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## The Potash Position.

THE situation of Great Britain as regards a due supply of potash is again attracting attention, and the present moment may be looked upon as opportune for briefly reviewing its leading features. Potash is one of the essential requirements of a country like our own; it is used in many ways, mainly in various branches of chemical industry, in glass manufacture, and in agriculture, its application in the last-named being by far the most important. Thus it has been estimated that in 1913 the world's consumption of potash (calculated as $K_2O$) was about 1,000,000 tons for agricultural purposes, as against 135,000 tons for all other purposes. Before the war this consumption was supplied entirely by Germany, chiefly from the mines situated in Germany proper—namely, Stassfurt, Brunswick, Hanover, etc.—and to a much smaller extent from the mines in Alsace, then subject to Germany. All these mines were in German hands, controlled by the Potash Syndicate, which deliberately limited the Alsatian output to 5 per cent. of the total, in order to protect the very large capital that had been invested in the North German potash mines. In 1913 the consumption of potash fertilisers (in tons of $K_2O$) was as follows:—

| | |
|---|---|
| Germany ... ... ... ... | 536,102 |
| United States ... ... ... | 231,689 |
| Holland ... ... ... ... | 43,478 |
| France ... ... ... ... | 33,115 |
| Austria-Hungary ... ... | 25,073 |
| Russia ... ... ... ... | 24,260 |
| Great Britain ... ... ... | 23,410 |
| Other countries ... ... ... | 62,955 |
| | 980,082 |

In that year German land received just about eight times as much potash per acre as did land in this country; it is true that our needs are less in this respect than are those of Germany, first, because our land is on the average much heavier than that cultivated in Germany, thus needing less potash, whilst it appears also to be richer naturally in potash; and, secondly, because some of the crops, such as potatoes, grown in Germany on a far larger scale than here, require more potash. In spite of this, however, there seems little doubt that this country could use with great advantage very much larger quantities of potassic manurial agents than it has done in the past.

Given the raw materials, the preparation of the various finished products is relatively a simple operation so far as chemical manufacture is concerned, so that the question whence we are to obtain the necessary supplies of potash can be answered only by a study of the natural sources available. Before the war these came, as has been seen, wholly from the vast deposits of potassium-bearing salts under German control. Since the recovery by France of the lost provinces of Alsace-Lorraine, our Ally has now resumed possession of the Alsatian potash deposits. These deposits are far more important than their restricted production under the German *régime* would have implied. They underlie an area of some 200 square kilometres, lie relatively flat at a depth of some 600 metres, are up to 4 metres in thickness, and are estimated to contain about 1500 million tons of crude potash salts. In their mode of occurrence, therefore, they present very great advantages over the steep-lying, contorted North German deposits, which lie beneath heavily watered strata, and can be won only by means of difficult and costly methods of shaft-sinking. Above all, the Alsatian deposits are immensely superior in chemical composition to their North German competitors; they are much richer in potash, for whereas the German crude salt averages about 10 or 12 per cent. of $K_2O$, the French deposits contain a proportion that is variously stated as between 18 and 25 per cent. of $K_2O$; moreover, the former contain a large proportion of magnesic chloride, whilst the latter are practically free from this objectionable impurity.

In addition to the Alsatian and German deposits, a number of other deposits are known. There are deposits in Galicia, which have been worked in a small way for some years, as also at Erythrea, in Italy, and the existence of a number of others that have not yet been worked has been recorded. It appears that the recently discovered deposits in Catalonia, Spain, are likely to prove quite important. In several parts of the world lakes rich in potash salts have been worked—*e.g.* in Tunis, in Chile, and in the United States. Those in the last-named country occur in Central Nebraska, and produced salts carrying 40,000 tons of $K_2O$ in 1918, the producing capacity being estimated at 50,000 tons, or about one-half of the total producing capacity of the entire United States.

In this country the only practically available source of supply is the flue-dust from blast-furnaces. It has long been known that this dust contains potash, but the amount was small, and, worse still, very variable, depending largely upon the working of the blast-furnace. As the result of a number of experiments initiated by Mr. K. M. Chance, of the British Potash Co., Ltd., it was discovered that by adding a small proportion of salt to the blast-furnace charge, practically all the potash present could be volatilised as chloride and recovered in the flue-dust. Messrs. Rossiter and Dingley investigated for the above company the percentages of potash in a large number of iron-ores, and published their results in November, 1919, in the Journal of the Society of Chemical Industry. The ores richest in potash are the bedded ironstones of Secondary age, such as those of Northamptonshire, Cleveland, Lincolnshire and Oxfordshire, which showed respectively 0·42 per cent., 0·36 per cent., 0·36 per cent. and 0·30 per cent. of potash. When salt is added to the charge of a blast-furnace smelting these ores, flue-dusts are obtained that contain about 30 or 35 per cent. of $K_2O$ as chloride or other water-soluble salts. Such dust is, therefore, considerably richer in potash than the ordinary manurial salts hitherto supplied from Germany, and it seems probable that it could be applied direct to the land with very beneficial results, though not much work has as yet been done in this direction.

The experiment of adding salt to the blast-furnace charge has as yet been tried in only a few works, and the bulk of the dust thus produced appears to have been worked up for potash salts at the works of the British Potash Co., Ltd., at Oldbury. In the paper already referred to, it is calculated that if the salt process were adopted in every blast-furnace in Britain, potash equivalent to 50,000 tons of $K_2O$ could be recovered annually. This figure is about double that of the British consumption of potash for agricultural purposes before the war, but falls far short of the amount that we really require in this country, whilst it need scarcely be said that nothing even remotely approaching it has as yet been produced, nor does there appear to be the slightest prospect of reaching it for many years to come.

In the meantime, British agriculture needs potash and needs it most urgently. Agriculture is the most vital of our industries, and when the process of destroying our coal-mining industry, and with it our manufacturing industries generally, now apparently in full swing, has been consummated, it will be the only means by which the inhabitants of these islands can continue to exist. It would appear, therefore, that the best policy in our national interests is to help our French Allies to develop as speedily as possible the potash resources of their recovered province, and to obtain from them the supplies of potash which our lands, neglected in this respect during the war, so sorely need. Of course, the potash-bearing blast-furnace flue-dust would continue to be worked up, as it is at present, for the manufacture of high-grade salts of potash, and no doubt it would be able to supply a certain proportion of the British consumption of such salts, and to this extent decrease our imports.

## Human Palæontology.

*Les Hommes Fossiles: Eléments de Paléontologie Humaine.* By Prof. Marcellin Boule. Pp. xi+491. (Paris: Masson et Cie, 1921.) 40 francs net.

ON opening the covers of this magisterial work by Prof. Marcellin Boule, one has the feeling of having entered a court of justice where a severe judge has conveyed to counsel and to witnesses that his cases are to be tried according to the strict law of evidence, and that he will stand no nonsense. All the cases on which is based our conception of the antiquity and origin of man come up for review; judgments are duly given in such clear, unmistakable terms that they carry with them an air of finality. For example, there is the case for eoliths—whether they have been fashioned by the hand of man or by Nature;

the judge listens to what Sir E. Ray Lankester and Mr. T. Reid Moir have to say for the worked flints from the Pliocene deposits of East Anglia. A decided verdict is given against them, because, so the judge asserts, it is impossible to tell Nature's handiwork from that of man! For the learned judge that ancient stone culture known to experts as Chellean, which many archæologists regard as marking a high point in man's skill as a worker in flint, is the earliest that can be attributed to human hands. He admits that there must be preceding and more primitive stone cultures, but Prestwich and Harrison, and also M. Rutot who has espoused the cause of eoliths "by the publication of an avalanche of pamphlets," were, and are, gravely in error.

Then the famous Piltdown case comes up; our eminent geologist, Dr. Smith Woodward, finds himself very severely handled by our equally eminent geological judge. Our British colleague is censured, in the first place, for giving the name Eoanthropus—"dawn man"—to the being discovered by Mr. Charles Dawson at Piltdown; this name, in the judge's opinion, should have been reserved for the early pygmy humanoid form which he expects may turn up any day. Here our learned judge leans on the case of the horse's evolution as a precedent, but it would be well for the reader to remember that the evolutionary histories of men and horses are not on "all-fours," or even on "all-twos." In the second place, Dr. Smith Woodward is censured for creating a new genus of mankind by fitting the lower jaw of an extinct chimpanzee to a human skull. Therein our judge follows the lead of Prof. Waterston and of Dr. Gerrit Miller. The latter has even given a name to the owner of the Piltdown mandible—*Pan vetus*. Prof. Boule does not like the American way of naming chimpanzees, and so has rechristened the supposed real owner of the mandible, *Troglodytes Dawsoni*! Nor are these all the points in the Piltdown verdict; Dr. Smith Woodward, it seems, in spite of his ultra-caution, is also in error as to the date at which this chimpanzee-man was, or chimpanzee and man were, alive on our Sussex weald. Dr. Smith Woodward, erring on the side of safety, placed them just before, or at the dawn of, the Chellean culture period; the verdict now delivered is that Dawson's man and Dawson's chimpanzee are later—towards the close of the immense span of time covered by the Chellean period. England had a different configuration then, but all are agreed that at the close of the Chellean, or early in the Acheulean, period our climate was much what it now is. Under such climatic conditions one can understand how Dr. Smith Woodward's Eoanthropus eked out a livelihood; but how a chimpanzee succeeded in this feat neither Prof. Boule nor Dr. Gerrit Miller has given us any enlightenment.

An equally erratic judgment is passed on the fossil remains discovered by Dubois in Java. Pithecanthropus is declared to be a giant gibbon moving towards the human stem. Verdicts such as these need not be taken so seriously as they are delivered. Even expert geologists, anatomists, and archæologists will have some sense of the humorous situation we have reached in human palæontology. For the benefit of those who keep an anti-Darwinian eye on what is passing in our anthropological courts, it may be well to explain that Prof. Boule is a convinced believer in the truth of evolution, is certain that man has descended from a simian form, and is confident that we shall find his ancestry in Miocene or earlier deposits. He admits, too, that modern man is more closely related to anthropoid apes than these are to Old World monkeys. The dispute turns on the particular route by which man has travelled to his present estate. The only evidence which will serve as guide has to be gleaned by a long and arduous study of the anatomy of Primates, and, with all due deference to our eminent French colleague and to Dr. Gerrit Miller, it is the opinion of the reviewer that neither the one nor the other has shown competence in this respect.

It is true that Prof. Boule denounces as utterly untrustworthy the Cuvierian axiom—namely, that any animal form may be reconstructed from a single bone; and yet when he comes to the mandible found at Piltdown—a bone showing exactly the same degree of fossilisation as an adjacent skull, of a size to fit the skull, with a texture and structure of bone in keeping with the skull, but with certain features in the mandible itself and in the teeth which are to be seen in the lower jaws of chimpanzees, and also other features which are not—he promptly forgets all about the falsity of Cuvier's axiom, and creates a new species of chimpanzee to get rid of the difficulties with which the Piltdown discovery has confronted him. He forgets, too, that on an adjoining page, when giving his verdict on the Heidelberg mandible, he states that, had he found the jaw without the teeth, he would have assigned it to an ape, but that, had he come across the teeth without the jaw, he would have supposed them to be human. If only the frontal bone of Neanderthal man were known, it would undoubtedly be assigned to a gorilla with a big brain, because it is provided with a great gorilla-like supraorbital ridge. The time has come which Darwin foresaw must come. He anticipated that, as our discoveries approach the point of human departure from a simian stock, doubts must arise as to whether we are dealing with ape-like men or man-like anthropoids, so great must be their mixture of simian and human features. This is the point we have reached in Pithecanthropus and in Eoanthropus, and Prof. Boule has bungled the diagnosis in each case.

Much as we regret to differ from our distinguished French colleague, we own to an open liking for his frank verdicts and to a fellow-sympathy for some of his human failings. He passes the most severe censure on those who venture to reckon the length of geological periods in years, but presently we find that he himself is a fellow-sinner, and gives 125,000 years as a round figure for his Pleistocene period—which begins with the extinction of *Elephas meridionalis*—and that about 10,000 years have elapsed since the Ice age ended. Then, again, he will have nothing to do with genealogical trees of man's descent; but anon we find him guessing just as hard as any of us. He admits that the tree that can be most easily "defended" is one which brings man's phylum off from the root-stock of the anthropoid apes; but all the same he is inclined to go rather deeper for a beginning—to the stock from which anthropoids and Old World monkeys arose—the Darwinian point of departure. Then, again, he expresses the utmost surprise that such a distinguished man of science as Prof. H. Fairfield Osborn should countenance the reconstruction of fossil forms of man. On an adjoining page we find quite a daring reconstruction of the face of Neanderthal man, with all the facial muscles dissected out in the most workmanlike manner. In short, we tender the author of this work our sincere homage; we commend it as a very clear and complete compendium of the evidence relating to man's antiquity and origin—with the proviso that the reader must use his own judgment as to the true bearing which the facts here presented have on the problem of man's evolution.

