumption made by Dr. Stoney that helium is escaping from our atmosphere. But these results do not stand alone as evidence of the permanency of our atmosphere. Prof. Bryan by an entirely different method (see *Transactions* of the Royal Society, London, 1901) reaches the same conclusion, both in regard to hydrogen and helium.

In the *Monthly Weather Review* for August, 1902, I further discussed the probability of molecules, in a highly attenuated atmosphere, reaching velocities much greater than under normal conditions, and it is there shown that no conceivable effect could influence the results sufficiently to allow the escape of helium from the atmosphere. In further evidence of the fact that the latter view has been accepted by other writers, I may cite the work of M. E. Rogovsky (see *Astrophysical Journal*, November, 1901), who, after having published the above article, published a note in NATURE (July 3, 1902) in which he stated that his results would have to be modified in accordance with the results obtained for the escape of gases according to the kinetic theory.

In conclusion, permit me to say that although I fully recognise the imperfection of the kinetic theory in dealing with problems of attenuated atmospheres, yet I believe that the results arrived at under the special assumptions made will have to stand until it can be shown by other *a priori* reasoning that these conclusions are not within the limits of the probable results, *i.e.* that the escape of helium from our atmosphere is practically *nil*.

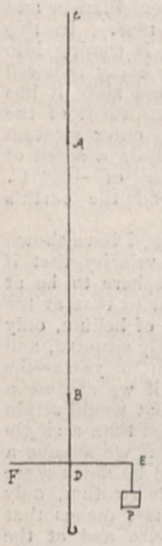
S. R. COOK.

Case School of Applied Science, Cleveland, O., February 22.

Demonstration of Magnetostriction by Means of Capillary Ripples.

IN his experiments on the change of length by magnetisation, Joule ("Papers," vol. i. p. 50) mentions that "the expansion, though very minute, is indeed so very rapid that it may be felt by the touch." If everybody were endowed with such an acute sense of touch as to discriminate an elongation of a micron, it would be superfluous to think out any arrangement which would serve to demonstrate the minute change of length due to magnetisation. Since the elongation generally amounts to a few millionths of the total length of the magnetised wire, it is necessary to have an intricate apparatus in order to show that the ferromagnetic wire changes its length by magnetisation. The demonstration of magnetostriction to a large audience is thus a matter of no small difficulty.

After trying in vain several means of showing the magnetic change of length and the Wiedemann effect in a classroom, I finally succeeded in demonstrating them by using the capillary ripples formed on the surface of mercury. A ferromagnetic wire AB is soldered at both ends to brass or copper wires AC and BD. D is bent into a hook, so that the wire can be properly loaded by hanging weights from it. Another wire DE is soldered at right angles to BD and bent downwards. The extremity of the wire carries a small plate P, and dips at the centre of a circular or rectangular mercury trough. AB is hung vertically in the axis of a magnetising coil, which should be much longer than the wire AB. By passing an alternate or intermittent current of known frequency fine capillary ripples are formed, which can be easily projected on the ceiling by placing a glass plate, inclined at 45° to the vertical, over the trough, and illuminating the trough by passing the sunbeam or electric light horizontally on the glass plate. By adjusting the weights, it can be easily demonstrated that for a current of given frequency the elongation or contraction generally reaches a maximum. It may be doubted if the maximum is not due to the coincidence of the frequency with that due to the period of the elastic vibration of the wire; repeated experiments show that this is by no means the case.



Next place the magnetising coil horizontally, and stretch the wire horizontally by attaching to D a flexible string, which is slid over a pulley and pulled by the weights. The portion of the wire EP is bent downwards, and P dipped in a mercury trough. The other end, F, of the wire ED is dipped in a mercury pool, and an intermittent or alternate current of known frequency passed through the wire FDBAC. On magnetising the wire longitudinally by a steady current, fine capillary ripples are seen in the trough, which can be projected as before mentioned.

As both effects are greater in nickel than in iron, better results are obtained with the former wire.

H. NAGAOKA.

Physical Laboratory, Imperial University, Tokyo,
February 2.

Earth Structure.

FROM Mr. Charles J. J. Fox's letter in NATURE of March 10, it is not wonderful to learn that Prof. Milne emphasises the demand for some theory which shall explain pulsatory movements by which large tracts have been alternately raised and lowered. Prof. Milne has seen too much of seismic phenomena not to do so. But with our limited knowledge of the earth's interior, it is still a matter of pure conjecture in what order the globe solidified from being a mass of heated vapours, and quite open to suppose that after the heaviest took the lowest place, a hollow was formed, and the crust became a cooling shell, with a layer of radium—about the heaviest of metals—underneath to remain a perpetual generator of subterranean heat. This state of things may be taken as the starting point; for it was not until the crust hardened into shape that the problem for which Prof. Milne demands some effort at a solution came into existence, and it is curiously enough propounded by the picture which happens to be on the opposite page of NATURE—"overfolding in Upper Carboniferous limestone"—to account for which there are geologists who would require oscillations between land and sea continued for an indefinable length of time.

It is easy to make a model range of strata in plastic clays and apply lateral pressure crunching them into similar foldings, while to stand before the real rock and coldly reason out what actually happened is another matter. Indeed, the present writer could make nothing that was not self-contradictory out of such contorted strata, especially when exposed on a very large scale, as occurs near Singapore, for instance, until on visiting one of the large (and active) craters in Java, a mile in diameter and with vertical faces 1000 feet high, the whole mystery at once became clear. For it was evident that a volcano (including fissures in the term) can erupt strata of every kind of material, red sandstone, conglomerates and shales, simulating those of aqueous deposition, and in all sorts of thicknesses from many feet to a few inches, the material being propelled for thousands of feet into the air, and perhaps all in the course of a few days of activity. Vesuvius, Etna, and even Hawaii can show nothing resembling the astounding volcanic formations in Java.

The most capricious vertical and lateral movements are to be associated with volcanic action, but in the main it is successive deposition on uneven ground that manifestly causes the curvings which are to be so often noticed in exposed sections, and are typically delineated in the picture on p. 439. Adoption of this theory, drawn from what is to be seen round Java craters on a scale nowhere else matched, does no doubt introduce some modern views into established geology, particularly in the element of time and as to the origin of much of our coal.

It is, however, widely allowed that there was a phase of great terrestrial instability just before the appearance of mammals, and equally certain that the vast ejections of successive periods varied in composition so as to give their special mineral character to the Silurian, Devonian, Carboniferous and later formations as classified by geologists. We can form only the faintest picture of the agitations on the surface of the globe in those days; of the tranquil intervals during which palms and forests grew, roamed in by animals, while shells were cast up on innumerable beaches; and then of their sudden submergence under beds of volcanic ejections following in rapid succession, and reducing all life to fossils. Now that the earth has quieted down, the process is only faintly indicated by what has occurred in historic times, as, for instance, in the consternation produced among the residents by the ejection of only a single covering of volcanic mud over many square miles of country at the eruption of Tarawera, in New Zealand, which the writer saw as a grey unctuous mass, evenly coating the surface of the landscape 18 inches thick six weeks after the eruption. Admission of the volcanic hypothesis, though it does not explain pulsatory movements on a continental area as yet, enables the origin of contorted strata met with so frequently in the British Islands and abroad to be recognised at a glance, as well as that of whole series of the stratified rocks.

A. T. F.

London, March 15.

Spawning of the Plaice.

IN continuation of the letter you published last week (March 17), I can now supply some information as to spawning in the open sea.

Mr. Andrew Scott, resident naturalist at the Piel (Lancashire) hatchery, who is now examining all our townettings taken in the Irish Sea, reports to me that the first plaice eggs this year appear in a gathering taken by our fisheries steamer on February 2 at $1\frac{1}{2}$ miles south-west by south of Patches buoy, off Aberystwyth; that the next occurrence was on February 19, 6 miles west of Morecambe Bay lightship; and then again on February 18 at 6 miles north-west of the Liverpool north-west lightship. Plaice eggs have been present in every gathering since that date off both the Welsh and the Lancashire coasts. The Port Erin tow-nettings later than January have not yet been examined in detail.

It is evident, then, that the plaice in the Irish Sea started spawning about a month earlier than those in our two hatcheries. It would be interesting to have the dates for the North Sea and the English Channel.

Liverpool, March 22. W. A. HERDMAN.

IN a letter in NATURE of March 17 Prof. Herdman mentions that "the plaice in the open-air ponds at the Port Erin Biological Station started spawning on March 3, and those at the Piel (Lancashire) Sea Fish Hatchery (under cover) on March 1." He would like to know how this record compares with that of fish in the sea. As the professor suggests that "probably the officials of the International Investigation will be able to speak as to the condition in the North Sea and . . . English Channel," I herewith state my experience.

About the middle of February I was informed by fishermen that plaice in the North Sea (southern part) were for the most part spent. From personal observation I can state that the larger plaice trawled by the s.s. *Huxley* in the Great West Bay on February 26 were spent. Further, the eggs procured in the tow-nets at the various hydrographic stations in the English Channel in the latter part of February can hardly fail to prove, on examination, to be those of plaice. Prof. Herdman is probably aware that investigations conducted by the Marine Biological Association in the south Devon bays during 1901 and 1902 established the conclusion that "the maximum spawning period lies between the third week of January and the second week of February."

In regard to the North Sea, I may mention that I examined on board about 300 plaice trawled by the s.s. *Huxley* on March 11 and 12 on the south-west part of the Dogger Bank, and that of these fish the larger were spent, the smaller immature. Only one female had a considerable remnant of ripe eggs in its ovary, but none of the males were "running." The eggs procured in the tow-nets in the southern part of the North Sea are apparently of several species, but plaice are almost certainly present, and probably predominate. From present facts and previous records I conclude that, as compared with the North Sea and English Channel, Prof. Herdman's plaice are late in *starting* to spawn. WM. WALLACE.

Marine Laboratory, Lowestoft, March 20.

Euclid's Definition of a Straight Line.

ON p. 409 your reviewer states that "Euclid says nothing about the extreme points of the line" in his definition of a straight line, but regards "*all* the points on it."

Will he kindly look at p. 410 of your vol. lvii., where I have given reason for considering the older translation of Euclid's words to be correct. R. E. B.

I HAVE read the passage referred to, but for many reasons cannot admit that the argument is conclusive. In the first place, the quotation from Aristotle's "Ethics" has no authority whatever; it has no grammatical connection with the previous context, and shows every mark of being a marginal annotation which has been wrongly incorporated with the text. Then the use of the same symbol for different points (AA, BB, ΓΓ denoting segments) is very unusual, and is not what we should expect from a competent mathematician, so it is rash to infer that the use of ἐφ' ὧν ΓΔ in the sense "of which Γ, Δ are the extremities" was a current technical practice at the time of the writer. But even if this be admitted, it does not follow that Euclid means the same thing in his definition of a straight line; all the evidence, it seems to me, points in another direction. Euclid has just defined points, and stated that the extremities of lines are points; if he had intended what the current English translation makes him say, would he not have written, "A straight line is a line which lies evenly (ἐξ ἴσου) with respect to its extremities"? Again, in i. 9 he says, "on AB let any point D be taken" (εἰλήφθω ἐπὶ τῆς AB τυχὸν σημεῖον τὸ Δ); now if D is taken "on" AB, surely it is included in "the points on AB" (τὰ ἐπὶ τῆς AB σημεῖα). Moreover, Euclid explicitly recognises infinite, or indefinitely long, straight lines; the enunciation of i. 12 is Ἐπὶ τὴν δοθεῖσαν εὐθεῖαν ἄπειρον, &c.; see also the scholia in Heiberg's edition of the "Elements," v. 78–83, 136–9.

The real difficulty, I think, is in the interpretation of ἐξ ἴσου; what this is intended to mean can hardly be settled, unless new documents should be discovered. Personally, I believe that what Euclid had in his mind was something of this sort:—if we stand at any point A on a straight line and look towards any other point B on it, the appearance of AB is always the same, and the same as that which we get by going to B and looking towards A. But this is only a conjecture; my principal contention is that τὰ ἐπὶ γραμμῆς τινὸς σημεῖα naturally means "the points on a line," namely, all the points on it, including its extremity or extremities if it does not extend indefinitely both ways, and that this is the sense which the phrase bears in Euclid's definition of a straight line. YOUR REVIEWER.

Respiration in Frogs.

THE respiratory movements of frogs have been studied by several observers, especially Gaupp and Baglioni, of recent years. These zoologists have pointed out that the rapid up and down movement of the floor of the mouth, so typical of most batrachians, is a kind of aspiration, and does not force air in or out of the lungs to any great extent.

In a frog recently under observation I noticed these movements taking place while the creature was entirely submerged, and not engaged in croaking. I should be glad to learn whether this is an occurrence well known to your readers. To the best of my knowledge neither of the above-mentioned naturalists allude to it, but I have not here access to their original papers (Gaupp, *Archiv. für Anat. und Physiol.*, Anat. Abtheil, 1896; Baglioni, *ibid.*, Physiol. Abtheil, 1900).