ARTHUR KEITH.

## British Scientific Instruments.

*Dictionary of British Scientific Instruments.* Issued by the British Optical Instrument Manufacturers' Association. Pp. xii + 335. (London: Constable and Co., Ltd., 1921.) 21*s*.

THE British Optical Instrument Manufacturers' Association, which is one of the industrial associations working in connection with the Department of Scientific and Industrial Research, has just issued this very useful dictionary. The main part of the work consists of a list of British instruments arranged alphabetically, with a brief description of each and an indication as to the firm or firms which supply it. Illustrations of a large number of the more important instruments are also included. Some of these are shown in position at the National Physical Laboratory. The utility of the book is obvious; it serves as a dictionary to the inquirer who wishes to know something about an instrument which he hears mentioned in conversation or reads of in a book; it is also a trade handbook, giving the would-be purchaser at a glance information as to where an instrument he desires to acquire can be obtained. This, however, is not all; the volume illustrates in a remarkable way the activities of the trade, the range of instruments of British manufacture, and the debt men of science owe to the instrument maker. The work has been well carried out, the list is very complete, and cross-references are numerous; the definitions or explanations are clear and concise. Thus:—

"*Galvanometer*.—An instrument for measuring electric currents usually by the deflexion of a magnetic needle in the magnetic field created by an electric current, or by the deflexion of a moving coil, carrying the current, in the field of a fixed magnet. There are thus two main types: the moving magnet and the moving coil galvanometer."

Or again:—

"*Hydrometer*.—An instrument for determining the specific gravity of liquids. Attributed to Archimedes, but not much used until it was re-invented by Robert Boyle. It usually takes the form of a narrow sealed instrument of cylindrical section, and consists of three parts—the counterpoise at the bottom; the bulb containing air; and the stem with the scale at the top. Made of glass or gilt brass. In the latter case the hydrometer is usually provided with weights which are slipped over the stem and alter the buoyancy of the instrument so as to adapt it to liquids of various specific gravities."

Useful illustrations of various patterns of galvanometer are given; it is a mistake, however, to spell Sir Wm. Thomson's name with a "p," and the astatic mirror galvanometer figured is one of his.

But there is more in the book than this dictionary. Meteorology, navigation, and astronomy have long been subjects of investigation, and many of the instruments described have been devised in order to facilitate the study of the weather and the stars, or to assist the navigator on the trackless waters. Hence there have been included very interesting accounts of Greenwich Observatory and the long list of distinguished astronomers to whom British instrument makers owe a large debt; of the Royal Meteorological Society, which for seventy years has fostered the study of meteorology and called forth much skill on the part of the instrument trade; and of the manufacture of optical glass in Great Britain.

This last chapter contains a somewhat sad story. The method of making optical glass was discovered by Guinaud, a Swiss joiner, who lived towards the end of the eighteenth century. It was carried on, but without much success, by Guinaud himself with Fraunhofer at Munich, and by one of his sons working with Bontemps at Choisy-le-Roi, near Paris. In 1848 Bontemps came to England and joined Messrs. Chance at Birmingham, and for some years the Smethwick firm produced most of the optical glass required by opticians throughout the world. Some forty years ago Schott and Abbe joined forces, and, carrying to success experiments commenced in 1834 by Harcourt and Stokes, were able to offer glasses with properties needed by the optician. The German Government realised what optical glass meant in time of war, and did its utmost to help the investigators. Then, as now, no support was given by the British Government to the British firm, just as in 1855, when Sir David Brewster did his best to persuade the Government to buy the pair of 20-in. lenses Messrs. Chance had made, "and construct with them the greatest achromatic telescope ever contemplated by the most sanguine astronomer," but could arouse no interest, and until the war the Jena glasses practically held the field.

The position is somewhat different now. Messrs. Chance and Messrs. Wood, of Derby, make successfully a number of the Jena glasses, and as a consequence of the work carried out in the Research Department three glasses have been manufactured with optical constants rather more extreme than any hitherto available. Still, even now the lesson of the last seven years has not been fully learned, and, in spite of all the promises, a trade vital to the defence of the country seems likely to perish before the Government takes the steps necessary for its support.

"Great Britain is proud," as the authors of the dictionary claim, "of her predominating share in creating the science underlying the manufacture of optical instruments. . . . It is only necessary," they continue, "to mention such names as Newton, Young, Brewster, Herschel, Airy, Dollond, Lister, Maxwell, and Rayleigh to realise to what a great extent this country has been responsible for the instrument making of the world." The work under review should help, to no small degree, in the realisation of this truth, and the British Optical Instrument Manufacturers' Association is to be congratulated on having brought such a publication to a successful issue.

## Text-books of Organic Chemistry.

(1) *Treatise on General and Industrial Organic Chemistry.* By Prof. Ettore Molinari. Translated from the third (enlarged and revised) Italian edition by T. H. Pope. Part i. Pp. xv+456. (London: J. and A. Churchill, 1921.) 30s. net.

(2) *A Text-book of Organic Chemistry.* By Prof. A. F. Holleman. Edited by Dr. A. Jamieson Walker, assisted by Dr. O. E. Mott, with the co-operation of the author. Fifth English edition, completely revised. Pp. xviii+642. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 18s. 6d. net.

THE two books under review are in a sense complementary, the one being mainly technical and the other theoretical. The author of the first says:—

"Holleman's treatise is confined to a theoretical and systematic exposition of the many organic compounds, the industrial side of the question and the application of these compounds being almost entirely neglected. It is hence difficult for the student to ascertain which of the thousands of substances described are really of practical importance."

It would be interesting to have Prof. Holleman's opinion of Molinari's treatise. Everything depends upon the point of view of the author and upon the class of student for whom he writes. Both books have their good points, and both are deservedly popular. We should, however, be unwilling to put either treatise into the hands of the beginner, who requires something more elementary, more general in scope, and less specialised in treatment. Having obtained a knowledge of fundamental principles, he could then take up Holleman and supplement it with Molinari. No more satisfactory combination could be made; for neither book is complete in itself.

(1) With all its wealth of detail and illustrations of technical operations, it must be admitted that in Molinari's treatise the philosophical method is conspicuous by its absence. This is partly due to

the arrangement, whereby the principles of structure and the various theories connected with the subject are condensed together in the introductory section, together with the essential facts upon which they are based.

Here is an example taken from p. 16:—

"Kekulé, and independently of him Couper [spelt 'Cooper'], brought to light another most important property of carbon, resulting from its four equivalent valencies. They showed that carbon atoms possess also the property of combining directly one with another."

No one reading this paragraph without previous knowledge would imagine that a theoretical conception was being put forward to explain certain facts, for none of the facts are forthcoming.

It is difficult enough in ordinary circumstances to impress upon the student the importance of separating his facts and his theories, but where theories and facts are jumbled together in this fashion the task is made well-nigh impossible.

Although the treatise does not profess to take into account industrial progress in the different branches of chemistry or statistical data beyond the year 1913, it is obvious that a large amount of additional information has been introduced—*e.g.* on p. 236 there is an interesting account of "Chemistry and the War," n which a description is given of the various "poison gases" and their preparation. Moreover, the increase in bulk in vol. ii. (Organic Chemistry) has made it necessary to divide it into two parts.

(2) The number of editions through which Prof. Holleman's text-book has passed and the variety of languages into which it has been translated afford sufficient evidence of its continued popularity. As previously stated, it is essentially theoretical in character, with passing and rather superficial references to the physical side of the subject. We think the student would be well advised to study this branch of the subject in a special treatise on physical chemistry, where it is treated in a more comprehensive and general fashion. It is impossible for him to obtain adequate information on the physical properties of organic compounds from such scanty descriptions as are given here.

In conclusion, may we suggest that the obsolete glass funnel and cone figured on p. 30 should be replaced by a modern porcelain funnel, and that an alternative and simpler form of melting-point apparatus should be added to the one illustrated on p. 31, which we believe was rarely, if ever, used by its inventor?

J. B. C.

## Forestry in the United States.

(1) *The United States Forest Policy.* By Prof. J. Ise. Pp. 395. (New Haven: Yale University Press; London: Humphrey Milford; Oxford University Press, 1920.) 21*s.* net.

(2) *Forest Management.* By Prof. A. B. Recknagel and Prof. J. Bentley, jun. Pp. xiii+269+iii plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) 13*s.* 6*d.* net.

(3) *Forest Products: Their Manufacture and Use.* By Prof. N. C. Brown. Pp. xix+471. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) 21*s.* net.

(1) THE wise use and the conservation of the wealth of timber still existing in the United States are promoted by a presentation of the history, by a trained economist, of the effects of legislation and Government administration on the ownership and management of American forests from Colonial days to the present time. The author calls it "a story of reckless and wasteful destruction of magnificent forests, and of flagrant and notorious thefts of public lands." The picture, however, is not so dark as this, though the account of the frauds perpetrated under cover of the Free Timber and the Stone and Timber Acts of 1878, and of even later legislation, is very startling.

The idea of forest conservation is not modern. In 1681 William Penn issued an ordinance which enjoined the preservation of one acre in six of the forests of Pennsylvania, while strict laws against forest fires were passed by many of the Colonies. These early measures proved ineffectual. Real progress began with the Act of 1891, which empowered the President to set aside forest reserves out of the public domain still retained by the Federal Government. This has been the means of creating the National Forests, which now aggregate 176,000,000 acres, under the control of a highly trained Forest Service. This splendid work of conservation has been done in the teeth of tremendous opposition, and even now in some quarters there is continual criticism of the policy and operations of the Forest Service. It is, however, generally admitted that a careful classification of all public lands is necessary, and that only those which are fit for agricultural purposes should be alienated. This principle will preserve the National Forests. Prof. Ise's treatise is an animated history of the struggle for the conservation of the forests of the United States, and deserves careful perusal by statesmen and economists in our own Dominions and Colonies.

(2) We doubt whether this book is sufficiently elementary to be of service to the private owners and managers of goods for whose use it was intended. A working-plan document, the headings of which take up ten printed pages, will scarcely appeal to the ordinary forester. The book is not a whit simpler than the well-known manual of Schlich, vol. iii., which for many years has been the recognised text-book on forest management in British and Indian forestry schools.

It may, however, supplement that authority to some extent, for it throws light on forestry terms and usages in America—for example, the advanced student will find in it interesting matter concerning subjects like "log-rules" and "stumpage-values." The chapter on "timber-cruising" will be useful to foresters who intend to practise abroad in wild regions where rough-and-ready methods of estimating the value of timber in virgin forests are the only practicable means. The book concludes with an appendix of useful tables.

(3) This volume treats of the main industries which are dependent for their raw materials on the miscellaneous products of the forest, and we welcome it as the first American text-book on this subject. The author spent ten years of investigation and travel in the United States on its preparation, and has incorporated with his own observations much information from scattered reports and papers. A separate chapter is devoted to each industry, ample details being given of raw materials, processes of manufacture, equipment and machinery, costs, utilisation of waste products, etc., interspersed with specifications, tables, and statistics, and concluding with a select bibliography.

The industries described are important, and include wood-pulp and paper, tanning materials, veneers, cooperage, turpentine, wood-distillation, charcoal, boxes, railway sleepers, poles and posts, mining timber, firewood, shingles, maple sugar, dyewoods, excelsior, rubber, and cork.

Prof. Brown's treatise is appropriately illustrated, and replete with accurate information. It will prove useful to foresters and manufacturers generally, and it should be perused by all interested in the economic working of our own woodlands, for it suggests methods by which thinnings, underwood, and waste timber might be utilised.

## Our Bookshelf.

*The Journal of the Institute of Metals.* Vol. xxiv. No. 2, 1920. Edited by G. Shaw Scott. Pp. xiv + 547 + xi plates. (London: The Institute of Metals, 1920.) 31*s.* 6*d.* net.

THE latest volume of this journal contains an unusually large number of important papers. The May lecture by Dr. Benedicks deals with recent work in thermo-electricity, and gives details of the author's discovery of a thermo-electric effect in circuits composed of a homogeneous metal. These results have been published elsewhere, but they are now brought together in a concise and convenient form. The study of crystal growth in metals which have been subjected to cold work, by Prof. Carpenter and Miss Elam, contains many interesting observations. The authors were fortunate enough to find an alloy which preserves a complete record of successive stages of crystal growth on a prepared surface, and this has enabled them to trace, with remarkable clearness, the course of events throughout a variety of conditions. The difficult system of alloys of aluminium and magnesium has been investigated by metallographic methods by Mr. Hanson and Miss Gayler, the results being recorded in the form of an equilibrium diagram presenting several unusual features. A note by Mr. Dickenson, on intercrystalline brittleness produced by the action of fusible metals on brass under stress, contains facts which bear on the nature of brittleness in general, while another note reviews the evidence for the allotropy of zinc. Several papers deal with practical brass foundry questions, and another describes the experience on war vessels with regard to the corrosion of condenser tubes, on which a committee of the institute and other bodies continues to conduct elaborate investigations. The volume contains, as usual, a very large number of abstracts of papers published elsewhere, and mention should be made of the excellence of the numerous plates of photomicrographs.

C. H. D.

*The Bahama Flora.* By Prof. N. L. Britton and Dr. C. F. Millspaugh. Pp. viii + 695. (New York: The Authors, New York Botanical Garden; London: Dulau and Co., Ltd., 1920.) 37*s.* 6*d.* net.

THE first thing which strikes one on opening this flora is the excellent paper, such as one seldom sees on this side of the Atlantic. Prof. Britton's name is a guarantee of the excellence of the work regarded as a flora; and though some who are accustomed to the older floras will probably find comparisons increased in difficulty by the number of splittings of genera that have been made, no one who has worked with tropical plants in the living condition will be likely to question the necessity of this splitting in a great number of cases. This is the first complete and modern flora of the Bahamas, and many people, not realising that the group is a trifle larger than Jamaica, and much larger than all the remaining British West Indian islands, may be surprised to learn that they contain 995 species of flowering plants.

Prof. Britton states that there is no geological evidence that there was ever land connection to the Bahamas, but the evidence of the flora itself points to such a probability. Inasmuch as the flora contains 133 endemic species out of 995, or 13 per cent., the connection must be far back, as is further indicated by the large proportion of the genera that are also found in Asia—*e.g.* 47 per cent. of the genera of Leguminosæ occur in Ceylon, 42 per cent. of Gramineæ, 30 per cent. of Rubiaceæ. The only endemic genus, on the other hand, is Neobracea, in Apocynaceæ. Taking the families that show genera confined to northern or to tropical America as being the oldest in those regions, one finds them well represented in the Bahamas. Of twenty-nine that have at least twenty genera in each confined to the regions mentioned, all are represented in the Bahamas but Ericaceæ, Gesneraceæ, and Saxifragaceæ. Moreover, they are represented by genera in roughly proportional numbers, the largest ten by 189 genera, the next ten by 85, the next by 42, and so on. Proportional representation like this is hard to conceive if there was never any land connection.

*The Gyroscopic Compass: A Non-Mathematical Treatment.* By T. W. Chalmers. (The *Engineer* Series.) Pp. x+167. (London: Constable and Co., Ltd., 1920.) 11*s.* net.

THE writer of this review read and admired many of the chapters composing this book as they appeared in the *Engineer* during the opening months of last year. The treatment is entirely non-mathematical in the ordinary sense of the term, and the author is to be congratulated on having produced a book which will appeal to all who are interested in gyroscopic action. Moreover, it will be of use to engineers and navigating officers who are responsible for the care of working instruments.

The book begins with an account of elementary gyroscopic phenomena, and this is followed by a clear explanation of the fundamental action of the compass, which, of course, depends on the rotation of the earth, and in no way on the earth's magnetism. The methods of damping out vibrations employed in the various types of instrument in use—the latitude error, north steaming error, the ballistic error, the quadrantal error and its elimination—receive excellent treatment in subsequent chapters. The explanations of the fundamental dynamics involved are clear and sound.

Having explained fully the principles of a gyroscopic compass, the author describes in detail the Anschütz, Sperry, and Brown compasses. The last chapter of the book contains an account of the Anschütz 1912 compass. This sequence is not correct, for in two respects that instrument is a pioneer one.

We have no hesitation in recommending this book. J. G. G.

*The Child Welfare Movement.* By Dr. Janet E. Lane-Claypon. Pp. xi+341. (London: G. Bell and Sons, Ltd., 1920.) 7*s.* net.

WITH a birth-rate nearly as low as it has ever been, and an infantile mortality which is capable of reduction by 30 or 40 per mille, the subject of the preservation of child life has assumed great importance. Dr. Lane-Claypon's book is, therefore, most opportune, and she has compiled a summary of the child-welfare movement which for completeness it would be difficult to equal. All aspects seem to have been dealt with, and little has been omitted. This very completeness, however, entails the inclusion of a mass of detail which tends to make the book dull reading.

The author rightly emphasises the importance of the breast-feeding of infants, and discusses in an adequate manner artificial substitutes. We are inclined to think that she deprecates unduly the value of milk as a food for older children. While it is true that up to a point other and cheaper foods may take its place, the valuable vitamine content of milk renders it a food second to none, particularly in these days when the cheaper vegetable margarines, which contain no fat-soluble A, have to take the place of butter. Moreover, the milch cow gives a much higher return for the energy-value of her food than does the beef steer.

We also think that Dr. Lane-Claypon unduly minimises the incidence and effects of venereal diseases on child life, and we have failed to find any reference to the effects of employment and factory life on the expectant mother.

Appendices occupy nearly 100 pages, and include specimens of leaflets, recording cards, and summaries of various Acts, Orders, circulars, and schemes connected with child welfare.

*Tuberculosis and Public Health.* By Dr. H. H. Thomson. Pp. xi+104. (London: Longmans, Green, and Co., 1920.) 5*s.* net.

THIS little book gives a concise summary of the problem of tuberculosis in relation to public health. While written primarily for the medical profession, the text for the most part is non-technical, and it should prove of value to non-medical readers who are interested in, or may have to deal with, tuberculosis. The matter is up-to-date; for instance, Brownlee's researches on the different types of pulmonary tuberculosis existing in the British Isles are referred to.

The author rightly points out the difference in infectivity of the open and closed classes of cases, an appreciation of which simplifies the measures to be taken to prevent the spread of infection. The schemes of treatment and of the care and control of patients outlined are very much to the point, and constitute an adequate summary on these important subjects. In dealing with diagnosis, a number of useful hints are given on the examination of the chest, the tuberculin reaction, and other aids.

When discussing the tubercle bacillus the author suggests that it may have a cycle of existence outside the body, and lays stress on the possible spread of tuberculosis among cattle by the fouling of pasture, etc., with the infected excreta of tuberculous beasts. R. T. H.

## 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.*]

### Earthworms Drowned in Puddles.

I HAVE long been familiar with the frequent occurrence of dead earthworms in surface "puddles" alongside gravel walks or roads, as described by Mr. Friend in NATURE of April 7, p. 172. I have supposed that they were "drowned" owing to the amount of free oxygen in the stagnant puddles being insufficient for their respiration. So far as I recollect, earthworms are *not* drowned (or, at any rate, not quickly) if they get into cool, clear, running water—which, presumably, contains a larger amount of dissolved free oxygen than does the rain-water accumulated about dead leaves and deoxidising or "reducing" mud. (See on this matter Darwin's "Vegetable Mould and Earthworms," pp. 13–16.) I confess that I do not know the facts as to the percentages of free oxygen and of oxygen-seizing matter in natural fresh-waters, or, indeed, in sea-water, in various circumstances; nor do I know the percentage of free oxygen necessary in water in order that it may—even for the brief period of an hour or two—support the life of an earthworm. I should be glad to know if these quantities have been determined. It is a common practice to kill earthworms for dissection by drowning them, but I think the water used is warmed. Many years ago I employed "normal saline solution" in the dissecting trough.

The respiration of the earthworm is carried out through the fine capillaries in the skin, which exposes a moist surface like that of a "lung" to the atmosphere. It is abnormal for it to be out of contact with atmospheric oxygen, even in the deepest burrows made by the worm. The abundant hæmoglobin in the blood of the earthworm must be kept charged with oxygen by its rapid passage through the extremely delicate capillaries of the skin, separated only from the atmosphere (as is the blood in the capillaries of a lung) by a moist membrane of extreme tenuity. How far this lung-like surface of the earthworm's body can suddenly take on the function of aquatic respiration is a question which some naturalist with a laboratory to work in should determine.

There are one or two striking facts in this connection which deserve consideration. First, there are numerous aquatic "water-breathing" Oligochæta closely allied to the earthworm, but they are not capable of aerial respiration as an alternative. Some of them inhabit black, foul mud at the bottom of ponds, but, as a rule, they inhabit well-aerated waters. The commonest of them all, *Tubifex rivulorum*, is extremely sensitive to the lowering of the percentage of dissolved oxygen in the water in which it lives. A handful of some thousands of these worms, if placed (with a little river-mud) in a basin standing on a "sink" under a tap giving a small stream into the basin which overflows into the sink, will group themselves in a definite order, their heads downwards and their tails free and undulating in a constant rhythm, the blood-vessels in the tails thus carrying on active respiratory gas-exchange. They will flourish thus, grow, and reproduce (by eggs) for months! But if the flow of fresh, oxygen-holding water from the tap is shut off the rhythmic movement ceases, the worms separate and exhibit spiral contortions. They die in the course of a few hours if the flow of water be not renewed, but when it is they at once recover and regroup themselves. I suppose (but have no further evidence) that they are as sensitive to the arrest of their normal aquatic respiration by loss of oxygen-carrying water as the earthworm is to the arrest of its normal aerial respiration by submersion.

On the other hand, it seems that one, at any rate, among our fresh-water worms is fairly tolerant of both the alternative conditions.

The "medicinal leech" (not to mention other leeches, such as *Trocheta viridis* and the numerous land-leeches) can live for many days out of water in "moist" surroundings, and also flourishes in submergence. The integument in the leech and the subjacent structures are firmer, and yet more elastic, than in the earthworm; and (as I showed nearly forty years ago) the branches of a very fine network of capillaries containing hæmoglobinous oxygen-seeking blood are actually distributed *between* the individual units of the single layer of cells which forms the epidermis. This brings them even closer to the atmospheric oxygen than in the earthworm. It seems that the leech shows the possibility of the same surface acting for either aquatic or aerial respiration. The exchange of the one respiratory medium for the other, without change in the respiratory organ, is exhibited by certain pulmonate Gasteropods allied to Limnæus, which in the Lake of Geneva inhabit deep water and take water into the lung-cavity. Conversely, the gill-chamber of some Gasteropods (Cyclostoma) becomes converted into a lung, as is also the case in various fishes liable to conditions of drought.

The presence, and also the absence, of hæmoglobin in the blood and in certain tissues of animals have an important relation to the special adjustment of various invertebrate animals to peculiar difficulties and requirements in regard to the supply of oxygen needful for respiration. I cannot in this letter even state the case adequately. For many years, by use of the microspectroscope, I have accumulated facts as to the distribution of hæmoglobin, but what is now especially needed is experiment and quantitative measurement to determine what is the significance of the presence of hæmoglobin in each case. To cite only a few cases, we ought to ascertain :—

(1) What *exactly* is the function of the hæmoglobin dissolved in the striped muscular tissue of vertebrates?

(2) What is its value in the muscular tissue of the lingual apparatus of all Gasteropods and Cephalopods, though otherwise absent from those animals?

(3) What is the explanation of the single exception to the rule as to glossophorous molluscs just stated, namely, the exceptional presence of abundant hæmoglobin dissolved in the rich red blood of the flat-coiled pond-snail (Planorbis), although it is absent from the blood of the common pond-snail (Limnæus) and of all other Gasteropods and Cephalopods? Again, what is the special value of hæmoglobin in the blood (in the form of red blood-corpuscles) of *Ceratisolen legumen*, whilst it is entirely absent from the common razor-fish (Solenensis) and from every tissue in practically all other Lamellibranchs excepting Arca and Pectunculus, which have (as has Ceratisolen) red hæmoglobinous blood-corpuscles like those of a frog?