Is it not possible that in certain circumstances, supposing the nostrils to be open and the glottis closed, even the adult frog may take in water into its mouth for the purpose of breathing? The remarkable condition of the blood capillaries in the mouth points to it as being normally a place for interchange of gases when air is admitted. If this suggestion be possible, the power possessed by frogs of undergoing prolonged immersion may be partially explained. M. D. HILL.

Zoological Laboratory, Eton College, Windsor, March 20.

Subjective Colours.

IN the discussion on this subject in NATURE I have not seen any mention of a phenomenon which I have now and then noticed of late years, but never before, nor have I seen it described anywhere. When I have been reading and have become sleepy, just as I was about to fall asleep portions of the print in patches in different parts of the page turned a brilliant red. It is impossible to make any exact observations on the subject, because the moment one rouses oneself to do that the printing resumes its ordinary black. I do not find that this phenomenon is affected by the amount of light in any way.

The phenomenon mentioned by Mr. E. Hubbard (p. 318) is true in my case, and I attribute it to the fact that the eye that is exposed to the greatest light is more or less dazzled, or else has light reflected into it from the eyelids, and so the field of view is suffused with red or orange light which combines with the tint seen with the shaded eye.

T. W. BACKHOUSE.

West Hendon House, Sunderland, March 18.

Secondary Radiations of Radium.

I ENCLOSE two prints I have taken with a radium screen. No. 1 shows the impression of a steel pen-nib, a steel screw, and an ordinary paper fastener. These articles were laid on a photographic plate and exposed for 6 days. No. 2 shows the impression of two bronze coins (halfpennies) similarly placed, but exposed for 13½ days. One coin rests partly on the other, and at this part the edge of the lower coin is very much blurred, pointing to rather great secondary radiation from the upper coin.

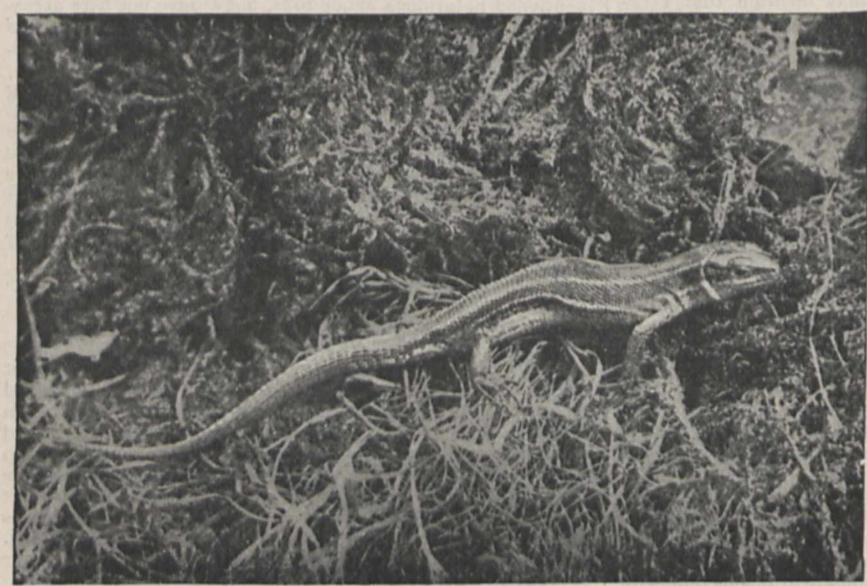
Another peculiarity seems to be that while in one of the photographs the articles are shown as shadows, in the other the coins show bright on a darker background. Does this point to the possibility of bronze exposed to radium rays for such a period as 13½ days becoming more radio-active than radium itself? J. S. DAVIS.

Culham College, Abingdon, Berks, March 19.

BRITISH LIZARDS.[1]

We are glad to welcome this companion volume to the author's excellent work on British snakes, for with the two together the amateur naturalist will learn practically all that he wants to know with regard to the reptiles of our islands. Not that these works are by any means exclusively for amateur naturalists, as there is much matter in both which cannot fail to interest their professional brethren. If Dr. Leighton can be induced to treat the amphibians in a similar manner, we shall have a complete account of the life-history of all the British terrestrial cold-blooded vertebrates.

The author's mode of procedure is very thorough. After giving the leading characteristics of lizards in general, he describes in some detail their anatomy, and then proceeds to deal, *seriatim*, with the five British representatives of the group. The external features of each are illustrated by reproductions from photographs, of the excellence of which our readers have an opportunity of judging for themselves from the accompanying specimen.



Photograph by Douglas English, Dartford.

Fig. 1.—Female of the Common Viviparous Lizard. (From Leighton's "Life-History of British Lizards.")

It is a common belief that reptiles are totally wanting in Ireland; this, however, Dr. Leighton shows to be an error, as the common viviparous lizard occurs in that island, where, however, it is the sole representative of its order. How it got there, to the exclusion of its brethren, he attempts to show. In the later chapters of the book the author has gone very carefully into the local distribution of lizards in our islands, with results of considerable interest; and in order that readers may record new observations for themselves a few tabulated blank pages are appended. Horticulturists should pay special attention to the author's statements as to the great value of the slow-worm as a slug-exterminator. The enlarged diagrams of the "squamation" of the head afford an easy and exact method of identifying the British species of lizards.

Special interest attaches to Dr. Leighton's investigations with regard to the phenomenon of tail-fracture in lizards. It is pointed out that such lines of fracture occur at regular intervals of two scales' length, such spaces coinciding with the lengths of the caudal muscle; and the author is of opinion that the superficial structures have much more to do with determining the fracture than have the septa in the caudal vertebræ.

Concise, exact, and at the same time interesting is our verdict with regard to this admirable little volume.

R. L.

[1] "The Life-History of British Lizards, and their Local Distribution in the British Islands." By G. R. Leighton. Pp. xiv+214; plates. (Edinburgh: G. A. Morton, 1903.) Price 5s. net.

THE EDUCATION OF JAPANESE NAVAL OFFICERS.

On reference to the second article on "Science in the Navy," published in Nature of last year, it will be found that the gist of that article was the condemnation of the over-specialisation of officers, accompanied by remarks in favour of the interchangeability of their duties, the practice of the German Navy being brought forward as an existing evidence in support of such views.

Increased support of these views will be found in a valuable lecture which was recently delivered by Lieut.-Commander K. Sato, of the Imperial Japanese Navy, at the Royal United Service Institution, on "The Education of Japanese Naval Officers of the Executive Branch," in which that officer shows that the "Eastern nation," thought at one time to be "too bookish," is by its methods of education making its naval officers eminently practical men with a good grounding of general and scientific knowledge.

The lecturer admitted that his country had fairly followed Great Britain's footsteps in this important matter of education, and had duly profited by the instruction of her officers, but modestly hinted that perhaps in one or two small particulars they had gone "one better" than we had. Here it is encouraging to note that the gallant chairman, with his life-long education in the traditions of our long established Navy, said that there were many things this country could learn from the Japanese Navy—encouraging because we believe that this power to see good in others where it really exists and determination to profit by the same is a ruling spirit amongst our officers.

Whilst giving due encouragement to the specialist officer, it is the constant effort of the Japanese to produce *all round officers* which is so striking, and one would think they had adopted the following as their maxim:—"Inadvertence is no excuse for the non-performance of any duty, for, it is the duty of an officer to make himself acquainted with the detail of every duty he may be called upon to perform."

This is a high standard, and not many fully attain thereto, but it will hardly be denied that it should be the aim of every officer, whilst those who regulate education should do all in their power to keep the road open with efficient aids by the way. Interchangeability is a very promising road to such a goal.

Another point which this lecture brings out clearly is the training of the specialist officer in the Japanese Navy. He is encouraged to specialise according to the bent of his mind, whether in gunnery, torpedo or navigation, but apart from the special course in those subjects which he has to go through, each officer has to take up several other subjects not immediately bearing upon the one in which he is to be strongest. Here again are points to be studied and thought over, for it is certain that until very recently our specialist officers have been kept too much in a groove. The gunner has "stuck to his linstock," the "timonnier to his helm," and though either might easily be called to do the other's duty, they have seldom if ever changed duties and thus obtained experience.

As rewards to specialist officers, the Japanese give the more important positions and earlier promotion, but no extra pay. We give extra pay but no earlier promotion; nevertheless, their expert knowledge bears fruit when selections are made for certain higher posts of the service.

With the personnel at our disposal, and a naval administration which does not hesitate to throw down the barriers of prejudice standing in the way of sound progress, may we not look to doing "one better" than any competitor in the naval world? The answer is, Yes, if the voice of science is clearly heard in its proper place.

THE NATIONAL PHYSICAL LABORATORY.

THE report of the National Physical Laboratory for the year 1903, which was submitted to the Board last Friday, is the first report covering a full year's working, and shows that very satisfactory progress is being made. It is clear, however, that on the financial side the laboratory is in need of further support, even if it is only to continue to work as at present, whereas it is eminently desirable that the work should be widely extended so that the laboratory can undertake to carry out a number of tests for which there is a demand, and which it is now obliged to refuse. These will in many cases necessitate a considerable increase in the equipment, which is at present very inadequate in many branches, and naturally also an increase in the annual expenditure, which will be only partially recouped by the fees derived from the tests carried out. It is also pointed out in the report that the staff is not large enough, and that the income should be sufficient to allow of higher salaries being paid to the assistants, as those which are at present paid are not liberal enough to secure the permanence of the services of men of the necessary ability.

The net result of last year's working was a loss of a little more than 100*l*., the receipts being, in round figures, 10,200*l*., and the expenditure 10,306*l*. The president and council of the Royal Society have been in communication with the Treasury, and it has been arranged that the grant of 4000*l*. shall be continued for another year (until April, 1905), and also that a scheme for the future working shall be drawn up by the executive committee for the consideration of the Treasury. It is earnestly to be hoped that satisfactory arrangements will be made, and that the very valuable work which the laboratory can perform in the future will not be crippled for want of funds. It is interesting to compare the Government grants to similar institutions abroad which are stated in the report. The Reichsanstalt alone enjoys a grant of 16,000*l*., the total grant to the various departments at Charlottenburg doing the same work as the National Physical Laboratory being 40,000*l*. In America the grant to the Standards Bureau is 19,000*l*., and in France the Laboratoire d'Essais had a grant of 5500*l*. for its first year's working.

If we turn, however, from these financial considerations to the technical parts of the report, we find nothing to cause dissatisfaction, but, on the contrary, a record of very valuable work accomplished. The laboratory has a double function to perform; it has to carry out tests, measurements and standardisations for the public, and it has also to undertake research work, often of a very difficult character, in connection with these measurements. Many of the tests which the laboratory is asked to make are, as a matter of fact, researches in themselves; some of these are quoted in the report, and we may mention, as an example, a series of comparative tests on the materials used for lagging steam pipes. But apart from these there is a vast amount of experimental work to be done in connection with the fixing and reproduction of primary standards of all sorts, and it is very gratifying to see that attention is being given to these questions in a manner which gives promise of excellent results in the near future. We cannot refer to all the work of this kind which has been undertaken at the laboratory but may mention a few typical examples.

Experiments have been carried out on the mercury standard of electrical resistance, eleven resistance tubes having been constructed by Mr. Smith. The results of the measurements made with these tubes show that they agree among themselves to about 3 parts in 100,000, and that the final result agrees with that of the Reichsanstalt to about 1 part in 100,000. Experiments on the standard (Clark) cell have shown that impurities left in the mercurous sulphate have a considerable effect on the value of the electromotive force; it is hoped that a standard method of purification leading to consistent results will eventually be obtained; at present it is stated that the general result of the work carried out and the tests on cells submitted for standardisation show that the Clark cell cannot be regarded as a trustworthy standard. The laboratory has also under construction a standard ampere balance, and when this is completed a Lorenz machine, to be presented by the Drapers' Company, can be taken in hand. The laboratory will thus in time be in a position to give final authoritative determinations of the three fundamental electrical units.

As typifying research work of a somewhat different character, we may refer to the work which the laboratory is doing in connection with photometry. This is a subject in which the only standard we possess—the pentane lamp—is at best only a secondary standard, and one of a very unsatisfactory character. Work is being carried out in connection with the variation of this standard with the barometric pressure, and with the amount of carbonic acid and water vapour present in the air. The result of these researches may lead to a more accurate definition of the conditions for using the pentane lamp, but the laboratory also proposes to undertake experiments on some more definite standard, such as the radiation from a square centimetre of glowing platinum or from a perfectly black body at a definite temperature, which may lead to the establishment of a standard which can be regarded more as a primary standard. It is to be noted that the laboratory is using large bulb electric lamps as secondary standards, and it is probable that these will prove more satisfactory than the pentane lamp, especially as a standard which requires a chemical analysis of the atmosphere every time it is used will not be very practicable. Another research of very great practical importance, which is being carried out by Dr. Harker, is the investigation of the various methods of measuring high temperatures; an examination has already been made of the relative merits and accuracy of the different methods available for measurements up to 1100° C., the results of which have been communicated to the Royal Society, and Dr. Harker is now engaged in carrying the investigation further—up to temperatures between 1000° C. and 2000° C. This research includes an examination of the thermoelectric force of various platinum and platinum-alloy junctions, and of the effects of small percentages of impurity. The results of this work should be of high value to a great number of industries.

We have referred more especially above to the work which is being done in the physics department, but we might equally have quoted from the work of the other departments. For example, in the engineering department important work is in hand in connection with wind pressure, with the specific heat of superheated steam, and with the determination of the physical properties of a series of nickel-steel alloys prepared for the laboratory by Mr. Hadfield. Similar examples might be taken from all the other departments, but space does not permit us to enter into further detail, and we must refer those particularly interested to the report, which is itself very condensed. Sufficient has been said, we trust, to give some idea of the importance of the work which the laboratory is carrying out and of the progress which has been made. It seems that the value of the institution is likely to be fully recognised by the technical public if one may judge by the steady increase in the number of tests which have been carried out. In 1902, during nine months' working, 269 tests were made; last year this number increased to 1330, which is equivalent to an increase of nearly 300 per cent.

MAURICE SOLOMON.

FERDINAND FOUQUÉ.

By the death of this illustrious geologist and mineralogist the ranks of science have lost one of their most notable chiefs. Half a century has passed away since he began that remarkable series of investigations which have contributed in so large a measure to the progress of vulcanology and petrography. In 1854, associated with St. Claire Deville, he published his earliest experiments on the losses effected by heat on minerals, but he was soon led into the domain of volcanic geology by studying the combustible gases given off from the flanks of Vesuvius. The eruption of Etna on January 31, 1865, furnished him with opportunities of investigating the phenomena of a volcano in full activity, and the series of communications to the Paris Academy of Sciences recording his observations and deductions established his reputation as an accurate and accomplished chemist and mineralogist. The following year came the famous outburst of Santorin, and Fouqué, who had now taken enthusiastically to the subject, hastened to profit by the rare opportunities which this eruption afforded for the detailed study of volcanic phenomena. For several years he continued to publish the results of his visit and of his analyses of the rocks and gases which he had collected, finally embodying the whole elaborate investigation in his great monograph "Santorin et ses Eruptions," which appeared in 1879, and was at once hailed as one of the most important treatises that had yet been written in the domain of vulcanology.

While these studies were in progress he applied the modern microscopic methods to the investigation of volcanic rocks. After some years of successful labour in this field he associated himself with M. Michel-Lévy, whose powers in the determination of the optical characters of minerals and the minute structure of rocks pointed him out as an admirable colleague in such a domain of research. Fouqué had given himself with the utmost ardour to the investigation of the optical characters of the felspars, a research in which he employed all the resources of modern chemistry and microscopy, which engaged his time and thought for some twelve years, and on which he justly prided himself as his most original contribution to science.

In the course of these inquiries his attention and that of his fellow-worker were directed to the importance of endeavouring to imitate the processes of nature by reproducing minerals and rocks artificially. In 1878 he published his "Synthesis of the Felspars," and in subsequent years the experiments were continued by the two observers through a series of trials in which they successively produced, by fusion and cooling, artificial compounds which, alike in chemical composition and minute structure, precisely resembled basic igneous rocks. From pyroxenic labradorite they were led to obtain in succession artificial leuco-tephrites, like the lavas of Vesuvius, basalts, diabases, dolerites and ophitic meteorites. The results of these researches were collected in the memorable "Synthèse des Minéraux et des Roches," the appearance of which in 1882 marked an epoch in experimental geology. Up to the end, however, it was found impossible to reproduce artificially the acid rocks of granitic type.

MM. Fouqué and Michel-Lévy, while engaged in these inquiries, found also time for a detailed study of the minute structure and composition of the crystalline rocks of France, and embodied the results of this laborious investigation in the great quarto monograph "Minéralogie Micrographique: Roches éruptives Françaises," which, with one volume of text and another of admirable coloured plates, was published by the Geological Survey of France in 1879.

The eminent petrographer was not merely one who relied on all the resources of a well equipped modern laboratory. He studied his subject in the field also. One great element of value in his volcanic investigations arose from personal acquaintance with the phenomena of active volcanoes. His knowledge of the eruptive rocks of his native country was likewise widened by prolonged examination of them on the ground. To him we owe some of the most interesting sheets of the map of the volcanic region of central France, where he traced the relations and order of sequence of the volcanic eruptions which give that part of the Continent such absorbing and perennial interest.

In his early years he had given some attention to the phenomena of earthquakes. Hence when the French mission was dispatched to study and report on the phenomena of the Andalusian earthquake of December 25, 1884, Fouqué was placed at its head as director, associated with some of the ablest geologists in France. The massive quarto memoir containing the report of this mission is specially notable for the record of the experiments made by MM. Fouqué and Michel-Lévy to determine the rapidity of the propagation of waves of shock in different kinds of rocks. Fouqué likewise showed his continued interest in this subject by contributing in 1888 a little popular treatise, "Les Tremblements de Terre," to the *Bibliothèque Scientifique Contemporaine*.

For many years past the professor had given courses of lectures at the Collège de France, where also he carried on his chemical and petrographic researches. He lectured with his usual clearness and earnestness on Saturday, March 5. On the following evening he seemed in his usual health, and discussed petrographical subjects with his son-in-law, Prof. Lacroix, but next morning (March 7) he passed away in his sleep at the age of seventy-five.

Gentle, modest and retiring, absorbed in his work, careless about worldly applause, and always happiest in the midst of his charming family, Fouqué was an example of one of the best types of a scientific man. His death makes an irreparable blank in the scientific society of Paris, and has filled with sorrow the heart of everyone who had the privilege of his friendship.

A. G.

NOTES.

A MEMORANDUM by the financial secretary to the Treasury explaining the estimates for Civil Services and the Revenue Departments, 1904–5, was issued on Tuesday. The estimate for education, science and art, is 15,798,217*l*., which is an increase of 1,217,893*l*. above the amount for 1903–4. The 1903–4 figures include a supplementary estimate of 45,000*l*. for the relief of the National Antarctic Expedition —a service of a quite exceptional character, for which any provision that may prove to be necessary next year will be made in a similar form. The bulk of the addition arises on the vote for the Board of Education, as the result of recent legislation, but Public Education (Scotland), Public Education (Ireland), and Universities and Colleges (Great Britain) also show increases. The Board of Education (England and Wales) requires 985,131*l*. more than this year. Of this increase 50,580*l*. is for grants for training teachers, pupil teachers, &c., and 52,303*l*. for grants in respect of education other than elementary. The principal increase, however (889,888*l*.), is for grants towards expenditure on public elementary schools. Universities and colleges, Great Britain, will require an additional 32,100*l*. to provide for grants for the new universities at Liverpool and Leeds (for each of which 2000*l*. is included), and for the proposed augmentation of the grants in aid of colleges, for which 54,000*l*. is inserted, or double the amount voted in the current year.

A REUTER telegram from Vienna, dated March 19, states that at the request of the Academy of Science, the Austrian Minister of Agriculture, in order to facilitate the solution of certain important questions relating to the nature of radium, has ordered that from January 1 last until further notice no trading should be permitted in the residues from the manufacture of uranium colours at Joachimsthal, and that 10,000 kilogrammes of those residues should be reserved for purchase by the academy and another 10,000 kilogrammes for M. and Madame Curie, in Paris. These consignments are to be devoted entirely to the purpose of scientific experiment.

AT Paris on Friday last M. and Madame Curie were honoured by the Municipal Council at the Hôtel de Ville, and congratulated on their researches on radium. The two investigators were presented with silver medals bearing the inscription, "City of Paris to M. Pierre Curie and Mme. Marie Curie, Laureates of Nobel prize in 1902."

THE *Washington Evening Star* states that the U.S. Congress has granted 5000*l*. for the continuation of Dr. S. P. Langley's experiments on aërial flight.

PROF. ABBE, professor of physics at Jena, and Prof. Neumann, professor of mathematics at Leipzig, have been appointed members of the Bavarian Maximilian Order for Science.

THE *British Medical Journal* announces that two distinguished physiologists, Prof. Luigi Luciani, Rome, and Prof. Angelo Mosso, Turin, have been named Senators of the Kingdom of Italy.

THE death is announced, at the age of sixty-five, of M. Jules Garnier, known for his explorations in New Caledonia and for his geological map of this district. His discovery of nickel ores in this French colony popularised the use of nickel in France, and was thus of material advantage to the colony. He was one of the founders of the French society of commercial geography.

A NUMBER of letters have been appearing in the *Times* with reference to the electric railways to be constructed in the heart of the Snowdon district, which, it is urged by several correspondents, will greatly impair the natural beauties of the neighbourhood. The scheme includes the electrification of the narrow gauge "toy" railway from Dinas to Snowdon, the extension of this line through Beddgelert to Portmadoc, and also the construction of a branch line from Beddgelert through Pen-y-gwryd and Capel Curig to Bettws-y-Coed. These extensions have been sanctioned by the Light Railway Commissioners, and a Bill for a further extension from Dinas to Carnarvon was before a House of Lords Committee last week, the preamble of which it found proved. The railway will thus not only serve a district largely frequented by tourists, but will enable the slate from the quarries to be brought down easily to Carnarvon without the two or three changes of conveyance now necessary. It is also proposed to supply power to the quarries; the power is to be obtained from Llyn Llydaw, on the slopes of Snowdon, whence a pipe line will be run to the nearest point on the railway at which a generating station will be built.

THE completion of the electrical equipment of the Liverpool and Southport line of the Lancashire and Yorkshire Railway must be regarded as an important step in the progress of steam railway electrification. This is the second steam railway to be electrified, but the change is of more importance in this case than in that of the Mersey Railway on account of the fact that it is likely to lead to the electrification of all the suburban lines of the Lancashire and Yorkshire Railway, and possibly also of the London and North-Western Railway. The section which has just been electrified is nearly twenty miles in length, and has to deal almost entirely with passenger traffic. The effect of the electrification will be nearly to double the number of trains running between the two termini, and to reduce the time taken over the journey from 54 to 37 minutes. Power is generated at Fromby, nearly at the middle of the line, at 7500 volts three-phase; this is transformed down and converted to continuous current at 600 volts, at which pressure the train-motors are supplied. The current is collected from a third rail outside the track rails, and each train has two motor-cars, one at each end, with two trailers in between. It is pleasant to note, considering that all our electrical tramway equipment has been borrowed from America, that the whole of the equipment of this line is of English design and manufacture, the rolling stock having been made by the railway company, and all the rest of the work executed by Messrs. Dick, Kerr and Co.

THE figures published by Mr. J. W. Bradley, engineer to the City of Westminster, giving the results of tests on the different lamps employed in street lighting, are exceedingly valuable as the tests are made under actual working conditions and include all costs of maintenance, interest on capital, sinking fund, &c. The results of the sixth series are published in the *Electrician* of March 11. From this series of tests Sugg's high pressure lamps in Parliament Street come out cheapest (7·65 pence per candle-power year), the arcs on the Westminster Supply Corporation being second best (8·73 pence per candle-power year). As the average of the six series of tests, however, this order is reversed, the arcs being cheapest (8·7 pence) and the incandescent gas second (9·85 pence). It is to be noted, however, that the cost of the arc lighting seems to vary considerably with the type of lamp and conditions of contract; there are three different electricity supplies in the City of Westminster, and the cost of the arcs on these three supplies is respectively 11·5, 15·1 and 8·7 pence per candle-power year. The triple flat-flame burners in the Strand cost 47·5 pence, and, indeed, there is apparently no other form of lighting that can compete with the arcs or Sugg's high pressure burners.

The report of the departmental committee on the use of electricity in mines which has recently been published is likely to be read with the greatest interest by all electrical and mining engineers. There can be little doubt that electrical machinery, which is already in considerable use in mining both here and abroad, is destined to play a still more important part in the future. The extreme flexibility of an installation of electric power is particularly advantageous in mining work, and numerous machines for performing the heavier mining operations have been constructed. The objection on the score of danger, especially in mines liable to an explosive atmosphere, is not in reality a serious one, as proper design and supervision of the machinery are easily obtained. The proposed rules which have been drawn up at the end of the report referred to above, though at first reading they may seem too stringent, should have the effect of ensuring the safety of the miners and of begetting confidence in electrical working, so that one may hope that the report will stimulate the application of electricity to mining.

Dr. C. Barus, of Brown University, Providence, R.I., has sent us several photomicrographs of fog particles condensed on X-ray and other nuclei. Unfortunately the details of the photographs are too fine to be reproduced satisfactorily in these pages. The nuclei were produced by passing the X-rays for from one to ten minutes through saturated dust-free air in a large condensation chamber. The nearly cubical chamber was made of wood impregnated with resinous cement, lined with a double layer of *wet* cotton cloth, and provided with faces of plate glass. The particles were caught on a plate of microscope glass covered with an oil film and exposed to the subsiding fog for thirty seconds. The plate was then adjusted for photography in the ensuing thirty seconds. In one photomicrograph fog particles of all sizes from about 0·0005 cm. to 0·0020 cm. are present, indicating a similar gradation of nuclei. Extremely fine fog particles (0·0003 cm. to 0 0009 cm. in diameter) appear on another picture corresponding to the large green-blue-purple corona, and are due to condensation on phosphorus nuclei. Dr. Barus hopes to apply this photographic method to the study of atmospheric nucleation, and thus to obtain those important but small qualitative differences of nucleation which must vanish from the corona as a whole.