(4) What is the physiological significance of the fact that all Hexapod insects of all kinds are totally devoid of hæmoglobin in any of their tissues, excepting the so-called "blood-worm" or larva of the Dipterous midge, Chironomus, in which the blood-fluid (not corpuscles) is richly coloured by it?

(5) Similarly, why of all the great tribe of Crustacea are the archaic Apus (which has blood as red as

that of a vertebrate) and a few water-fleas the only members possessing even a trace of hæmoglobin, excepting one marine fish-parasite (Lernanthropus)?

(6) The only common feature in the "conditions of life" or environment of these exceptional cases of the presence of hæmoglobin is that some of them, viz. the Planorbis snail, the larval Chironomus, and the crustacean Apus, live in stagnant fresh-water, even in black mud, where free oxygen is scarce owing to the decomposition of vegetable débris. But in what special way and to what extent is the hæmoglobin valuable to its possessors, seeing that other closely related species are associated with them and are devoid of hæmoglobin?

(7) One more case must be noted, namely, the very common presence of hæmoglobin in the blood-fluid of the Chætopod worms, both marine and fresh-water, whilst, nevertheless, it is absent from many. In some of these worms "red blood-corpuscles" replace the entire vascular system and its red fluid; they float in the cœlomic fluid. In one case, that of the large and beautiful marine worm, Aphrodite (the "sea-mouse"), whilst hæmoglobin is absent from the blood, it is present in such quantity in the nervous tissue of the great nerve-cord as to give it a ruby-red colour. It also gives a pale pink colour to the great muscular pharynx. In what way does the sluggish Aphrodite benefit by having its nerve-cord saturated with the oxygen-seizing hæmoglobin? Similarly, some few of the remarkable Nemertine worms have hæmoglobin in the corpuscles which float in the fluid of certain vessels, and others have it only in the tissue of the nerve-cord and brain.

To conclude, we might, it seems to me, arrive at some better understanding of the general physiology of respiration in animals were the cases I have cited more accurately (I mean *quantitatively*) investigated; and were the striking facts also held in view, that no Protozoon, no Sponge, and no Coral or Polyp is known to develop "hæmoglobin," whilst in only one starfish and one Holothurian (recent additions to the list may have escaped my attention) has hæmoglobin been recorded, and that in the form of "red blood-corpuscles."

E. RAY LANKESTER.

44 Oakley Street, Chelsea, S.W.3, May 3.

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## A "New" Type of Tool of Mousterian Age.

THE object of this letter is to describe briefly a hitherto unrecognised type of implement of Mousterian age and to ask readers of NATURE for any information they can give me as to its geographical distribution.

Considerable collections of flint—or, more correctly, chert—implements of Palæolithic types were made by myself in 1914, and by Mr. G. W. Murray, of the Survey of Egypt, in the following years. My own specimens are from the western desert, Mr. Murray's from sites discovered by himself in the eastern desert. Both series show a number of tortoise cores of Mousterian age—the age determined not only by type, but also the discovery by myself of a typical core in a hard cemented gravel recognised by Dr. Hume as of Pleistocene age—which have been worked up to produce a type of tool which, so far as I can discover, has not been recognised previously. Before describing this form of implement I must point out that typically domed tortoise cores are not common in Egypt; most cores are flatter, presumably because the nodules from which they were made were oval rather than spherical, and are so trimmed as to have, roughly, the shape of a half of a somewhat flattened pear, the notch indicating the point at which the core is struck being situated at the broad end of the pear.

Regarding the face of the core from which a Levallois flake has been struck as the upper surface, the "new" tool consists in the production at the narrow end of this surface of an upturned point or beak. In its simplest form this is produced by the meeting at the narrow end of the core of the two planes (or facets) bounding the flake-bed left by the removal of the Levallois flake, and of a facet constituting a third plane, joining these at an angle, produced by striking off a flake from near the point

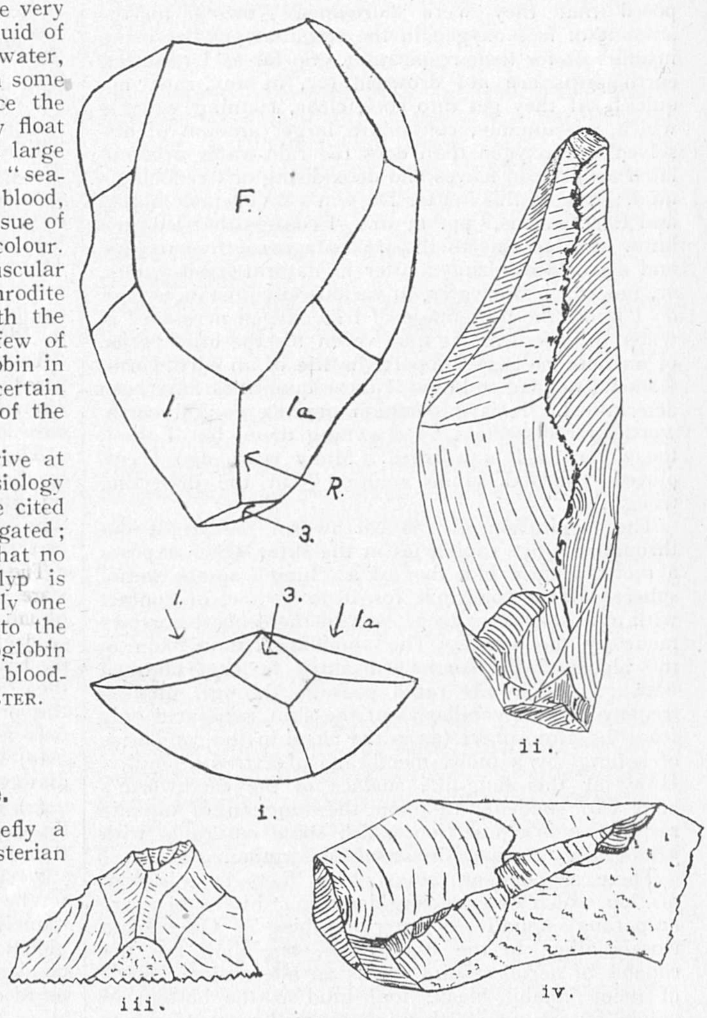


FIG. 1.

of the lower (convex) surface of the core. The diagram (Fig. 1, i.) will make this description clearer; it will be seen that the lower part of the scar-bed of the Levallois flake (F) is bounded by two narrow facets (1 and 1*a*) the intersection of which gives rise to a crest or ridge (R). This crest and its two bounding facets are terminated abruptly by the facet (3) produced by a blow struck on the convex surface of the stone.

Fig. 1, ii., is a somewhat diagrammatic rendering of the side view of an implement of the type described, and shows the heavy triangular point not unlike the beak of a chelonian, which is characteristic of the tool. It is for this reason, and not because these points are commonly worked on a tortoise core, that I propose for them the name of "tortoise point." But although the point is triangular in section in typical specimens, it seems that the blow on the convex surface of the core was not always successful, and in these cases matters were improved by a good deal of secondary working, so that points like those shown in Fig. 1, iii., are not uncommon. Further, although the great majority of tortoise points were worked on tortoise cores, the "point" was at times produced independently; thus Fig. 1, iv., reproduces the front part of a roughly bilobed pebble upon which a particularly good tortoise point has been worked.

The form of these tortoise points indicates that they were used as a heavy drawing tool, *i.e.* used with a drawing or dragging motion while the hand exerted considerable pressure. Additional evidence for this view is offered by a certain number of specimens in which the distal portion of the crest, *i.e.* that nearest the point, shows minute abrasions. The only method of holding the implement allowing this that I have been able to discover is to grip the base of the stone between the bent fingers and the ball of the thumb, the convex surface of the tool being towards the palm. The point is then brought in contact with the surface it is desired to cut or grave, the implement being but slightly inclined and drawn steadily away from the body. The suggestion may be made that these tools were used for cutting hides; such a point would furrow or cut a stiff, sun-dried hide, such as those used by the Veddas, just as it does a piece of stout millboard.

This form of implement has not, so far as I can discover, been recognised in Europe hitherto; it is certainly uncommon, for the Abbé Breuil tells me that he does not know of any example. Its existence is, however, suggested by the reproduction by Commont ("Les Hommes Contemporains du Renne dans la Vallée de la Somme," 1914, Fig. 59) of two "instruments moustériens" from the St. Acheul loess, of which one at least seems to represent the "new" implement.

C. G. SELIGMAN.

Toot Baldon, Oxford.

## Molecular Structure and Energy.

THE difficulties with the Lewis-Langmuir theory expressed by Prof. Partington in NATURE of April 7 have been felt by the writer, and doubtless by others. They may, perhaps, be met in part by the following considerations:—

(1) In the case of molecules such as carbon dioxide and nitrous oxide the central octet is postulated as tetrahedral, with pairs of electrons at each apex, rather than as cubic. Such an arrangement would diminish rigidity in the axis passing through the three atomic nuclei and permit a measure of rotational energy about this axis. Again, it must be recalled that at higher temperatures the ratio of the specific heats for even diatomic gases falls below 1·4, and that this can well be accounted for by the increasing importance of energy of intramolecular vibration—that is, to-and-fro oscillation of the component atoms. In the case of triatomic gases such as carbon dioxide, the specific heat is much more affected by rise of temperature than in diatomic gases, frequencies of vibration in this case corresponding doubtless to the three well-marked spectral bands of carbon dioxide in the infra-red. For this reason alone the value of $\gamma$ for carbon dioxide might well be expected to turn out, even at ordinary temperatures, lower than that anticipated for a gas with molecules exhibiting only two degrees of rotational freedom, provided that vibrational energy in this case is not negligible at ordinary temperatures in comparison with translational and rotational energies. The halogen gases consist of pairs of atoms sharing, according to the Lewis-Langmuir theory, only one pair of electrons, which acts as though it were located at a point. It is worth pointing out that this less rigid connection permits the ratio of the specific heats for these gases to fall well below 1·4 even at ordinary temperatures, in consonance with the above suggestion.

(2) In the case of nitrogen the specific heat data offer no difficulty if, as may be inferred from the models of Langmuir and of Sir J. J. Thomson, the positive nuclei in their ovoid electronic envelope are sufficiently far apart to allow an appreciable moment of inertia in two directions of rotation.

As the writer has already hinted elsewhere, however, an acetylenic type of union of the two octets concerned may indeed prove more satisfactory in explaining other facts, such as those of molecular dimensions as estimated by Perrin or Rankine or such as will be brought forward in a forthcoming publication from this laboratory by R. N. Pease.

ALAN W. C. MENZIES.

Princeton University, U.S.A., April 19.

## British Laboratory and Scientific Glassware.

THE inclusion of scientific glassware in the proposed Key Industries Bill seems to have aroused a sense of apprehension in some quarters, partly on the ground that if Continental products are prohibited users may not be able to procure satisfactory apparatus, and partly because it is feared that, if given comparative security in the home market, manufacturers may lose their incentive to improve the quality of their goods and increase prices unduly.

The lack of confidence in British chemical glassware expressed in certain quarters is probably due to unfortunate experience with some of the earliest productions of the industry, when the experience of the blowers was practically negligible and the demand for the goods so urgent that nothing usable was allowed to be sorted out.

Increased experience, both on the part of the actual glass-blowers in the manipulation of the glass and on that of the technical staffs in the methods of obtaining desired results, has achieved great improvement in the quality of the products, and the better classes of British laboratory glassware compare favourably with any other.

As regards the quality of the glass itself, very thorough tests have been made by a trustworthy and impartial authority (see Journal of the Society of Glass Technology, 1917, vol. i., p. 153), and in the conclusions arrived at appears the statement: "Taking all the tests into consideration, the six best glasses are B, C, D, E, F, and G, and this list includes all the British glasses in the market. . . . *Jena glass, A, comes seventh on the list.*" Samples of post-war Jena laboratory ware with the well-known "Schott" stamp are inferior in all but appearance to the pre-war goods.

Further scientific investigation into the problem of annealing laboratory glassware and the adaptation by manufacturers of the information so obtained have led to great improvement in the direction of reduced liability to cracking in use due to temperature differences. This was formerly a frequent cause of complaint, but methods of annealing now in use are so efficient that British laboratory glassware will fulfil any reasonable requirements.

The average standard of British graduated apparatus is distinctly higher as regards accuracy of graduation than similar pre-war German articles. The British firms manufacturing scientific glassware are controlled by trained men of science who have had long practical experience in the use of the articles produced and appreciate fully the essential features of particular pieces of apparatus.