Reference is made in the *Times* of March 9 to a despatch which has been received by the India Office in which the Indian Government indicates the methods by which it hopes to effect an improvement in the quality of exported Indian cotton. The most difficult question, and one for which no remedy has been found, is how to prevent the admixture of inferior grades in the packing. The other problem which is engaging the attention of the Government is concerned with the improvement of the seed so that the cotton obtained may be of better quality. The acclimatisation of foreign species has not been attended with much success, but the Government now hopes to attain its object by the improvement of some of the indigenous species either by selection or by hydridisation. Experiments are in progress at Surat, and also in Behar, in the United Provinces, and in the Punjab.

It has generally been assumed that in the wood of trees, especially the heart-wood, the cell-walls are entirely lignified, so that the paper contributed by Prof. M. C. Potter to the *Annals of Botany*, in which he gives proof of the cellulose-staining qualities of the walls of some cells, even in the heart-wood of trees forty and sixty years old, will lead to a modification of present conceptions. Another fact emphasised in the paper, but which has been known since Hartig treated the subject in 1878, is the digesting action of certain fungi by which lignin is changed into cellulose compounds, and, as Prof. Potter shows, the same result is obtained by steaming wood, the explanation being that the water extracts from the wood the substance which gives the characteristic lignin reaction.

The vital importance to farmers of a thorough knowledge of the habits of the insects which damage their crops and granaries is gradually being recognised by all civilised nations, and Italy is now taking up the matter in real earnest. From that country we have received Nos. 7 and 8 of the second series of the *Bolletino* of the Royal Higher School of Agriculture in Portici, the former dealing with insects injurious to stored grain, and the latter with the scale-insects of the genus Diaspis. Both are illustrated.

From the U.S. Department of Agriculture we have received two *Bulletins* issued by the division of entomology. In the one Mr. F. M. Webster treats of insects attacking the stems of growing cereals and the best means of destroying them. It appears that in the States the injuries inflicted on corn-stalks by no less than eight species of minute flies are all laid to the charge of the Hessian fly, and it is the object of the paper to point out how these different species and their modes of attack can be distinguished from the latter. In most instances the ravages of these insects can be prevented or mitigated by very simple measures. The second paper, by Mr. F. H. Chittenden, is devoted to the insect enemies of the sugar-beet. Although the beet-sugar industry is still in its infancy in the States, about 150 species of insects are known to prey on beet, and although comparatively few of these inflict serious losses, there is little doubt that, as the cultivation of this crop increases, other kinds will use it as a food-supply, so that more extensive injuries may be looked for every successive season.

Whatever difference of opinion may exist as to the advisability of the restricted sense in which mammalian generic names are now employed by a number of zoologists, and likewise with regard to the revival of obscure and frequently "barbarous" names for such genera, absolute unanimity must prevail among all naturalists as to the value and importance of a thoroughly complete and trustworthy list of all the generic names for mammals which have ever been given. Such a list has been compiled, with immense labour, by Mr. T. S. Palmer, and forms No. 23 of the "North American Fauna," in course of publication by the Biological Division of the U.S. Department of Agriculture. When it is stated that up to the end of 1900 more than 4000 generic names for mammals had been proposed, and that more than 100 new ones were added in 1901, some idea of the magnitude of Mr. Palmer's task may be gleaned, although only those who have been accustomed to work of this nature are able to appreciate this fully. This is, however, by no means all, for the list before us differs from most of its predecessors in giving the family and ordinal groups to which the various genera respectively belong, thus not only greatly increasing the labour, but likewise vastly enhancing the value of Mr. Palmer's "Index."

UNDER the title of "On Humanising the Animals," Mr. J. Burroughs, in this month's issue of the *Century*, continues his protest against the practice of attributing human powers of thought and prescience to animals. While admitting that the example of parents stimulates the imitative instincts of their offspring, the author insists that teaching—in the sense of imparting true knowledge—is conspicuous by its absence in all animals. Such communications as do pass between animals (and means of communication undoubtedly exist) relate only to the present, and have no reference to either the past or the future. Hence they come under the denomination of feeling or emotion, in contradistinction to knowledge. Such communications are, however, undoubtedly of value to the young, which always thrive far better when reared by their parents than when brought up by hand. As regards the means by which large bodies of animals, such as flocks of starlings or peewits, herds of deer or antelope, or shoals of herring or mullet, act in complete unison, as if acting under the influence of a leader or a code of instruction, the author is inclined to attribute the phenomenon to something analogous to telepathy in mankind. "There is nothing," he writes, "in this state of things analogous to a military organisation. The relation among the members of the flock is rather that of creatures sharing spontaneously the same subconscious or psychic state, and acted upon by the same hidden influence, in a way and to a degree that never occur among men."

THE development of the giant salamander (*Megalobatrachus maximus*) of Japan forms the subject of a paper by Dr. C. Kerbert, of Amsterdam, in No. 10 of vol. xxvii. of the *Zoologisches Anzeiger*. A female at Amsterdam laid a number of strings of eggs, which were deposited in a heap at the bottom of the water. As they lay there, the male on two occasions forced himself into the midst and communicated a vibrating motion to the whole mass, apparently to allow a free percolation of water between the eggs. This constitutes a new phase of the many examples in which male amphibians assist in the care or hatching of the eggs. The newly-hatched tadpoles have three pairs of external gills, and are remarkable for the circumstance that the extremities of the anterior limbs are bifid. The figures of certain newly-hatched tadpoles reproduced by the Messrs. Sarasin as those of the giant salamander have been shown to belong to *Onychodactylus japonicus*, and Dr. Kerbert's specimens are therefore the first examples at this age known to science.

LAST May Major Leishman, R.A.M.C., described certain bodies which he believed to be parasitic in nature, and which were obtained from a case of fever with enlarged spleen (not malaria) contracted in India. These bodies have since been studied by Donovan, Laveran, Ross, and Manson and Low in cases of the disease known as kala azar. The parasite is a small rounded or ovoid body about $3-7\mu$ in diameter, and either free or embedded in a matrix, in which case as many as twelve may be present in one mass. Each body consists of a larger and of a smaller mass of chromatin, and the free forms are encapsuled. These bodies have so far not been met with except in the spleen. Leishman at first believed that they were degenerate trypanosomes, Laveran has placed them in the genus Piroplasma, but since they are not intracorpuscular this hardly seems to be correct, and Ross now considers that they may belong to a new genus of sporozoa, and suggests for them the name *Leishmania donovani*.

WE have received from Mr. E. Philip, of Cardiff, a form of spinthariscope called Perman's radioscope, which gives the now well-known scintillations on a blende screen with marvellous brilliancy. The following statement is made in the circular which accompanied it:—"The effect is somewhat the same as in Crookes's spinthariscope, but the radium is spread over a larger surface and produces a very pleasing and striking appearance, resembling a multitude of bright stars twinkling brilliantly in a dark sky. Moreover, in different instruments different effects are produced owing to differences in the arrangement of the radium salt. The effect is produced by the radiation from the radium known as the α-rays, which consist of minute particles of atomic size; these are projected forth with great velocity, and when they strike the blende screen cause cleavage of the minute crystals which they meet, the cleavage being accompanied by a flash of light or scintillation. These or similar scintillations are being constantly produced spontaneously in hexagonal blende, and can be seen at any time, when the eye is sufficiently sensitive, by looking into a radioscope tube *without any radium*; but under the influence of the radium they are increased enormously in number and brightness." In the specimen forwarded to us sufficient variation of focus to suit different eyes is not provided.

THE *Quarterly Journal* of the Geological Society for February contains a short but interesting article by Mr. and Mrs. Clement Reid on their discovery of a probable Palæolithic floor at Prah Sands, about seven miles east of Penzance. This ancient floor was shown to overlie the raised beach, which rests on an uneven rocky platform that is about 15 feet above high-water mark. The floor is formed of loam which at one time was a true land surface, as it is full of small vertical roots. Towards the top of it is a black layer, with fragments of charcoal, burnt bone, and burnt earth. The authors conclude that here is evidence of a land surface on which Palæolithic man made hearths and lighted fires. They found also in this black layer pieces of vein-quartz, apparently fashioned into rude implements. Above this earthy deposit was a thick mass of angular detritus or "head," which was banked up against the old sea-cliff, and is generally considered to belong to the later stages of the Glacial period. In the same *Journal* Mr. E. T. Newton records the discovery, for the first time in Britain, of the remarkable genus of fishes known as Edestus. It was obtained from the Coal-measures of north Staffordshire. Prof. J. W. Gregory writes on the Glacial geology of north-west Tasmania in a well illustrated article, in which he shows that the lowest level at which evidence of Pleistocene glaciers has been found is 400 feet above sea-level. There is, however, evidence of more recent uplift of the land.

PROF. S. P. LANGLEY's biographical notice of James Smithson, the founder of the Smithsonian Institution at Washington, has been reprinted from "The Smithsonian Institution, 1846–1896: the History of its First Half Century," edited by the late Dr. G. Brown Goode.

A SECOND edition of Dr. Holmes C. Jackson's "Directions for Laboratory Work in Physiological Chemistry" has been published in New York by Messrs. John Wiley and Sons, and in London by Messrs. Chapman and Hall, Ltd. The book has been thoroughly revised, and numerous additions have been made to the subject-matter.

WE have received a copy of the first issue—that for 1903—of *Mimir*, which is wholly concerned with Iceland and Icelandic institutions. The annual publication is intended to help Icelandic research, to keep the people of Iceland and the foreign student informed of the progress of this research, and to promote the proper development of the island and its people. Among the interesting contents we notice the account of institutions in Iceland, the addresses of foreign students of Old-Northern letters, and numerous notes on Icelandic matters of general interest. *Mimir* is printed in English, and is published by Martius Truelsen, of Copenhagen.

THE tables relating to the output of coal and other minerals and the number of persons employed at mines worked under the Coal and Metalliferous Mines Regulation Acts during the year 1903 have now been printed. The tables have been prepared by direction of the Home Secretary from returns furnished by H.M. Inspectors of Mines; and they form part of the general report and statistics for 1903 of mines and quarries. The output of coal from mines under the Coal Mines Regulation Act, which was 227,084,871 tons in 1902, was 230,323,391 in 1903, showing an increase of 3,238,520 tons. The number of persons employed at these mines in 1903 was 842,066, an increase of 17,275.

Two new general methods of preparing aldehydes are given in the current number of the *Comptes rendus*. The first of these, by M. E. E. Blaise, consists in the conversion of the acid through its bromine derivative into the corresponding α-hydroxy-acid, which by the action of heat is first converted into a lactide, and this on distillation splits up into carbon monoxide and the aldehyde of the next lower acid. The yields are very good, from 50 to 60 per cent. of the acid employed, and from the results obtained would appear to be generally applicable to the higher fatty acids. The second method, published by M. F. Bodroux, is based upon the action of magnesium alkyl compounds in toluene solution upon ethyl orthoformate. Here again the reaction gives good yields—from 55 to 75 per cent. of the theoretical—and the examples given by the author include members of both the fatty and aromatic series.

THE Geneva *Archives des Sciences* for January contain an important article on the theory of nickel steels, by M. Guillaume, of the Bureau international des Poids et Mesures. One of the most important properties of these alloys is their low coefficient of expansion, which becomes zero at about 36 per cent. of nickel. It is pointed out that the conversion, below 890° C., of the hard, non-magnetic γ variety of iron into soft, magnetic α iron is accompanied by an expansion of 3 mm. in a rod a metre long. The addition of nickel lowers the transition temperature until in presence of 20 per cent. of nickel magnetic properties only appear when the alloy has been cooled below 200°, whilst (owing to a kind of thermal hysteresis) the magnetic properties do not disappear again until the alloy has been heated to 600° C. In the non-expansive alloys the transition temperature appears to have been brought down to atmospheric temperatures, and the constancy of length is attributed to the same change in structure as that which causes the abrupt expansion in pure iron when cooled below 890°. A striking proof of the correctness of this view was obtained by cooling a metre rod in liquid air, when it suffered a permanent expansion of 3·9 mm., and subsequently showed the high coefficient of expansion characteristic of α iron in place of the lower coefficient characteristic of γ iron.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mrs. L. A. Moline; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Captain Campbell; two Eastern Sarus Cranes (*Grus antigone*) from Northern India, presented by Lieut.-Colonel H. H. Smyth; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. C. Hammett; a Hybrid Pheasant (between *Phasianus reevesi* and *Euplocamus nycthemerus*), presented by the Earl of Ducie; two Ring-tailed Lemurs (*Lemur catta*) from Madagascar, an Azara's Opossum (*Didelphys azaroe*) from South America, a Blue-necked Cassowary (*Casuarius intensus*) from New Guinea, four Dusky Francolins (*Pternistes infuscatus*), two Jackson's Francolins (*Francolinus jacksoni*), two Schueth's Francolins (*Francolinus schuethi*) from East Africa, two Hybrid Parrakeets (between *Platycercus semitorquatus* and *P. barnardi*) from Australia, deposited. In additions in last week's issue (p 473), Snow Leopard presented by Major Cox should read Major Mackintosh.

OUR ASTRONOMICAL COLUMN.

VARIATIONS OF THE MARTIAN CANALS.—During the 1903 opposition of Mars, Mr. Lowell observed changes in the canals which he believes were the results of artificial interference. Among the canals mapped by Schiaparelli in 1877 were three, situated on the eastern edge of the Syrtis Major, which met at a common point, the Lacus Tritonis, and which he named Thoth, Triton and Nepenthes respectively. In 1882 and 1884 Thoth appeared double, but was undoubtedly seen, and in 1884 Nepenthes was also distinctly double.

At the commencement of Mr. Lowell's observations in 1894 he was surprised to find no trace of these three canals, or of the Lacus Moeris, a widening of Nepenthes, although other well known but smaller features were plainly visible. Instead of Thoth another canal, which he named Amenthes, appeared, running from Syrtis Minor to the Aquæ Calidæ, nearly parallel to the earlier recorded directions of Thoth and Triton. During the oppositions of 1896–7 and 1901 this continued as an easily seen object, and Mr. Lowell concluded that it was really Thoth which had been wrongly placed on the earlier drawings. During February and March, 1903, Amenthes was still visible but less distinct, and on April 19 it was accompanied by Thoth in exactly the position shown on Schiaparelli's earlier map; on April 20 Thoth alone was visible. Suddenly, on May 29, the Lacus Moeris, which had long been given up, appeared and became a noticeable feature of that region of the planet's surface. In July Amenthes reappeared alongside Thoth and Triton, and thus settled the question of the presence of *two* canals.

These changes are entirely independent of the seasonal changes, and whilst the two "visibility" curves of Thoth and Amenthes vary inversely, the curve derived from the summation of them agrees very closely with that of a "mean" canal, for which only the seasonal changes have as yet been observed.

From these phenomena Mr. Lowell reasons that owing to the small amount of water on Mars it becomes necessary to irrigate the surface in sections, and for this purpose the canals are artificially regulated, Thoth and Amenthes being allowed to fill up and irrigate the regions surrounding them alternately (Lowell Observatory *Bulletin*, No. 8).

PROF. BURNHAM'S MEASURES OF DOUBLE STARS.—One of the *Decennial Publications* (vol. viii.) of the Chicago University is devoted to a record of the measures of double stars made by Prof. S. W. Burnham with the Yerkes 40-inch refractor during 1900 and 1901. The systems which have been measured are those which have been long neglected and are little known, and those which, from the few early measures or the uncertainty of their results, could not be classified as to their motion or otherwise. Most of the pairs were selected from the Herschel and South catalogues, whilst some of the rejected Struve stars have also been measured.

Eighteen new pairs discovered by Burnham are also included. The pairs are arranged in order of R.A., and the coordinates (for 1880·0), the number in the original catalogue, and the measures of position angle and distance are given.

ORIGIN OF AURORÆ.—In a lengthy communication to the Société Française de Physique (*Bulletin* No. 3, 1903), M. Ch. Nordmann discusses the causes which produce auroræ. After reviewing the various observations of the phenomena attending auroræ, and discussing in detail the theories of Arrhenius and Birkeland, he formulates his own theory in the following words:—"I think that the Auroræ Boreales are luminous phenomena produced in the upper atmosphere by the Hertzian waves emanating from the Sun."

In support of this belief he discusses each of the phenomena attending the appearance of auroræ, and shows that the forms and orientation, the extension, the frequency, the height, the spectrum and the diurnal, annual and undecennial periodicities may all be explained by the application of his theory. In discussing the relations between auroræ, solar disturbances and magnetic storms, he states that the emission of the Hertzian waves becomes more intense in the regions of spots and faculæ at the period of maximum solar activity, and quotes the observed fact that it is only the rapidly moving auroræ (*i.e.* those due to the greater disturbances) which apparently affect the magnetic needles.

ASTRONOMICAL DETERMINATION OF LATITUDE AND AZIMUTH.—In a recent publication of the Royal Geodetic Commission of Italy, Prof. V. Reina gives the details and the results of the astronomical determination of the latitude and azimuth of five selected stations situated near to the meridian of Rome. The main object of this determination was to study the action of the local attraction on these two coordinates. A number of circum-meridian observations of certain fundamental stars were made at each station, and the results are given separately. Auwers's correction to the astronomically determined position is then applied, and the final results are embodied in a table, which also shows the reduction of each position to the "mean pole," the effects of local attraction, and the differences between the results of the astronomical and geodetical determinations.

THEORIES OF THE RESOLVING POWER OF A MICROSCOPE.[1]

GEOMETRICAL optics in its relation to instruments has been studied to great advantage abroad; we in England have of recent years somewhat neglected the subject, with the result that only a small share in the recent advance in lens construction has been ours. The books and papers under review tell us of the advance.

It was in 1878, in his report on the London International Exhibition of Scientific Apparatus, that Prof. Abbe first directed attention to the fact that the further perfection of the microscope as an optical instrument depended on the advance of the art of glass making. With the glasses then at their disposal it was not possible for opticians to get rid of the secondary spectrum of their object glasses; while a glass could be made achromatic for two wave-lengths, the differences in the relative dispersion of the two ends of the spectrum were such that there was an outstanding amount of colour which prevented the attainment of the highest perfection of the image. It was to this fact that the establishment of the now celebrated firm of Schott and Company was due, and the results of Abbe's own work on microscope lenses are summed up in the first volume of his collected papers, which has recently appeared.

The well-known paper, "Contributions to the Theory of the Microscope and of Microscopic Perception," which forms the basis of his work, is here reprinted, and it will be interesting to consider some of the points it raises.

But first let us contrast what is now possible so far as achromatic correction is concerned with what was possible, say twenty years ago. In those days the ordinary flint and crown glasses only were available. In the case of a telescope object glass with a focal length of one metre for the D line, the variation in focal length will, with such glasses, amount to 1·4 millimetres for A′ and 2·2 millimetres for G′. In an object glass using modern glass, such as that designed by Mr. H. D. Taylor, these errors are reduced respectively to −0·1 millimetre and +0·3 millimetre.

These figures are enough to show how much the optician owes to the art of the glass maker.

Turning now to some theoretical matters connected with the microscope which are dealt with by Abbe in his papers, let us consider first the term numerical aperture in its relation to the resolving power of the instrument. We owe to Abbe the introduction of this term, and the realisation of its importance as defining, in certain circumstances, the resolving power of the instrument. By numerical aperture is meant the value of the quantity $\mu \sin \alpha$, where μ is the refractive index of the medium in which the object is placed, 2α the vertical angle of the cone subtended at the object glass by the point in which the axis of the instrument meets the object. Let us suppose, then, that an object is on the stage viewed by transmitted light, and to simplify matters let us suppose the source of light at some distance.

Then, according to Abbe[1] and his followers, in considering the image formed in the focal plane of the eye-piece we are not to start from the object as a self-luminous source and consider where the image of such a source would be if formed by the laws of geometrical optics; we are to start from the source itself, to consider its image formed in the focal plane of the object glass, and to treat this image as a self-luminous source of light in the microscope tube from which arises the image we see.

If the object be small, the focal image will be modified by diffraction due to the object, and according to the views enunciated in the paper before us, it is on the nature of the diffraction images and the number of them which are formed that the definition depends.

We will return later to the question whether it is necessary thus to consider our problem.

At present let us develop it and examine whether it affords us a satisfactory solution of the problem of resolving power.

Suppose, now, the microscope has been focused on some object on the stage and then this object has been removed; the parallel rays from the source are brought to a focus in the focal plane of the object glass, forming there a circular patch of light; rays diverge from each point of this, and reaching the eye produce the sensation of a uniform luminous field.

Now let the field in the focal plane be limited by diaphragms pierced with a series of small apertures. The distribution of light in the focal plane of the eye lens, the view plane, will be no longer uniform; we shall see the diffraction pattern formed there by the apertures.

If, for example, there be but one aperture, a single narrow slit, the field will still be uniform; light diverges from the slit uniformly in all directions, and no structure is seen.

If we have a number of equidistant slits the view plane will be crossed by a series of equidistant dark and light bars. The distance between these bars and the distribution of light between them will depend on the distance between the slits of the diaphragm and the distribution of luminosity among the slits. If this be known, the distribution of light in the view plane can be calculated. If, for example, the distance between the slits be doubled, the distance between the maxima in the view plane will be halved, that is to say, the number of bright bars in a given interval will be doubled. The distribution in the view plane depends on that in the focal plane, and can be calculated from it; this is quite certain.

[1] "Gesammelte Abhandlungen" Von Ernst Abbe.
"Das Zeisswerk und die Karl Zeiss-Stiftung in Jena."
"Zur Theorie der Mikroskopischen Bild-erzeugung." By Victor Grunberg.
"The Helmholtz Theory of the Microscope." By J. W. Gordon.
"The Theory of Optical Images." By Lord Rayleigh (*Journal* of Royal Microscopical Society, 1903).

[1] It was stated recently by Dr. Czapski (*Proc.* Royal Microscopical Society, August, 1903, p. 569) that it would be a mistake to suppose that Prof. Abbe had merely given a grating theory of the microscope; he has treated the matter more fully.

But now, instead of producing a variable distribution in the focal plane of the object glass by means of diaphragms, we can do it by means of the diffraction effects of small objects on the stage.

Thus if we put on the stage a grating consisting of a series of equidistant spaces, and if e be the grating distance, then, taking homogeneous light, a series of narrow bands of light, the diffraction images of the source, will be produced in the focal plane with darkness between them; the central image will be on the axis, and if θ_1 θ_2 . . . be the angular distances between the images, then $\sin\theta_1=\lambda/e$, $\sin\theta_2=2\lambda/e$, &c.

It may be shown that the image in the view plane produced by this series of diffracted images is the ordinary geometrical image of the grating. It should be observed that in this proof there is no discussion of the distribution of light in the interspaces between the maxima, and it is on this distribution that the question of resolving power depends. It is clear, of course, that if we modify the number of spectra in the focal plane we modify the image, and this is done in an ingenious way in some of the experiments arranged by Prof. Abbe's pupils to illustrate the theory.

If we cut out all but the central image the view field is uniform, no structure is visible; if we allow the first image on either side of the central one to become effective, the bands appear in the field in their proper positions, and so on. It is said to be the fundamental result of Abbe's theory that the object, the grating, can be fully resolved if one diffraction image is formed on either side of the central one. It is clear that in this case there will be variations of intensity in the view plane; we shall see later what they amount to.

Now the number of spectra is limited by the fact that some of the diffracted light may be so obliquely diffracted as not to enter the object glass. If 2α be the angular aperture of the object glass measured from the axial point of the stage, then the nth diffracted image will not appear if $\sin\theta_n$ is $>\sin\alpha$, but $\sin\theta_n=n\lambda/e$.

Hence for the nth image to be excluded, $n\lambda/e$ must be greater than $\sin\alpha$, but according to Abbe, for resolution the first diffracted image must appear, and hence resolution is just possible if λ/e is equal to $\sin\theta$.

It has been assumed that air is the medium on either side of the object glass; if on the object side we have a medium of refractive index μ, then it is easy to show that we must replace $\sin\theta$ by $\mu\sin\theta$, and the condition of resolution is that e should be equal to $\lambda/\mu\sin\theta$, or, introducing the term numerical aperture for the quantity $\mu\sin\theta$, we have the result that a grating is resolvable if the space between the lines is not less than the result found by dividing the wave-length of light by the numerical aperture.

Now, while the truth of this result can in certain cases be established, the reasoning given in the books under consideration is insufficient to prove it.

In order to decide if the grating can be resolved we must establish the law of variation of intensity in the view plane, and then consider whether these variations are such that they can be detected by the eye. This has been done by Lord Rayleigh. The images formed in a microscope are, like all other images, produced by interference; in considering resolving power we have to consider diffraction effects it is true, but the diffraction which concerns us mainly is that due to the aperture of the object glass, and only indirectly that due to the object viewed.

Neither is it necessary, if we know completely the distribution of the light over the stage, to go back to the source in our consideration of the problem; having given the distribution over the stage both in amplitude and phase, we are potentially able to determine that in the view plane without reference to the source. Difficulties of calculation may stop us, it is true, but that is another matter.

Let us take, again, the case of a grating illuminated by plane waves, their plane being parallel to that of the grating; we have to consider the effect due to a series of equidistant lines of light; these differ, however, from a series of independent equidistant linear sources in that, with the grating, the phases of the various sources are the same; we have therefore to remember that interference will take place between the light from the different lines, while with a series of independent lines there is no relation between the phases; we can calculate the intensity due to each source separately, and superpose the whole.

Lord Rayleigh's solution of the problem, which is presented when a narrow double line in a spectrum is viewed through a telescope, or when the attempt is made to resolve two close double stars, is better known than his equally valid solution of the grating problem, and as it is simpler it will be useful to indicate it first.