Manufacturers are desirous of meeting the requirements of consumers so far as possible, and if users of chemical apparatus would acquaint manufacturers directly with their special requirements and difficulties or offer practical suggestions for improvement, further advances might soon be made.

The advances that have already been made can be maintained and extended only if some measure of security is afforded to manufacturers. Up to date the industry has been largely in the experimental stage, and manufacturing costs have consequently been high. Manufacturers are faced with competition by imported glassware which is frequently sold under cost price in order to regain the British market. This, together with the present rates of exchange, deprives them of any incentive to put down fresh plant or to design new furnaces specially adapted to the manufacture of scientific glassware, which would render the products at the same time cheaper and of better quality.

The British manufacturer should have an opportunity in reasonable security to develop under normal conditions the industry he established with such success in the stress and strain of the war period. Should there ever be another war it is certain that the extension of "chemical warfare" would be on a scale far greater than anything experienced in the late war, and the position of this country would indeed be hopeless if it were dependent on imports for supplies of essential scientific and laboratory glassware. There would not again be an opportunity given for the industry to be re-created in time to be efficient.

J. H. DAVIDSON.

(Messrs. Wood Bros. Glass Co., Ltd.)

Barnsley, April 13.

**Protozoa and the Evolution of the Gregarious Instinct.**

IN the *résumé* given in NATURE of April 14, p. 222, of the proceedings of the Academy of Sciences of Paris on March 21, mention was made of the observation by Mme. Anna Drzewina and G. Bohn that certain aquatic animals (Convoluta and the larvæ of *Rana fusca*) become grouped together and appear to emit a protective substance as a defence against toxins introduced into the water. That the congregating of protozoa in such circumstances had a protective value of this nature was suggested by me in a note to *Country-Side* (August, 1913, vol. v., No. 8, p. 541), where I pointed out that the combined effort of a number of organisms massed together would no doubt produce a greater antitoxic effect than could a single isolated organism surrounded on all sides by water containing toxin.

The grouping of protozoa can easily be observed if a slide be prepared of living infusoria such as are found during warm weather in flower-vases and examined under the microscope, when it will be found on applying a little vinegar to the edge of the cover-slip that these organisms become arranged in clumps or clusters, each individual being in a state of vigorous vibration. As is well known, a similar phenomenon occurs with bacteria under somewhat the same conditions, and is made use of as a diagnostic test by pathologists. Agglutination in such circumstances is usually regarded as a purely physical occurrence due to surface tension.

It appears probable that the crowding together of protozoa as a protection against toxins represents the dawn of a gregarious instinct. Many modern psychologists are in agreement that evolution of body and evolution of mind are parallel; that is certainly the case with the nervous system and the mind of the higher vertebrates. We should, therefore, expect to find in the simplest animals the beginnings of mind; and purposive behaviour—the characteristic of mental activity as distinct from purely psychochemical reaction—has already been shown to occur in certain protozoa by Jennings and others (Jennings, "Behaviour of the Lower Organisms," Columbia University Biological Series, 1906). Animals the behaviour of which is purely upon the instinctive plane, *e.g.* instincts, are provided with innate dispositions tending to their own self-preservation and to the preservation of their race. On the part of protozoa, protection against toxins in the water is a necessary precaution that has to be taken to safeguard the individual, and therefore grouping together to produce antitoxins may have been an early mode of purposive behaviour in the first living organisms, when toxins in the water in which they lived must have been one of the chief dangers besetting them in the absence of larger enemies. Probably, then, we have in this crowding together of protozoa the dawn of the gregarious instinct—the beginnings of that instinct seen in so many different groups of the animal series and terminating in its most highly evolved and complex form as a fundamental element in the formation of human society.

REGINALD JAMES LUDFORD.

Zoological Laboratory, University College, London, April 21.

**The Nature of Vowel Sounds.**

PROF. SCRIPTURE's arguments on this subject which appeared in NATURE for January 13 and 20 last seem to me to be open to criticism. It is true, no doubt, that a strongly damped resonator may be excited by periodic impulses even when its free period is not an exact submultiple of the period of the impulses. But it does not appear justifiable to argue from this that the vibration so excited is inharmonic to the fundamental period. As an illustration of the error in the argument, we may consider the somewhat analogous case of the vibrations of the resonator of a violin. The bridge, belly, and enclosed air of this instrument form a resonating system having a series of free modes of vibration, which, especially those of higher pitch, are strongly damped by reason of the communication of energy to the external atmosphere and otherwise. These free periods are, in general, inharmonic to the fundamental period of the string. It is easily shown from the known mode of action of the bow that the force exerted by the vibrating string on the bridge changes impulsively from a positive to a negative value once in each period. If Prof. Scripture's argument were valid, we should be entitled to argue that the response of the bridge and belly to these discontinuous changes of force should be inharmonic to the fundamental period of the string. Actually, however, we know that this is not the case. The overtones which fall near the free periods of the resonator are, no doubt, strongly reinforced, but the motion of every part of the violin continues to be in strictly harmonic relation to the period of the forces impressed by the bow.

So far as I can see, there is no very vital difference between the dynamical principles involved in this and the foregoing case, except that the body of the violin has four or five well-marked free periods instead of only one or two, as in the case of the resonator concerned in the production of the human voice. The special character of the vowel sounds really arises from the last-mentioned circumstance, as a result of which most of the energy is concentrated in a small group of partials. It seems to me that there is no justification for supposing that there are any "inharmonics" present in the voice tones.

C. V. RAMAN.

210 Bowbazar Street, Calcutta, March 29.

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IN reply to Prof. Raman's interesting letter, I may say that the response of a strongly damped resonator to a series of sharp impulses may be harmonic or inharmonic to the period of the impulses; the essential fact is that they are independent. If we knew nothing more of the vowels than that the exciting voice tone consists of a series of sharp puffs and that the vocal resonators are strongly damped, we could say nothing of their relations except that they might be anything. The analyses of the vowel curves show, in fact, that the cavity tones may hold any relations to the voice tone, both harmonic and inharmonic.

With the violin the case is different. The string does not produce sharp puffs, but continuous vibrations of alternating phases. During each phase the action on a resonator is constant. The vibration aroused in the resonator has no pause in which to die away. The resonance vibrations are thus forced, and not free, vibrations. They must be harmonic to the fundamental. This is clearly shown in the plot reproduced from Prof. Miller's book in NATURE for March 3 last. The fundamental is strong and the overtones are all harmonic. This is in contrast to Prof. Miller's plot for a vowel. The fundamental is apparently absent; the overtones form a queer group of discordant tones that can represent only an inharmonic in that region.

E. W. SCRIPTURE.

## Literature for Jerusalem University.

AT the third annual conference of the Inter-University Jewish Federation held at Oriel College, Oxford, on August 3, 1920, it was unanimously resolved, in response to a request of the Zionist Organisation, to render every possible assistance to all efforts on behalf of the Hebrew University at Jerusalem. The most urgent need at the present juncture is an immediate and abundant supply of *books* for the Jerusalem University library. We can conceive no cause more precious and commendable than the full development and firm consolidation of the intellectual and spiritual resources of the Jewish national home. To this end books are the first requisite. In a scarcity of books the mind of a people is denied free expansion and healthy growth. To Jews, with their love of learning, the lack of books is most distressing. In Palestine, unfortunately, there is a real book famine, and even with help from all over the world it will need a great effort to build up the present University library of about 40,000 volumes into an up-to-date library worthy of the Jewish University.

For various reasons, including the difficulty of obtaining sufficient funds to establish a complete university from the start, it is proposed to institute research departments as the first foundations of the University. These will include institutions for chemical, microbiological, and medical research to deal with the resources of Palestine and its special difficulties. Books on physics and mathematics, sets of scientific journals, and pamphlets of permanent value are especially required; good text-books of established repute will also be useful. Readers of NATURE have it in their power to render great assistance in supplying these scientific books and pamphlets.

Considering that this is an important step towards a spiritual revival of Palestine, and that our credit as an enlightened people is at stake, we appeal to readers of NATURE to send all the books that they can spare as a freewill offering to those who will treasure them in Palestine. A single book will be welcome, but it is hoped that donors will send as many as they can. Gifts of books may be sent either direct to the University Library, Jerusalem, or to Miss N. Mandler, 75 Great Russell Street, W.C.1, who will, if necessary, arrange for the collection of the books. An artistically designed book-plate, the generous work of Mrs. L. Pilichowski, will permanently record the names of the donors.

S. ALEXANDER,
Chairman.
ISRAEL M. SIEFF,
Treasurer.
D. B. STANHILL,
Hon. Secretary.

Jerusalem University Library Committee,
75 Great Russell Street, W.C.1, April 29.

## Waste Oil from Ships.

IN the *Landmark* for May Sir Arthur Shipley has a very timely and important article on "The Danger to Fish and Bird Life from Oil-driven Ships." I could add my testimony in support of his argument, but wish now to raise the question whether, as he states, "nothing can prevent the oil getting into the bilge." When I was recently at Funchal, Madeira, I visited H.M.S. *Dunedin*, of the Light Cruiser Squadron, and was shown the oil-burning engines and many other wonderful things. I raised the question of the injury caused by the oil, and was assured that there was no loss of oil in the *Dunedin*, and that leakage, when it occurred, was due to faulty construction. If this is true, the remedy is obvious; it is intolerable that so much damage should result from preventable causes, and the public is entitled to protection. In any event, all those interested in the matter should urge the engineers to attack the problem at once, and show us what to do to abate the nuisance.

T. D. A. COCKERELL.

4 College Road, Isleworth, Middlesex.

## Organism in Flint.

Is not the organism photographed under the care of Mr. C. Carus-Wilson (NATURE, May 5, p. 299) far more probably a radiolarian than an insect? The apparent segmentation of the "antennæ" may be due to secondary deposits of silica, and the partition may be caused by the nearness of the plane of section to the inward bulge on the meeting-line of the two chambers of the test. Without an examination of the slide, any suggestion may be rash; but we know little of the Mesozoic types of Cyrtida, and this organism may represent a previously undescribed member of that group. References to descriptions of Cretaceous radiolaria are given by W. Hill and A. J. Jukes-Browne in the Quarterly Journal of the Geological Society, vol. li., p. 600, 1895.

GRENVILLE A. J. COLE.

## Isotopes and Atomic Weights.[1]

By DR. F. W. ASTON.

POSSIBLY the most important generalisation in the whole history of chemistry is the atomic theory put forward by John Dalton in 1803, and it is a striking tribute to the shrewd intuition of that observer that of his five postulates only one seems to be in the least degree faulty, and more than a century of active and unremitting investigation has been necessary to detect the flaw in that.

The postulate in question states that "atoms of the same element are similar to one another and equal in weight." Of course, if we take this as a definition of the word "element," it becomes a truism; but, on the other hand, what Dalton meant by an element and what we understand by the word to-day is a substance such as hydrogen, oxygen, chlorine, or lead, which has unique chemical properties, and cannot be resolved into more elementary constituents by any known chemical process. For many of the well-known elements Dalton's postulate still appears to be strictly true, but for others, probably the majority, it needs some modification.

The general state of opinion at the end of last century may be gathered from the following quotations from Sir William Ramsay's address to the British Association at Toronto in 1897:

> There have been almost innumerable attempts to reduce the differences between atomic weights to regularity by contriving some formula which will express the numbers which represent the atomic weights with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. . . . The idea . . . has been advanced by Prof. Schützenberger, and later by Mr. Crookes, that what we term the atomic weight of an element is a mean; that when we say the atomic weight of oxygen is 16, we merely state that the average atomic weight is 16; and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight.

That such conjectures were then regarded as wildly speculative shows how strong was the faith in Dalton's postulate, which is all the more remarkable when we consider that at that time not one single direct experimental proof of it had been offered. Such proof, obviously, can be obtained only by some method which measures the masses of atoms individually, and at that time none had been developed.

The first direct evidence that the atoms of an element were, at least approximately, equal in mass appears to be that obtained by Sir J. J. Thomson in 1910 by his well-known method of analysis of positive rays. The fact that sharply defined parabolic streaks were obtained at all proves that the ratio of the masses of the separate particles causing them to the charges of electricity they carry is constant. The latter was known to be a definite unit, or a simple multiple of it, so that if the masses of the individual atoms varied amongst each other in an arbitrary manner, an indistinct blur would result instead of a clear-cut parabola.

Before going on to consider the evidence of positive rays in greater detail, it will be as well to re-state briefly the evidence upon which the theory of isotopes was founded. The first indication that it might be possible to obtain substances having identical chemical properties, but different atomic weights, was afforded by the brilliant researches on the radio-active elements made by Sir E. Rutherford and his colleagues. Investigations on the transformations of the different radioactive families showed that certain products, such as lead, could be formed in several ways. Each of the leads so formed was found to have chemical properties identical in every respect with those of ordinary lead, but their method of production precluded any possibility of them all having the same atomic weight. Such bodies, although having different atomic weights, must occupy the same position in the periodic table of the elements, and on this account have been called "isotopes" by Prof. Soddy.

Moseley's epoch-making discovery has shown us that chemical properties depend, not upon atomic weight, but upon something much more fundamental, namely, *atomic number*. The atomic number of an element is the number of units of positive electricity on the nucleus of its atoms; the nuclear charge of hydrogen is 1, of helium 2, of lithium 3, and so on. We see, therefore, that isotopes are elements having the same atomic number, but different atomic weights.

The theory of isotopes was triumphantly vindicated during the war by the researches of Soddy, Richards, Hönigschmid, and others on the atomic weights of lead found in various radioactive minerals. Quantities were obtainable which were ample for the most accurate determinations by chemical methods, and the atomic weights were found to differ from each other and from ordinary lead by quantities altogether outside possible experimental error. Long before this convincing proof was forthcoming, the theory of isotopes was discussed with the greatest interest in connection with atomic weights in general. If isotopes occurred among the heavy elements, why should they not be possible among the lighter non-radio-active ones, in which case elements with fractional atomic weights might clearly be mixtures, the constituents having atomic weights equal to whole numbers? This explanation was a very attractive one, for the

[1] Discourse delivered at the Royal Institution on Friday, February 11.

curious jumble of whole numbers and fractions in the atomic weights when referred to oxygen as 16 has always been a serious stumbling-block in the way of any simple theory of atom-building. The accurately determined atomic weight of chlorine, 35·46, has certainly nothing to recommend it. It is reminiscent of the number of square yards in a square rod, pole, or perch; but the idea of Nature working on the same lines as the British weights and measures is eminently unattractive.

The first support of the isotope theory among non-radio-active elements was given by the anomalous behaviour of the inactive gas neon when analysed by Sir J. J. Thomson's method of positive rays. It is of interest to note that the announcement was made in this room by Sir J. J. Thomson himself, and that the first sample of gas to show the effect was supplied by Sir James Dewar. This peculiarity was that whereas all elements previously examined gave single, or apparently single, parabolas, that given by neon was definitely double. The brighter curve corresponded roughly to an atomic weight of 20, the fainter companion to one of 22, the atomic weight of neon being 20·20. In consequence of reasoning adduced from the characteristics of the line 22, the discoverer was of the opinion that it could not be attributed to any compound, and that therefore it represented a hitherto unknown elementary constituent of neon. This agreed very well with the idea of isotopes which had just been promulgated, so that it was of great importance to investigate the point as fully as possible.

The first line of attack was an attempt at separation by repeated fractionation over charcoal cooled with liquid air, but, even after many thousands of operations, the result was entirely negative. It is some satisfaction to know that this result was inevitable, as Prof. Lindemann has recently shown on thermodynamical grounds. Fractional diffusion through pipeclay was more effective, and gave a positive result. An apparent difference of density of 0·7 per cent. between the lightest and heaviest fractions was obtained after an exceedingly laborious set of operations. When the war interrupted the research, it might be said that several independent lines of reasoning pointed to the idea that neon was a mixture of isotopes, but that none of them could be said to carry the conviction necessary in such an important development.

When the work was recommenced, attention was again turned towards positive rays, for it was clear that if an analysis could be made with such accuracy that it could be demonstrated with certainty that neither of the two atomic weights so determined agreed with the accepted chemical figure, the matter could be regarded as settled. This could not be done with the parabolas already obtained, but the accuracy of measurement was raised to the required degree by means of the arrangement illustrated in Fig. 1. Positive rays are sorted out into a thin ribbon by means of the two parallel slits $S_1 S_2$, and are then spread into an electric spectrum by means of the charged plates $P_1 P_2$. A portion of this spectrum deflected through an angle $\theta$ is selected by the diaphragm D and passed between the circular poles of a powerful electromagnet O the field of which is such as to bend the rays back again through an angle $\phi$ more than twice as great as $\theta$. The result of this is that rays having a constant mass (or, more correctly, constant $m/e$) will converge to a focus F, and if a photographic plate is placed at GF, as indicated, a *spectrum dependent on mass alone* will be obtained. On account of its analogy to optical apparatus, the instrument has been called a positive-ray spectrograph, and the spectrum produced a mass-spectrum.

Fig. 2 shows a number of typical mass-spectra obtained by this means. The numbers above the lines indicate the masses they correspond to on the scale O = 16. It will be noticed that the displacement to the right with increasing mass is roughly linear. The measurements of mass made are not absolute, but relative to lines which correspond to known masses. Such lines, due to hydrogen, carbon, oxygen, and their compounds, are generally present as impurities, or purposely added, for pure gases are not suitable for the smooth working of the discharge tube. The two principal groups of these reference lines are the $C_1$ group due to C(12), CH(13), $CH_2$(14), $CH_3$(15), $CH_4$ or O (16), and the $C_2$ group (24 to 30) containing the very strong line $C_2H_4$ or CO (28). These groups will be seen in several of the spectra reproduced, and they give, with the $CO_2$ line (44), a very good scale of reference.

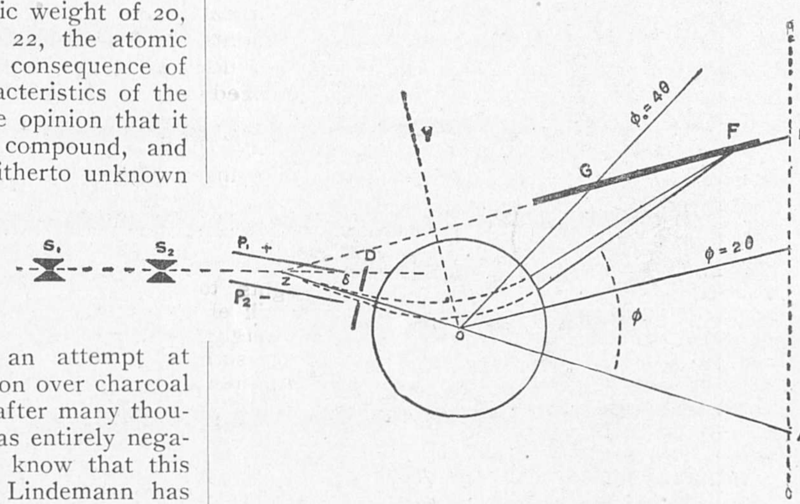


FIG. 1.—Diagram of positive-ray spectrograph.

It must be remembered that the ratio of mass to charge is the real quantity measured by the position of the lines. Many of the particles are capable of carrying more than one charge. A particle carrying two charges will appear as having half its real mass, one carrying three charges as if its mass were one-third, and so on. Lines due to these are called lines of the second and third order. Lines of high order are particularly valuable in extending our scale of reference.

When neon was introduced into the apparatus four new lines made their appearance at 10, 11, 20, and 22. The first pair are second-order lines, and are fainter than the other two. All four are well placed for direct comparison with the standard lines, and a series of consistent measurements showed that to within about one part in a thousand the atomic weights of the isotopes composing neon are 20·00 and 22·00 respectively. Ten per cent. of the latter would bring the mean atomic weight to the accepted value of 20·20, and the relative intensity of the lines agrees well with this proportion. The isotopic constitution of neon seems, therefore, settled beyond all doubt.

These rays are formed by a normal, positively charged ray picking up two electrons. On the negative spectrum of chlorine only two lines, 35 and 37, can be seen, so that the lines at 36 and 38 cannot be due to isotopes of the element. These results, taken with many others which cannot be stated here in detail, show that chlorine is a complex element, and that its principal isotopes are of atomic weight 35 and 37. There may be, in addition, a small proportion of a third of weight 39, but this is doubtful. Spectra II., III., and IV. show the results with chlorine taken with different magnetic field strengths.

The objection has been raised on many occasions that if chlorine consists of isotopes, how is it that its atomic weight has been determined so

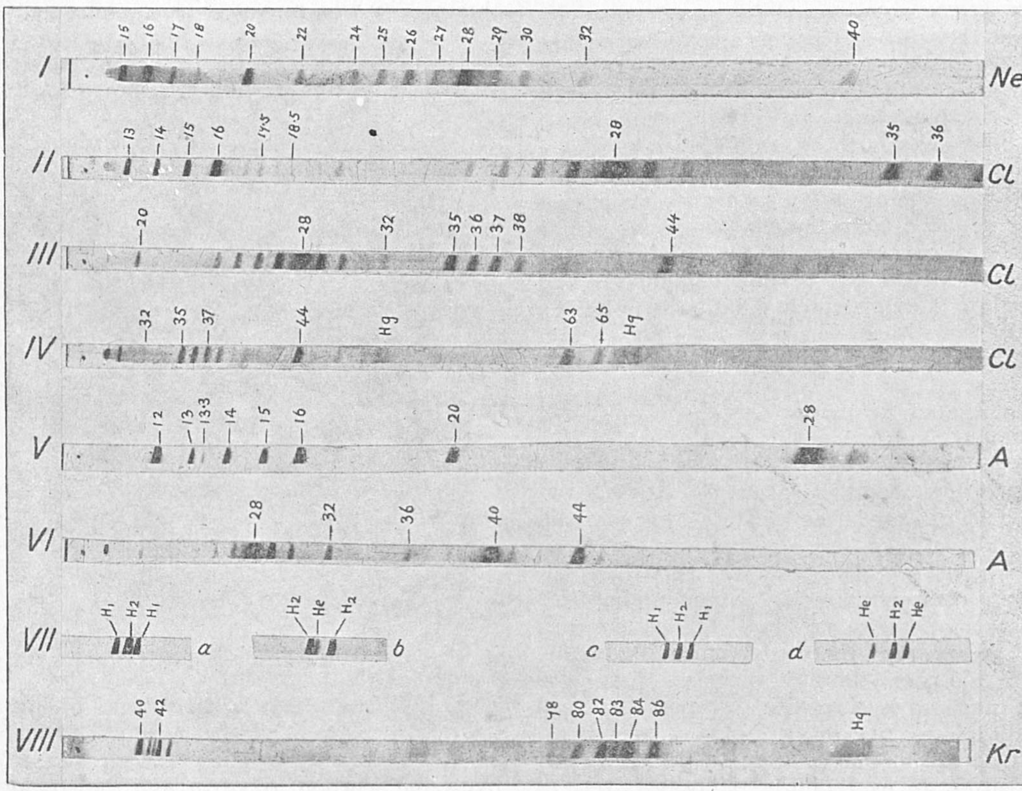


FIG. 2.—Typical mass-spectra.

The element chlorine was naturally the next to be analysed, and the explanation of its fractional atomic weight was obvious from the first plate taken. Its mass-spectrum is characterised by four strong first-order lines at 35, 36, 37, 38, with fainter ones at 39, 40. There is no sign whatever of any line at 35·46. The simplest explanation of the group is to suppose the lines 35 and 37 are due to the isotopic chlorines, and lines 36 and 38 to their corresponding hydrochloric acids. The elementary nature of lines 35 and 37 is also indicated by the second-order lines at 17·5, 18·5, and also, when phosgene was used, by the appearance of lines at 63, 65, due to $COCl^{35}$ and $COCl^{37}$.

Quite recently it has been found possible to obtain the spectrum of negatively charged rays.

accurately and so consistently by different chemists? The obvious explanation of this appears to be that all the accurate determinations have been done with chlorine derived originally from the same source—the sea—which has been perfectly mixed for æons. If samples of the element are obtained from some other original source, it is quite possible that other values of atomic weight will be determined, exactly as in the case of lead.

The mass-spectrum of argon shows an exceedingly bright line at 40, with second-order line at 20, and third-order line at $13\frac{1}{3}$. The last is particularly well placed between known reference lines, and its measurement showed that the triply charged atom causing it had a mass 40·00 very exactly. Now the accepted atomic weight of argon is less than 40, so the presence of a lighter isotope was suggested. This was found at 36, and has now been fully substantiated; its presence to the extent of about 3 per cent. is sufficient to account for the mean atomic weight obtained by density determinations.