The intensity in the view plane for a single linear source, assuming for the moment that we are dealing with a telescope with a rectangular aperture, is given by a certain curve. If we assume a second independent source parallel to the first we get a similar curve alongside the first. The resultant intensity is found by adding the corresponding ordinates of the two curves, and the lines will appear as double when the drop in the resultant intensity curve is sufficient to be detected by the eye.

Lord Rayleigh suggested that in his case the drop would be just distinguishable when the maximum of intensity due to the second curve was superposed on the first minimum due to the first, and experiment has borne this out. In this case the two halves of the aperture send light in opposite phases to the first minimum, and the angular deflection of the minimum is the angle subtended by the wavelength of light at the distance of the breadth of the aperture. Two lines which subtend a greater angle than this can be resolved.

Similar methods were applied by Lord Rayleigh in 1896 to the microscope, and additional results have been given in his recent communication to the Royal Microscopical Society which follows Mr. Gordon's interesting paper on Helmholtz's theory of resolving power in the *Journal* of the Society. In his paper Mr. Gordon discusses in detail Helmholtz's theory, and points out how far it is from fully explaining all the difficulties of microscopic vision.

In Lord Rayleigh's earlier paper he deals with (1) two independent linear sources viewed through a microscope, and shows that they can be resolved if the distance between them is half that given by Abbe's theory; (2) two sources which are always in the same phase; in this case resolution is impossible if the distance is that given by the theory.

If, instead of having *two* sources, either cophasal or independent, we have a long series, the problem is more complex, but the method is the same. An expression is found for the variations of intensity in the view plane, and the question is considered whether or no these variations are sufficient to be noticed by the eye.

In the paper the question of the visibility of a dark bar on a uniform field is dealt with, and here again a distinction must be drawn between the case in which the field is self-luminous and that in which it is due to a distant source. In the latter case it appears that the image of the bar would be marked by a perceptible darkening across the field, even when the breadth of the bar was but 1/32 of that given by Abbe's theory, though the breadth of this shadow would not be a measure of that of the bar; in the former case the fall in intensity over the geometrical image is only one-half of what it is in the latter. Moreover, we are certain to arrive at erroneous consequences if we apply results obtained from the case of a grating of a large number of parallel slits to a case such as that of a single small aperture through which light is coming or a single small obstacle obstructing the light; the diffraction pattern due to such an obstacle is entirely different from that due to a grating, and the conditions of resolution will be different also.

It appears, then, that while Abbe's theory of microscopic vision is undoubtedly correct in that a small object or objects on the stage produce diffraction patterns in the focal plane of the object glass, and the illumination in the view plane can be inferred from these diffraction images, still this method of regarding the question is not the only possible one, neither is it necessary to go back to the original source if we know the distribution in the object plane. By proceeding, however, in the way indicated by Lord Rayleigh, we can evaluate the distribution of intensity in the view plane, at any rate in certain cases, and obtain thus a numerical estimate of the resolvability.

R. T. G.

FROST EFFECTS AT NIAGARA.

MR. ORRIN E. DUNLAP, writing from Niagara Falls, sends us some striking photographs of ice formations noticed at Niagara during the past winter. An ice bridge formed in the gorge below the Falls in December last, and thousands of persons crossed from shore to shore on this curious formation. Another remarkable object was an ice mountain composed of a massive collection of frozen spray (Fig. 1). Usually this mound rests on the débris slope between the inclined railway building and the falling water, but last winter it bridged the torrent of the American Fall and extended over in front of the Fall. Here a grotto-like effect was caused by the wearing tendencies of the falling water, and the effect was repeated on the outside, or ice bridge side, of the mountain. From the ice bridge the different layers of ice that went to make up the mound could be distinguished.

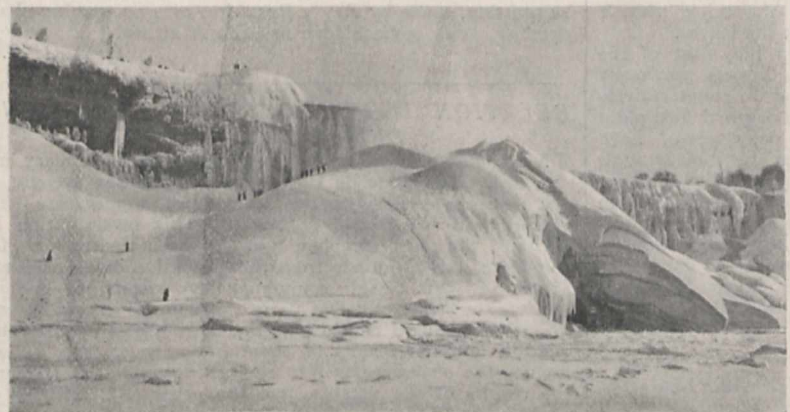


Photo. *O. E. Dunlap.*

FIG. 1.—Mass of Frozen Spray at Niagara.

A part of the face of the cliff over which the American Fall usually flows was hidden under huge icicles that hung from the brink to the talus at the foot of the precipice. In Prospect Park the ice that gathered on the trees was very destructive. The ice grew so heavy that the largest trees lost many branches, and some were left with only their trunks.

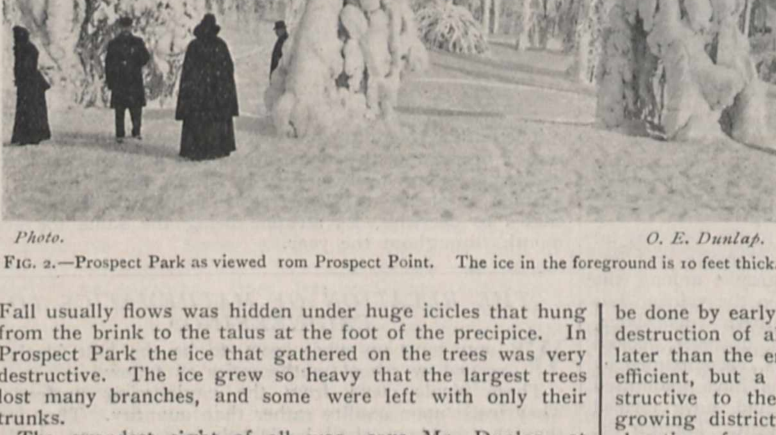


Photo. *O. E. Dunlap.*

FIG. 2.—Prospect Park as viewed rom Prospect Point. The ice in the foreground is 10 feet thick.

The grandest sight of all was, says Mr. Dunlap, at Prospect Point in the middle of February. The wind blew from the south-west, and the spray of the American Fall fell upon the Point, where it was frozen with great rapidity. Every hour added to the mass, until finally it was more than 30 feet high from the water as it plunged over the American Fall. The mound extended back into the park, half burying trees that were already weighted with great loads of ice (Fig. 2). One of the accompanying illustrations shows this ice mound. Realising that the mound might damage the lower section of the inclined railway building or cause loss of life among the many who climbed about the ice and mountain below, it was resolved to try to blast it away. To accomplish this holes were drilled along the upper river side, and eight sticks of dynamite placed in them; but their explosion accomplished little, owing to the slight resistance offered by the ice.

A FORMIDABLE ENEMY TO THE COTTON PLANT.

GREAT alarm has been caused in America by the ravages and rapid spread of a new insect pest, the Mexican Boll-weevil (*Anthonomus grandis*, Boheman), which was described from Vera Cruz in 1843, but first attracted serious notice in the region around Monclova, in the State of Coahuila, Mexico, about 1856, and within six years from that time had devastated the cotton crops to such an extent that the cultivation of the plant was actually abandoned in the neighbourhood. Thence the insect extended its ravages north and east until it reached Matamoras, at the mouth of the Rio Grande, the river which forms the boundary between Mexico and Texas.

In 1892 the weevil crossed the river, and by 1894 had spread throughout the cotton region of southern Texas. In 1894 the damage done in many of the infested districts, both in Texas and Mexico, was estimated at no less than from 50 to 90 per cent., and the American Government was strongly urged by the entomologist who prepared the first official report on the subject (Mr. C. H. Tyler Townsend) to take instant and drastic measures to try to stamp out the pest. However, nothing was done, and with some fluctuations the insect continued to spread, and though the American entomologists reported on it from time to time in "farmer's bulletins" and elsewhere, it was not until June, 1902, that funds were allotted for experiments on a large scale. At present the insect is still confined to Texas, but already the infested area is estimated to include about 1/28th of the whole cotton district of the United States, and there is now no reasonable probability of either stamping out the pest or preventing its extension within the next twenty years over the whole cotton-growing region of the southern United States, nor is there any probability that its attacks will become less serious with the lapse of time. The loss in Texas alone in 1902 is variously estimated at from 8 to 25 millions, and though other causes may have contributed to the deficient crop, there is no doubt that it was largely due to the attacks of the weevil. Still, much can be done by early planting and thorough cultivation, and the destruction of all stalks and other refuse by burning, not later than the end of September. Poison and traps are inefficient, but a cold December and January are very destructive to the insect; nor has it attacked the cotton-growing district of Laguna, in Mexico, which lies at an elevation of 3500 feet.

At length the authorities are roused, and the American House of Representatives has lately passed a Bill for the appropriation of a sum of 250,000 dollars for the extermination of the pest. But we fear that it is too late now to do more than to oppose the insect by special methods of cultivation, and to institute stringent measures to try to prevent the invasion of districts not yet attacked.

The weevil itself is a greyish beetle, very similar in shape to our own destructive apple weevil (*Anthonomus pomorum*, L.), which belongs to the same genus, but it is larger, measuring nearly a quarter of an inch in length. The eggs are laid singly in the "squares" or buds, which afterwards fall, or else in the "bolls" or seed-pods, in one of which latter sometimes as many as twelve of the thick whitish grubs may be found. They do not attack the leaves.

The history of this insect is curiously like that of the Colorado potato beetle. In both cases insects previously only known to entomologists, and feeding in comparatively small numbers upon some wild plant (the original food-plant of the Boll-weevil has not yet been determined), have attacked a cultivated plant, and increased enormously with devastating effects, and spread over a large tract of country. One subject which demands immediate attention from Governments (apart from those of countries already infested) is the instant adoption of any precautionary measures which may be necessary to prevent the danger of the insect being carried from Texas or Mexico to other cotton-growing countries, such as Africa or India.

W. F. Kirby.

GEOLOGICAL STUDIES IN PERU.

The third number of the *Boletín del Cuerpo de Ingenieros de Minas del Peru* (Lima, 1903), by Francisco Alayza y Paz-Soldán, director of the survey, raises several matters of general interest to geologists. It deals with the districts of Moquegua and Tacna, including some striking volcanic country between the Andes and the coast. The terrific eruption of Huainaputina in 1600 has left its traces in immense deposits of scoriæ across the adjacent country;

Fig. 1.—Ground disturbed by subsidence, Pallata.

the crater of the mountain was completely blown away, and a barrier was formed by the ejected blocks, strong enough to convert the Tambo River for twenty-eight hours into a lake. Part of the devastation was due to the bursting of this barrier, and the phenomena of earthquake and explosion justify the ranking of this catastrophe among the greatest in the human period. Since 1600 the volcano has become completely extinct. Its northern neighbour, Ubinas, on the same line of activity, is, however, looked on with suspicion, and still emits vapours, accompanied by a continuous roaring. These emanations have kaolinised the felspars in the surrounding lavas, and have formed alums, anhydrite, and sulphur near the vent. Though the last eruption, about which little is recorded, took place in 1662, it was of cataclysmic magnitude, and the author points out that repetitions may reasonably be expected.

Disturbances of quite another nature are described from Pallata, where sudden fractures of the volcanic surface have occurred as recently as 1902, leading to both depression and elevation. These are traceable to the absorption of water by the underlying tuffs, much as, according to Arcidiacono, the "earthquake" of Nicosia in 1901 was caused by the swelling up of clays during a rainy season, beneath a series of Miocene sandstones. The four excellent illustrations make us desire more from this little known region of Peru. It is unnecessary to emphasise the importance of the volcanic chain in connection with the Pacific coast-line, and with the suggestion, made by Rey y Bassadre, of a companion chain opening along some hidden fissure out at sea.

G. A. J. C.

RELATION BETWEEN TEMPERATURE AND ELEVATION.