The elements hydrogen and helium presented peculiar difficulties, as their lines were too far removed from the reference lines for direct comparison. By means of a special "bracketing" method, moderately accurate values were obtained. Helium appears to be exactly 4 on the oxygen scale, but hydrogen is definitely greater than unity. The value obtained agrees very well with that already arrived at by chemical methods—namely, 1·008. At the same time, measurements of the 3 line, first observed by Sir J. J. Thomson, were made which came out at 3·024, satisfactorily proving it to be due to triatomic hydrogen.

Krypton and xenon gave surprisingly complex results, the former consisting of six isotopes 78, 80, 82, 83, 84, 86. The weights of these could be determined with great accuracy by means of the excellent second- and third-order lines they gave. The first experiments with xenon led to the observation of five isotopes, the provisional values of which were given as one unit too low. Owing to the kindness of Prof. Travers and Dr. Masson, I have recently been enabled to repeat the analysis with gas much richer in xenon. With this the second-order lines could be observed and measured. The five principal isotopes of xenon are 129, 131, 132, 134, 136; there is apparently a faint sixth component at 128, and a doubtful seventh at 130.

Experiments with boron fluoride indicated that boron has at least two isotopes, 10 and 11, and that fluorine is a simple element of atomic weight 19.

Silicon is another unmistakably complex element having two isotopes, 28 and 29, with a possible additional one, 30.

Bromine was of great interest. As it has an atomic weight almost exactly 80, it might reasonably be expected to be simple and an isobare of one of the kryptons; actually it consists of equal parts of 79 and 81.

Sulphur, phosphorus, and arsenic are all apparently simple elements. Mercury is certainly complex, though its closer components cannot be resolved with the present apparatus. Its very characteristic groups are seen as high as the fifth order, and appear on nearly all the spectra taken. The group consists of a continuous succession of lines forming a band 197 to 200, a strong line at 202, and a weak one at 204. Recently at Copenhagen Brönsted and Hevesy have succeeded in partially separating the isotopes of mercury by a fractional distillation at extremely low pressure. They give as their figures for the densities compared with normal mercury as unity:—

| | | |
|---|---|---|
| Condensed mercury | ... ... | 0·999980 |
| Residual mercury | ... ... | 1·000031 |

The probable error claimed is less than one part in a million.

Selenium, tellurium, antimony, and tin have all been used in the discharge tube, with no results of any value. This is unfortunate, for the atomic weight of selenium, 79·2, suggests that one of its isotopes must be an isobare of bromine or krypton; also the relation between tellurium and iodine is of great interest.

Iodine, fortunately, gave a very definite result. It is a simple element of atomic weight 127. This is rather surprising, for all the theoretical papers on the isotopic constitution of elements have predicted a complex iodine. Prophecy in physics becomes a difficult trade when experimental results produce these surprises, and apparently the only really trustworthy prediction is that there are plenty more in store for us.

The following is a list of elements and isotopes determined to date:—

*Table of Elements and Isotopes.*

| Element | Atomic number | Atomic weight | Minimum number of isotopes | Masses of isotopes in order of their intensity |
|---|---|---|---|---|
| H | 1 | 1·008 | 1 | 1·008 |
| He | 2 | 3·99 | 1 | 4 |
| B | 5 | 10·90 | 2 | 11, 10 |
| C | 6 | 12·00 | 1 | 12 |
| N | 7 | 14·01 | 1 | 14 |
| O | 8 | 16·00 | 1 | 16 |
| F | 9 | 19·00 | 1 | 19 |
| Ne | 10 | 20·20 | 2 | 20, 22, (21) |
| Si | 14 | 28·30 | 2 | 28, 29, (30) |
| P | 15 | 31·04 | 1 | 31 |
| S | 16 | 32·06 | 1 | 32 |
| Cl | 17 | 35·46 | 2 | 35, 37, (39) |
| A | 18 | 39·88 | 2 | 40, 36 |
| As | 33 | 74·96 | 1 | 75 |
| Br | 35 | 79·92 | 2 | 79, 81 |
| Kr | 36 | 82·92 | 6 | 84, 86, 82, 83, 80, 78 |
| I | 53 | 126·92 | 1 | 127 |
| X | 54 | 130·32 | 5, (7) | 129, 132, 131, 134, 136, (128, 130?) |
| Hg | 80 | 200·60 | (6) | (197–200), 202, 204 |

(Numbers in brackets are provisional only.)

By far the most important result of these measurements is that, with the exception of hydrogen, the weights of the atoms of all the elements measured, and, therefore, almost certainly of all elements, are whole numbers to the accuracy of experiment—namely, about one part in a thousand. Of course, the error expressed in fractions of a unit increases with the weight measured, but with the lighter elements the divergence from the whole-number rule is extremely small.

This enables the most sweeping simplifications to be made in our ideas of mass. The original hypothesis of Prout, put forward in 1815, that all atoms were themselves built of atoms of protyle, a hypothetical element which he tried to identify with hydrogen, is now re-established, with the modification that the primordial atoms are of two kinds—atoms of positive and negative electricity.

Although the latter unit has long been known to us as an "electron," its mate, which appears to be the real unit of mass, has only recently been given the name of "proton."

The Rutherford atom, whether we take Bohr's or Langmuir's development of it, consists essentially of a positively charged central nucleus around which are set planetary electrons at distances which are great compared with the dimensions of the nucleus itself. As has been stated, the chemical properties of an element depend solely on its atomic number, which is the charge on its nucleus expressed in terms of the unit charge *e*. A neutral atom of an element of atomic number N has a nucleus consisting of K+N protons and K electrons, and around this nucleus are set N electrons. The weight of an electron on the scale we are using is 0·0005, so that it may be neglected. The weight of this atom will, therefore, be K+N, so that if no restrictions are placed on the value of K any number of isotopes is possible.

The first restriction is that, excepting in the case of hydrogen, K can never be less than N, for the atomic weight of an element is always found to be equal to, or greater than, twice its atomic number. The upper values of K also seem to be limited, for, so far, no two isotopes of the same element have been found differing by more than 10 per cent. of its mean atomic weight; the greatest numerical difference is eight units in the case of krypton. The actual occurrence of isotopes does not seem to follow any law at present obvious, though their number is probably limited by some condition of stability.

Protons and electrons may therefore be regarded as the bricks out of which atoms have been constructed. An atom of atomic weight $m$ is turned into one of atomic weight $m+1$ by the addition of a proton *plus* an electron. If both enter the nucleus, the new element will be an isotope of the old one, for the nuclear charge has not been altered. On the other hand, if the proton alone enters the nucleus, and the electron remains outside, an element of next higher atomic number will be formed. If both these new configurations are possible, they will represent elements of the same atomic weight, but with different chemical properties. Such elements are called "isobares," and are actually known among the radio-active elements.

The case of the element hydrogen is unique, for its atom appears to consist of a single proton as nucleus with one planetary electron. It is the only atom in which the nucleus is not composed of a number of protons and electrons packed exceedingly close together. Theory indicates that when such close packing takes place the effective mass will be reduced, so that when four protons are packed together with two electrons to form the helium nucleus this will have a weight rather less than four times that of the hydrogen nucleus, which is actually the case.

It is not to be supposed that the whole-number rule is of exact mathematical accuracy, for the unit of the oxygen scale is a "packed" proton+an electron, and its value will certainly alter slightly with the degree of packing. On this account it is of the greatest importance to push the accuracy of methods of atomic weighing as far as possible, for variations from the whole-number rule, if they could be determined with precision, would give us some hope of laying bare that innermost of secrets, the actual configuration of the charges in the nucleus.

The results I have described lie on the borderline of physics and chemistry, and although as a chemist I view with some dismay the possibility of eighteen different mercuric chlorides, as a physicist it is a great relief to find that Nature employs, at least approximately, standard bricks in her operations of element-building.

## Natural Camouflage.[1]

THE fine volume under notice is a new edition of the beautifully illustrated work which, originally appearing in 1909, first brought in a connected form before the public the many classical principles of concealing-coloration established by the genius of the American artist-naturalist Abbott H. Thayer. Important discoveries such as these, especially when the enthusiasm of their originator could recognise well-nigh no limits to their application, were bound to bring sharp differences of opinion. In America we have seen the rise of two rival camps, one, headed by the late Theodore Roosevelt, opposing the whole of Thayer's conclusions, the other accepting the whole and even interpreting the advertisement of Warning Colours and their simulation in Mimicry as examples of the working, in one form or another, of concealing-coloration.

In England, where, as the result of the writings of Wallace and Bates, and still earlier of Erasmus Darwin, the subject as a whole is older, an intermediate position has been taken. Here, naturalists recognise to the full the enduring value and fundamental importance of Thayer's discoveries, although believing that they do not offer a complete interpretation of animal colouring as a whole; and, in the beautiful frontispiece of the book, representing a peacock in the woods with its blue neck against the sky and posed so as to illustrate the conclusion that its pattern is "a marvellous combination of 'obliterative' designs, in forest-colors and patterns," in this and the flamingoes, and spoonbills with "the skies they picture" (plates viii–x), English naturalists

[1] "Concealing-Coloration in the Animal Kingdom. An Exposition of the Laws of Disguise through Colour and Pattern: Being a Summary of Abbott H. Thayer's Disclosures." By Gerald H. Thayer. With an Introductory Essay by A. H. Thayer. New Edition with a New Preface. Illustrated by Abbott H. Thayer and Others, and with Photographs. Pp. xix+260+xvi plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) 25*s*. net.

believe that they witness the attempt to carry a theory too far, and a tendency to be blinded, by the dazzling brilliancy of one set of interpretations, to the value and importance, and even the existence, of others.

The author's conclusion that all pattern is obliterative does not conflict with the theory of

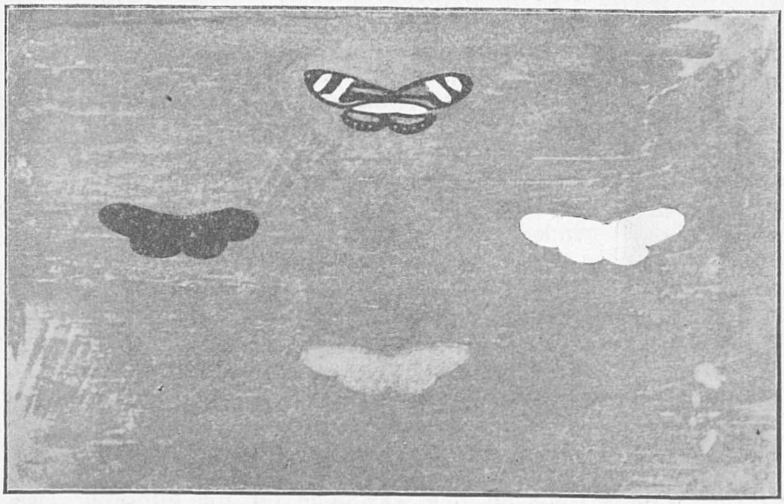

FIG. 1.—At a distance of seven or eight yards in bright light or at a shorter distance with less illumination, the brightly patterned butterfly disappears before the three butterflies of monochrome tint. From "Concealing-Coloration in the Animal Kingdom."

Warning Colours if we bear in mind that obliteration is dependent on distance. This is well shown in Fig. 1, where, as the author states, at the right distance or in a sufficiently reduced light, the brightly patterned butterfly disappears before the three monochrome ones, even the dimmest. We see here the effacing effect of "contrasted juxtaposed color-notes," and are led to understand the inconspicuousness of the zebra as described long ago by Sir Francis Galton, and to conclude that it is this rather than "background-matching," as maintained on pp. 135–36, which is the bionomic meaning of its remarkable pattern. But, returning to the butterfly diagrams, it is obvious that anywhere near the striking distance of an enemy the contrasted colour scheme is far more conspicuous than the other three, and this is all that the theory of Warning Colours requires. That it should be obliterated at a greater distance is all to the good, for, as the present writer has maintained, "all animals with warning colours have enemies, all are liable to special attacks, in times of exceptional hunger, by enemies which would at other times neglect them. . . . Provided such forms are easily seen and avoided by enemies which respect their special modes of defence, it is clearly an advantage to be as far as possible concealed from those which do not respect them" (Trans. Ent. Soc., 1903, p. 573).