In a communication to the *Comptes rendus* of January last Prof. Teisserenc de Bort gave a condensed account of the research relating to the decrease of temperature with elevation in the region of Paris. This investigation is, perhaps, the most complete that has been undertaken, for the deductions are made from the discussion of an excellent series of 581 aërial soundings by means of *ballon-sonde* extending over five years. From so many observations the general conclusions are therefore of considerable weight, and the results of great importance. The author divides the observations into two groups, one (A) showing the results of 581 ascents, and the other (B) restricted to 141 ascents when the altitude attained fourteen kilometres. In the tabular statements which accompany the paper the temperature values are given for every 500 metres up to a height of 5000 metres, after which values for each kilometre rise are adopted; the results are also grouped to show the changes between the four seasons of the year. Two sets of values for the air temperature in degrees Centigrade are given here, namely, those obtained during summer and winter, the letters under each heading belonging to the groupings previously referred to:—

Altitude	Summer		Winter	
	A	B	A	B
Ground	+13·5	+13·0	+ 1·7	+ 1·9
500 m.	+13·9	+13·6	+ 1·1	+ 1·4
1,000	+11·8	+11·8	− 0·4	− 0·2
1,500	+ 9·2	+ 9·7	− 1·9	− 0·2
2,000	+ 6·8	+ 7·3	− 3·7	− 1·4
2,500	+ 3·3	+ 5·0	− 5·7	− 3·7
3,000	+ 1·7	+ 2·1	− 8·2	− 6·0
3,500	− 0·4	+ 0·2	−10·9	− 8·7
4,000	− 3·4	− 2·7	−13·6	−10·9
4,500	− 5·9	− 5·3	−16·7	−14·2
5,000	− 9·3	− 8·3	−19·8	−17·0
6,000	−15·3	−14·8	−26·4	−23·7
7,000	−22·3	−21·7	−33·6	−31·5
8,000	−29 9	−29·3	−40·8	−39·0
9,000	−37·9	−38·0	−47·4	−46·9
10,000	−45·2	−45·3	−52·9	−54·0
11,000	—	−50·3	—	−57·9
12,000	—	−52·7	—	−57·9
13,000	—	−51·5	—	−56·9
14,000	—	−51·3	—	−55·5

The author refers in some detail to the peculiarities of the rate of decrease of the temperature, and indicates the "zone isotherme" previously noted by him, which lies at an altitude of about 11 kilometres, in which the temperature ceases to decrease, its altitude being the same for every month throughout the year.

THE RELATION OF MATHEMATICS TO ENGINEERING.[1]

We may sum up what seem to be the best ideals in secondary school mathematics as follows:—

These ideals come from the engineering professions. They insist upon quality rather than quantity. They insist that the problems shall be largely concrete and shall be worked out to an accurate numerical result. They insist

[1] Abridged from an address delivered by Prof. C. A. Waldo, as president of the section of mechanical science and engineering of the American Association, at the St. Louis meeting.

that the thought shall precede the form, that the symbol shall not conceal the thing symbolised. They insist that systematic and progressive problems based upon every-day experience and observation shall be, to a much greater extent, the materials of education. They demand that the several elementary mathematical subjects, from arithmetic to the calculus, shall develop side by side in the boy's mind. They demand that the mastery of these subjects shall be more the work of the judgment than of the memory. They demand that from first to last, at least during the secondary period, mathematical ability and the ability to think clearly, investigate closely and conclude correctly shall develop together, and to the extent that four well-spent years will on the average permit. Those who formulate these ideas contend that they lead to the correct mathematical training for all professions and all careers.

The proposition that mathematics is the very bone and sinew of an engineering course needs no discussion. It is everywhere conceded. The extent and nature of the mathematical element in the curriculum, however, are two decided fluents with curves of opposite slope. More mathematics but fewer kinds seems to be the tendency. The opinion appears to be gaining ground that the purely descriptive and highly specialised and professionalised elements in our technical courses should be reduced, while more subjects with a mathematical basis, with long unbroken continuity and bound together with a strong logical element should command the attention of the student to the end of his undergraduate period.

Upon the question as to what mathematical subjects shall the undergraduate courses include in our technical colleges, opinions are decidedly at variance. Upon the four ordinary elementary subjects the sentiment is practically unanimous, but these should be principally taught in the secondary schools. The practical people, however, are inclined to relegate analytic geometry and the calculus to the scrap pile. To such subjects as vectors, theory of functions, theory of groups, they allow no place whatever.

One cannot but feel that this verdict against analytic geometry and the elementary calculus—not to mention higher subjects—is a great pity. Especially does it seem true when we recall that instruction in these two lines forms the principal mathematical element of the second and third years of the ordinary technical course, and that the calculus itself is probably the most powerful and wonderful tool for investigation that the genius of man has ever contrived.

Why do practical men almost unanimously place calculus among the dispensable elements of a technical curriculum? The answer, of course, is very simple; they have never found any use for it, probably because they have never learned how to use it. Yet they dare not pronounce against it altogether. They know that Rankine and Maxwell were master mathematicians, and that through this mastery of the most powerful of tools they were able to do for terrestrial what Newton and Laplace did for celestial mechanics. In college the engineer has not learned to use the modern tool called the higher analysis; it remains to him as foreign currency. Out of college he has not time to learn its use.

The most effective teaching of the higher analysis will be possible only when reforms in mathematical instruction have permeated the principal secondary schools.

The teacher should be saturated with his subject. Not only should he be strong and apt on the formal side, but more important still, its inner meaning should be clear to him and its close relation to the phenomena of the objective and subjective life. Some contend that the only man to whom the mathematics of a technical college can be entrusted is an engineer. Does that make any difference? Rather are not these the essential questions? Does the man know his subject? In his teaching can he assemble from engineering and other records the material that will vitalise his work? Is he in sympathy with engineering essentials and ideals?

Throughout the college course the teaching should be mainly concrete. The problem, say from the physical sciences including engineering, should first be presented concretely. It should then be stated in mathematical symbols. The operations performed upon the symbols should be accompanied by drawings or models, the final result reduced to numerical form, and then interpreted in language. Upon every problem the student must bring to bear the whole range of his acquired powers and be taught to select the shortest method within his ability.

In other words, all typical problems should receive a threefold consideraton:—(*a*) its statement in words, and the statement in words of its solution when effected; (*b*) its graphical statement and solution, involving geometry and mechanical drawing with squared paper; (*c*) its analytic statement and solution, ending with a numerical result.

The purely formal should be presented as a necessity arising from the so-called practical, and in order that a body of knowledge and technical ability may be accumulated which will give the student easy control over the practical in whatever one of its various forms experience shows that it may arise.

The problems chosen should be progressive in character, and their mastery should amount to a complete laboratory course in all that part of the higher analysis in which it is desirable that the engineering student should be well versed.

The course should be lecture and seminarium and individual, more after the manner of the German Technische Hochschule. The text-book should become a book of reference. The instructor should know clearly and be able to state accurately the limitations of his methods, but abstruse discussions of obscure points should be postponed as long as a due regard for logical development will allow. Time is wasted in removing difficulties the existence and importance of which the student has not yet recognised.

These are some of the necessary extensions into college work of the reformation now urged upon the secondary schools, and though every one of them seems familiar enough when taken separately, all together their united application to the mathematical courses in our technical colleges amounts to a departure from our present traditional methods little short of revolutionary.

In recent years mathematical instruction in the United States has greatly improved in its thought content, but it has responded slowly and conservatively to modern methods. We are still more English than German. In the work of training a master of the physical sciences the text-book and the senseless repetition of words and formulas have been replaced by the lecture, the laboratory and the seminarium. Why should not mathematics, so intimately related to them, follow their lead and partake in the benefits of modern methods carried to their legitimate and logical completion?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

HARVARD UNIVERSITY has, we learn from *Science*, received a gift of 50,000*l*. from Mr. David Sears, of Boston, a graduate of the class of 1847.

A COMMEMORATION day will be celebrated at Glasgow University on April 19, when an oration will be given by Sir William Ramsay on Joseph Black, who was lecturer on chemistry from 1756 to 1766 in the old college.

DR. HAROLD JACOBY, adjunct professor of astronomy at Columbia University, New York, has been promoted to a professorship. Prof. Jacoby will continue as acting director of the Columbia University Observatory during the absence of Prof. Rees on account of illness. Dr. C. L. Poor, formerly at the Johns Hopkins University, has also been appointed a professor of astronomy, and will be associated with Prof. Jacoby at Columbia.

THE governing body of the South-western Polytechnic, Chelsea, has unanimously appointed Mr. Sidney Skinner, of Christ's College, Cambridge, to the position of principal in succession to Mr. Herbert Tomlinson, F.R.S., who is retiring. Since 1888 Mr. Skinner has been attached to the teaching staff of the Cavendish Laboratory at Cambridge, and also has acted as lecturer and director of natural science studies at Clare College. Mr. Skinner will take up his duties at the polytechnic about the beginning of May next.

LORD CURZON'S scheme for the reform of Indian education, referred to last week (p. 476), has been received with approval in this country, especially in so far as it condemns the dominating influence of the examination system. The whole system of education is to be reorganised with the idea of coordinating all the forces and promoting action in rational directions. A Reuter message from Calcutta states that on Monday, March 21, the Universities Bill was passed by the Legislative Council after a second sitting lasting three days. In the course of a speech upon the objects of the Bill, Lord Curzon said that the university question was a most vital, tremendous, and sacred one, and would have a profound effect upon the future of the people.

A FREE public reference library, having distinctive characteristics, is in course of formation by the London County Council at the Horniman Museum, Forest Hill. The primary intention is to encourage the study of geology and the biological sciences—especially as represented in the Horniman Museum collections—by providing the best books on these subjects, more particularly the works of admitted authority which, by reason of cost and a relatively small demand, are not ordinarily found in libraries freely accessible to the general public.

IT has already been announced that the Committee of the Privy Council has agreed to recommend the scheme for the foundation of the University of Leeds on the understanding that a capital sum of at least 100,000*l*. be raised for university purposes. At a meeting of Leeds citizens held on Tuesday, it was stated that annual grants amounting to about 12,000*l*. have been promised from various public sources, but the power to utilise this additional income effectively will depend to a great extent on the raising of a sufficient capital sum to carry out the extensions. These extensions, with their equipment, will cost not less than 70,000*l*., and an effort should be made to add at least 50,000*l*. to the endowment fund. Promises of nearly 40,000*l*. have been already received. Many of these are, however, conditional on 100,000*l*. at least being raised. The following resolution was unanimously adopted:—"That this meeting welcomes the foundation of a university upon the basis of the Yorkshire College, and expresses its earnest hope that such a capital sum will be obtained forthwith as will enable the university to carry out the important educational purposes for which it will be established."

IN a lecture delivered at Owens College, Manchester, on March 15, Mr. Brudenell Carter laid down the general proposition that if ever the art of education is placed upon a scientific basis, it will properly be regarded as a department of applied physiology. Referring to the educators of to-day, Mr. Carter said that their art is purely empirical, and they work upon a basis of limited personal experience uncontrolled by scientific knowledge or by any general and admitted principles of action. They differ widely from one another on questions which should be placed beyond the reach of doubt, and there is no general recognition of any authority to which they can appeal. In these circumstances it is surely time for physiology to emerge from her seclusion and to apply herself to a systematic investigation into that which is fitting or necessary to be done. The physiologist who desires to elucidate educational problems, the lecturer remarked, is confronted by three of primary importance. The first is to ascertain the conditions which determine the greater or less strength of the brain as a whole; the second, assuming every healthy child to be adequately furnished at birth with brain cells in a rudimentary state, is to ascertain what are the conditions which call those cells into activity or which condemn them to remain only partially developed; and the third is to ascertain what circumstances determine development in one direction rather than in another.

THE Goldsmiths' Company has decided to give up the Goldsmiths' Institute at New Cross on September 29 next, and the staff have received notice that their engagements will be terminated on that date. The reasons for this decision of the company are given in a letter addressed to all members of the staff. The letter states that the funds necessary for the site, buildings, equipment, and maintenance of the institute have been provided out of the company's private resources, and as a consequence the institute has, unlike the other polytechnic institutions in the metropolis, occupied an entirely independent position; but this independence cannot be maintained in the future, for the Education Act has constituted a single authority for the whole of London education, and this body will have supreme power over all schools and institutions maintained by public money. It is desirable that voluntary institutions such as the Goldsmiths' Institute should be coordinated with other metropolitan educational institutions. It has of late been increasingly difficult for the Goldsmiths' Institute to hold its own, and to keep pace with other institutions financed by means of charitable and public funds, and this difficulty will be greatly accentuated in the future, having regard to the fact that the cost of secondary, as well as that of primary, education will be paid for out of the rates. For these and similar reasons the Company has decided to discontinue the institute.

SIR DONALD CURRIE has given 80,000*l*. for the erection of a school of advanced medical studies in connection with University College, and in this way has removed the only impediment to the complete incorporation of University College with the University of London. In a letter to Lord Rosebery, the Chancellor of London University, and Lord Reay, president of University College, making known his generous intention, Sir Donald Currie says he gives the sum necessary for the purpose knowing that when the incorporation has been accomplished, University College "will be maintained as a centre of wide academic culture, and that anatomy, physiology (including pharmacology), biology, chemistry, physics, &c., which are subjects of preliminary and intermediate medical study, will still continue to be taught there." In addition, Sir Donald Currie has given a further 20,000*l*. to provide a suitable nurses' home and accommodation for medical students, and his daughters have given 2500*l*. to furnish the home and to secure a library for it. In thanking Sir Donald Currie for his magnificent gift, Lord Rosebery and Lord Reay point out that the donation will assist the university and the college to carry out the scheme of incorporation which it is believed will be of the highest importance to the future of university education in London, and will direct the course of the university authorities along the line of development by which London may be made the seat of a university worthy of the metropolis of the Empire.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 3.—"The Optical Properties of Vitreous Silica." By J. W. **Gifford** and W. A. **Shenstone**, F.R.S.

The authors have made a number of measurements of the optical constants of vitreous silica, which substance, owing to its uniformity of composition, to its great transparency to ultra-violet radiations, and to its not being doubly refracting like quartz, seems likely before long to play an important part in optical work.

At present it is rather costly, but this difficulty is rapidly being overcome.

The prisms used by the authors were made by processes already described in our columns (NATURE, vol. lxii. p. 20, and vol. lxiv. p. 45). The uniformity of the new glass was tested by building up a compound prism from four slabs of silica, prepared separately, by cementing them one above another and then cutting a prism from the mass. This was compared with a similar prism made from four pieces of borosilicate glass (Schott's No. 0·364), all from the same melting, and was found to be distinctly superior in its performance to the latter.

The paper includes a curve for a thin doublet of fluorite achromatised with vitreous silica which shows that the focal length of the combination is almost independent of the wave-length, also a list of focal lengths for a lens of fluorite and vitreous silica, and a table of the partial and proportional dispersions of fluorite, vitreous silica and quartz.

The following refractive indices for vitreous silica are recorded in the paper :—

Wave-length	Index	Wave-length	Index
7950 (Rb)	1·453398	2748·68 (Cd)...	1·496131
A′ 7682·45 (K_α)	1·4538915	2573·12 ,, ...	1·503707
B′ 7065·59 (He)[1]	1·455180	2445·86 (Ag)	1·51096
C, 6563·04 (H_α)...	1·4564147	2312·95 (Cd)	1·519373
D 5893·17 (Na)...	1·4584772	2265·13 ,, ...	1·523053
A 5607·1 (Pb)...	1·459507	2194·4 ,, ...	1·529103
E 5270·11 (Fe)...	1·4609945	2144·45 ,,[2] ...	1·533898
F 4861·49 (H_β)...	1·463165	2098·8 (Zn)...	1·538547
G′ 4340·66 (H_γ)...	1·4668500	2062·0 ,, ..	1·54271
H′ 3961·68 (Al)...	1·470542	2024·2 ,,[3] ...	1·54721
3610·66 (Cd)...	1·475112	1988·1 (Al) ...	1·551990
3302·85 (Zn)...	1·480610	1933·5 ,,[4] ...	1·55998
3034·21 (Sn)...	1·486881	1852·2 ,, ...	1·5743

Temperature Refraction coefficient for D for 1° C. – 0·00000346.

Note.—The number of figures in each index indicate the estimated freedom from errors of observation. The following interpolated indices (see focal curves) are in all probability more correct for the wave-lengths given:—

[1] 1·45516. [2] 1·53392. [3] 1·54728. [4] 1·56003.

Royal Astronomical Society, March 11.—Prof. H. H. Turner, president, in the chair.—The secretary gave a short account of a paper by Prof. Ernest W. **Brown** on the degree of accuracy of the new lunar theory, and on the final values of the mean motions of the perigee and node.—An account was also given of a paper by Mr. E. **Nevill** on the comparison between the purely theoretical and observed places of the moon, containing some criticisms of Mr. Cowell's note on the errors of the moon's tabular longitude published in the November number of the *Monthly Notices*.—Prof. **Turner** read a note on the instrumental errors affecting observations of the moon, in which he concluded that it seems probable that meridian instruments may give very different values for the parallactic inequality, and that the results derived by Mr. Cowell, especially that for the sun's parallax, must, until these instrumental errors have been more fully discussed, be received with caution.—Mr. **Cowell** read a paper on methods of analysis of the moon's errors, with some results.—The **Astronomer Royal** described the volume of the Greenwich Astrographic Catalogue, now in course of publication. The determination of positions and magnitudes of the stars was discussed, and the probable errors of photographic star places compared with those obtained from meridian observations.—Mr. **Furner** read a paper by Mr. **Storey** and himself on the absolute proper motions of certain double stars showing large relative motion.—Mr. **Maunder** read a paper by Mrs. **Maunder** and himself on the date of the passage of the vernal equinox from Taurus into Aries, illustrated by photographs of Babylonian tablets.—Other papers were taken as read.

Royal Meteorological Society, March 16.—Captain D. Wilson-Barker, president, in the chair.—Mr. Richard H. **Curtis** delivered a lecture on water-vapour.

PARIS.

Academy of Sciences, March 14.—M. Mascart in the chair.—On the solubility of silicon in zinc and lead : Henri **Moissan** and F. **Siemens.** Silicon commences to dissolve in zinc at a temperature of about 550° C., and at 850° C. the molten metal contains about 1·62 per cent. of silicon. As the temperature increases the solubility increases very rapidly. Silicon commences to dissolve in lead at a much higher temperature than in zinc, about 1100° C., and only 0·79 per cent. is dissolved at the boiling point of the lead. The results are expressed in the form of curves.—On a new mode of formation of calcium carbide : Henri **Moissan.** By the electrolysis of fused calcium chloride, or better, of a mixture of fused calcium fluoride and chloride, in a graphite crucible, the metallic calcium formed combines partially with the carbon, forming calcium carbide. The yield is poor, but the observation is interesting, since the carbide is formed in this reaction at a temperature as low as 650° C.—Observations concerning the mode of fructification of the Cycadofilicineæ : R. **Zeiller.** A discussion of the bearing of some recent work by R. Kidston on the views of M. Grand'Eury. It is pointed out that the gymnosperms held a much more important place in the formation of the Coal-measures than has hitherto been supposed.—The comparative actions of heat and the *n*-rays on phosphorescence : R. **Blondlot.** It is known that a rise of temperature increases the intensity of phosphorescence of a faintly luminous screen, but a comparison of this effect with that of the *n*-rays on a similar screen shows important differences. Thus, whilst the *n*-rays increase the quantity of light emitted normally by the screen, they diminish the amount emitted obliquely. The effect of heat, on the other hand, is to increase the light emitted in all directions. An experiment is described by means of which the two effects can be compared on the same screen.—On the paludian character of the plants which form combustible fossils of all ages : M. **Grand'Eury.**—Note by M. **Bertin** accompanying the presentation of an Italian marine atlas published by M. Corazzini.—On an experiment made by the Suez Company for the suppression of malaria by the destruction of mosquitoes : Prince **d'Arenberg.** By the adoption of the preventive measures indicated by Ross and Laveran the mosquitoes in the Ismailia district have been practically destroyed. As a consequence, a very marked diminution in the number of cases of malaria has resulted.—M. Volterra was elected a correspondant in the section of geometry in the place of M. Cremona, M. Brögger a correspondant in the section of mineralogy in the place of M. Carl von Zittel, and M. Flahault a correspondant in the section of botany in the place of M. Millardet.—On perfect ensembles and uniform functions : M. **Zoretti.**—On the optical measurement of the difference between two thicknesses : A. **Perot** and Ch. **Fabry.**—New laws relating to the anomalous propagation of light in optical instruments : G. **Sagnac.**—On the amount of energy set free in a receiving antenna at different distances : C. **Tissot.** By modifying the method described in a previous paper, the author has been able to obtain a bolometer giving a much higher sensitiveness as a detector of the Hertzian waves. A comparison of the energy received at different distances showed that this probably varies as the inverse square of the distance of the receiver from the sending station.—On the disappearance of the radio-activity induced by radium on solid bodies : P. **Curie** and J. **Danne.** The intensity of the induced radiation can be expressed as a function of the time as a difference of two exponentials. These results can be explained theoretically by adopting the views of Rutherford, who supposes that the emanation, acting on the solid walls, creates a radio-active substance which disappears according to a simple exponential law. In disappearing this gives rise to a new radio-active substance, also following a simple exponential law, with a different coefficient.—On the natural rotatory power of certain bodies for the *n*-rays : H. **Bagard.** The rotatory power of solutions of sugar, tartaric acid, and of turpentine for eight groups of *n*-rays has been examined, the rays being distinguished by their refractive indices through aluminium and by their wave-length (Blondlot). For turpentine and sugar, the rotations are in the same sense as with ordinary light, and are normal in that the rotation varies in the inverse sense with the wave-length. For tartaric acid, which produces a dextro-rotation with ordinary light, the rotation is to the left with the *n*-rays. The rotations observed with the latter are several hundred times greater than with ordinary light; thus a solution giving +4° 42′ in a column of 20 cm. length with ordinary light gave −138° with *n*-rays in a column only 0·055 cm. long. It was found that the rotations produced were proportional to the thickness of the solution within the limits of experimental error.—Bishop's circle for 1902–1904 : F. A. **Forel.**—Simple demonstration of the phase rule : A. **Ponsot.**—On an apparatus designed to act as a regulator for a water pump : J. **Meunier.**—The action of carbonic acid upon solutions of sodium nitrite : C. **Marie** and K. **Marquis.** Fresh experiments are adduced in support of the view that nitrous acid is set free from nitrites by the action of carbonic acid, in reply to the criticisms of M. L. Meunier.—On some derivatives of α-campholytic acid and of α-campholenic acid: G. **Blanc** and M. **Desfontaines.**—A method of preparation of aldehydes and the systematic degradation of acids: E. E. **Blaise.**—On a general method of synthesis of the aldehydes: F. **Bodroux** (see p. 496):—A method of estimating vegetable proteids: L. **Beulaygue.**—On two new larval forms of Thrombidium, parasites of man: F. **Heim** and A. **Oudemans.** The names *T. striaticeps* and *T. periceps* are proposed for the new species, which are described in detail, with illustrations.—On some experiments carried out in the laboratory in the catacombs of the Natural History Museum: Armand **Viré.** A study of the modifications produced in animals kept in total darkness.—On a new Cerianthus: Louis **Roule.**—On the secretory mechanism producing pearls: Raphael **Dubois.** The formation of the pearl cannot be considered as due to a simple ordinary secretion, the organic skeleton and the calcium carbonate not being secreted by the same element.—On the distribution of the chemical elements in the earth and its possible relation with the atomic weights: L. **de Launay.** From the considerations adduced by the author it would appear that whilst the earth was still in a fluid state the elements already constituted arranged themselves at distances from the centre which were greater as the atomic weights were smaller, as if, in fact, the atoms, absolutely free from all chemical affinity at such high temperatures, had obeyed, in a fluid sphere in rotation, a central attraction combined with centrifugal force.—On a new variety of orthose: L. **Duparc.**—The generalisation, by means of the nerves, of the action of the *n*-rays applied to a point of the organism: Augustin **Charpentier.**—The insufficiency of development of toxic origin: MM. **Charrin** and **le Play.**—The action of formaldehyde on milk: A. **Trillat.** The casein of milk is rendered absolutely insoluble by the action of very small amounts of formaldehyde. At the same time the antiseptic is not fixed by the albumenoid, and is free to exert its well known injurious effects when taken into the digestive system. The effect of the addition of this antiseptic to milk is thus doubly injurious.—On the essence of *Artemisia herba alba*: E. **Grimal.**

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part vi., 1903, contains the following memoirs communicated to the society:—

October 31, 1903.—S. **Nakamura**: On the law of the velocity of light in tourmaline. R. A **Houstoun**: On the action of a transitional stratum in total reflection.

November 28, 1903.—G. **Herglotz**: Contribution to the theory of electrons.

December 12, 1903.—H. **Gerdien**: Measurements of the electrical conductivity of free air during four balloon ascents.

The *Proceedings* of the society include a discourse, by Prof. Verworn, on natural science and cosmical theory; an address of congratulation on his jubilee to Dr. Lipschitz, of Bonn; and a note by F. Klein and K. Schwarzschild on a recently published portrait of Gauss at the age of twenty-six, which they decide to be in reality a portrait of Bessel.

DIARY OF SOCIETIES.

THURSDAY, MARCH 24.

ROYAL SOCIETY, at 4.30.—Croonian Lecture, on the Chemical Regulation of the Secretory Process: Prof. E. H. Starling, F.R.S., and Dr. W. M. Bayliss, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Direct Reading Measuring Instruments for Switchboard Use: K. Edgcumbe and F. Punga.

FRIDAY, MARCH 25.

ROYAL INSTITUTION, at 9.—Liquid Hydrogen Calorimetry: Prof. Dewar, F.R.S.

PHYSICAL SOCIETY, at 5.—Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance: Prof. J. A. Fleming, F.R.S.—A Hot-wire Ammeter for Measuring very small Alternating Currents: Prof. J. A. Fleming, F.R.S.—The Energy of Secondary Röntgen Radiation: C. G. Barkla.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Relative Advantages of Continuous and Alternating Current for Traction Purposes: J. M. Kennedy.

SATURDAY, MARCH 26.

ROYAL INSTITUTION, at 3.—The Life and Work of Stokes: Lord Rayleigh.

MONDAY, MARCH 28.

INSTITUTE OF ACTUARIES, at 5.—On the Valuation of Whole-life Industrial Assurances, with Allowance for Lapses: T. G. Ackland and J. Bacon.

TUESDAY, MARCH 29.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Lowering the Sill of the Ramsden Dock, Barrow-in-Furness: L. H. Savile.—Burntisland Harbour; Construction of the East Dock: R. Henderson.

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