The author's interpretation of the black-and-white pattern of the skunk will be sufficiently clear when Figs. 2 and 3 are compared, Fig. 2 being the "mouse's or cricket's view" with the sky let down, as it were, into the pattern, and leaving a black shape unrecognisable as an animal, while Fig. 3 shows the "sky 'background' cut off by dark, making his white conspicuous." To this interpretation it may be objected that it is very doubtful how far a nocturnal animal like the skunk requires to be hidden from its prey, but there is no doubt that it is advantageous for it to be concealed from enemies which mean to attack, and these, so far as I know, are only predaceous birds which would see it from above against the ground. From these the obliterative effect at a great distance of the skunk's contrasted black and white may well be a protection, but to all large ground animals likely to attack it, it would be extremely conspicuous. Furthermore, the slow and deliberate movements of the skunk and the flapping or floating flight of conspicuous butterflies must be remembered in association with their display and the special protection of which it is an advertisement.

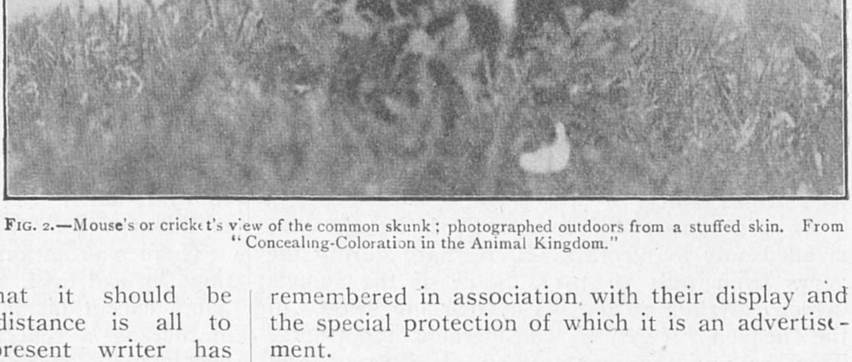

FIG. 2.—Mouse's or cricket's view of the common skunk; photographed outdoors from a stuffed skin. From "Concealing-Coloration in the Animal Kingdom."

Although I am unable to agree with these and some other conclusions of the authors, and have been obliged to devote so much of the available space to criticism, I should wish again to emphasise the far-reaching importance of the principles which they have clearly explained and beautifully illustrated. It is to be hoped that the volume will be widely and carefully read. Considering the scale and style of the work, with its

FIG. 3.—Common skunk as in Fig. 2, but with sky "background" cut off by dark, making his white conspicuous; photographed outdoors from a stuffed skin. From "Concealing-Coloration in the Animal Kingdom."

sixteen coloured plates and 140 black-and-white figures, the price is very moderate.

The appearance of this new edition is, as is explained by Gerald H. Thayer in his preface, related to the great part which its principles have played in the war. That they should have been collectively named "camouflage" is a curious instance of word-history. "Camouflage" is not to be found in Murray's Oxford Dictionary, but "camouflet" is there, with this meaning: "a mine containing a small charge of powder, placed in a wall of earth between the galleries of besieged and besieger, so as, in exploding, to bury, suffocate, or cut off the retreat of the miner on the opposite side; a 'stifler.'" *"Camouflet or stifler"* is quoted from the "Penny Cyclopædia" of 1836. Then, when smoke came to be employed above ground it kept the same name; and, as its chief use was to act as a concealing screen or curtain, "camouflage" became, in the Great War, transferred from the cause to the effect, and extended to concealment, however attained.

G. H. Thayer states that it has recently come to light that, in Germany, the original edition was "searched through with most diligent care for information which could be put to military or naval use." Here in England its principles were applied long before the war, for many years ago the great guns in our coast forts were painted white beneath to neutralise their shadows, and coloured above with an obliterative pattern. But while all this was done for the guns our men were sent to the war with a cap that seemed specially designed, by its reversal of principles explained in this volume, to render the head conspicuous to an enemy.

E. B. P.

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## Obituary.

### PROF. W. R. BROOKS.

PROF. W. R. BROOKS was one of the most successful of all modern comet-hunters. He nearly equalled the wonderful success of Pons, who found twenty-eight comets in the first twenty-five years of last century. Prof. Brooks's total was twenty-seven comets, but in regard to several of these he was anticipated.

Prof. Brooks was born at Maidstone, Kent, on June 11, 1844, and with his parents migrated to the United States in 1857. He was educated in various public and private schools in England and America. He was awarded the Hon. A.M. degree by Hobart College in 1891, and the Sc.D. by Hamilton College in 1898. He was director of Redhouse Observatory, Phelps, New York, from 1872 to 1888, and was appointed to the Smith Observatory in the latter year; finally he became in 1900 professional astronomer at Hobart College Observatory.

As a discoverer of comets Prof. Brooks was rivalled only by Prof. E. E. Barnard during the years from 1881 to 1911. Some of the comets detected by him during his unwearying sweeps of the heavens were of considerable importance. Thus he was the first to find, in 1883, Pons's periodical comet of 1812, and in 1886 he picked up the expected comet of Olbers, last seen in 1815; he also discovered comets of short periods belonging to the Jovian family in 1886 and 1889. The latter broke up into several fragments and proved quite a notable object.

Like Messier, Pons, Tempel, Barnard, Perrine, and others, Prof. Brooks displayed special ability in this field of observation, and though he engaged in other departments of practical astronomy, it was in exploring the sky for comets that he met with his greatest successes. His results afford another instance of the fact that natural ability combined with enthusiasm, opportunity, and well-directed effort usually bring ample reward.

Prof. Brooks received ten gold prizes from Mr. Warner, and nine comet medals from the Astronomical Society of the Pacific; he also received the Lalande medal from the Paris Academy of Sciences, and a number of other special distinctions. He was elected a fellow of the Royal Astronomical Society on January 13, 1888. His discoveries ranged over the thirty years from 1881 to 1911, but it was during the first twenty years of this period that his principal work was done.

There was nothing in his early life or associations to lead Prof. Brooks to the pursuit of astronomy except his inclination. His initial success in making a reflecting telescope and in finding new comets enabled him to relinquish his daily avocation and to devote the greater part of his life to the study of the heavens. He died on May 3 in his seventy-seventh year.

W. F. DENNING.

THE death occurred in January this year, at seventy-five years of age, of DR. JULES HARMAND, who was well known for his extensive explorations in French Indo-China. In 1873 Dr. Harmand took part in the investigations of the ruins of Angkor, in Cambodia. His explorations in subsequent years embraced the basin of the Tonle Sap and the lake of that name, as well as the country between there and Bassac, on the Mekong. In 1877 Dr. Harmand explored the Boloveu plateau in Laos, and succeeded in crossing the mountainous country to Hué, in Annam. These explorations shed much light on the interior of Indo-China, and gained for Dr. Harmand in 1878 the gold medal of the Paris Geographical Society. Later he entered the diplomatic service and was for many years French ambassador at Tokio. Dr. Harmand was the author of "Domination et Colonisation," published in 1910, and he prepared a French edition of Sir John Strachey's "India" in 1892.

WE learn with regret from *Science* of April 22 that the death occurred on April 14 of DR. HENRY PLATT CUSHING, who was for twenty-six years professor of geology in Western Reserve University, Cleveland, Ohio, and for about the same time geologist in the Adirondack region for the Geological Survey of New York.

## Notes.

"CULTURED" pearls, recently introduced by a Japanese firm, appear to have caused some alarm in the gem trade. It has long been known that pearls are the result of local irritation in the pearl-oyster or pearl-mussel, caused by the introduction of some foreign matter—usually the larva of a parasitic organism which spends another part of its life-cycle in an animal that feeds on the mollusc. The mollusc retaliates by coating the unbidden guest with a smooth layer of nacre (identical with the mother-of-pearl layer of its shell, and consisting mainly of the orthorhombic crystalline modification of calcium carbonate corresponding with the mineral aragonite); and the resulting pearl is the elegant tomb of the objectionable parasite. The Chinese have for centuries produced this result artificially by inserting objects between the shell and mantle of the fresh-water mussel, and figures of Buddha on the inner surface of such shells are common. The difficulty hitherto has been to cause the formation of a spherical secretion unattached to the shell of the mollusc. This now appears to have been achieved by Mr. Mikimoto as a result of experiments extending over forty years. It is said that fragments of mother-of-pearl are inserted in the tissues of the molluscs, which are then returned to the sea for a period of several years. Another obvious method would be to infect the oyster-bed with the appropriate parasite. But, whether the foreign matter is introduced accidentally or intentionally, the result produced by the oyster must be the same. The qualification "artificial" would here apply rather to the pretence that the products are essentially different. Attempts on the part of the trade to discredit what is apparently an interesting scientific discovery are clearly made only with the view of keeping up inflated prices. The same selfish fight was made some years ago against the artificially formed rubies and sapphires (miscalled "synthetic," "reconstructed," and even "imitation"), which can be produced much more economically than the naturally formed stones. Strawberries raised in pots under glass are sold without question as strawberries—but wisely at a higher price. Pearls are high in price because of their rarity, but if they were plentiful and the more brightly coloured mother-of-pearl were rare the cry would be very different.

THE Kelvin gold medal for engineering was founded in 1914, principally by British and American engineers, to commemorate the achievements of Lord Kelvin in those branches of science which apply specially to engineering. The award is made by a committee of the presidents of the representative British engineering institutions, and recommendations are received and considered from similar bodies in all parts of the world. The first recipient was Dr. William Cawthorne Unwin, and the presentation was made by Mr. A. J. Balfour in the hall of the Institution of Civil Engineers on Wednesday, May 4. In the course of his address Mr. Balfour said that Lord Kelvin combined in a manner which had scarcely been equalled before, except perhaps by Archimedes, the power of theorising on the darkest and most obscure secrets of Nature, and at the same time of carrying out efficiently and practically some engineering feat. It was therefore fitting that we should remember Kelvin as one of the leaders in the movement which compelled all modern engineers worthy of the name to be not only men of practice, but also of theory. Dr. Unwin's name was honoured wherever engineering was studied in English-speaking lands, and he had imprinted his own seal upon the whole course of study which young engineers had now to pursue. In his reply Dr. Unwin congratulated the young engineers of to-day upon their advantages in the possession of well-organised colleges and on the recognition by all universities, even Oxford and Cambridge, of a faculty of engineering.

WE are very glad that a reasonable agreement has been arrived at between supporters and opponents of the Plumage (Prohibition) Bill, with the result that the Bill passed through Standing Committee D of the House of Commons on May 10. It has often been suggested that an advisory committee should be set up to prepare a schedule of birds the plumage of which might be imported, but this has been objected to by promoters of prohibitive measures. The agreement now arrived at includes the following terms :—

(1) The Act to come into operation nine, instead of six, months after the passing thereof. (2) Within four months after the passing of the Act the Board of Trade shall appoint a joint Advisory Committee consisting of an independent chairman, two expert ornithologists, three representatives of the feather trade, and four other independent members. The function of this Committee will be to advise the Board of Trade as to additions to and removals from the existing schedule (ostrich and eider-duck) of birds the plumage of which may be imported. By the adoption of these clauses the Bill will in all probability be placed on the Statute Book during the present session of Parliament.

AN announcement in the *Times* of May 9 states that Sir Hercules Read, Keeper of the Department of British and Medieval Antiquities and Ethnography of the British Museum, will retire in July next on completion of forty years' service. Sir Hercules Read joined the museum staff in 1880 under Sir Wollaston Franks, with whom he had worked for six years previously, and whom he succeeded in 1896. Under him the department has developed greatly, particularly in connection with prehistoric and medieval antiquities. By his influence among wealthy connoisseurs, of whom he numbered a great many among his friends, he was able to secure for his department and the nation a large number of valuable specimens of artistic or scientific importance which otherwise might have been lost to us. Mr. J. Pierpont Morgan was largely guided by him in his generous gifts to public collections, and it was at his instigation that the famous Greenwell collection of Bronze-age antiquities was secured and presented by Mr. Morgan to the museum. Sir Hercules Read's connection with the British Museum will not be severed by his retirement. As president of the Society of Antiquaries he will continue to act as a Trustee *ex officio*.

IN presiding at a dinner given by the council of the Iron and Steel Institute to the president, Dr. J. E. Stead, last week, Sir Robert Hadfield spoke at some length on the industrial crisis in this country. He took the view that the present Labour disturbance was unreasonable, since it had been admitted by some of the miners' leaders that its object was political. He stated that no one wished to see reductions in the income of the wage-earners less than he did, but that the existing fictitious state of affairs, both financial and industrial, made it impossible for us to get on a sound footing until some re-adjustment, in which all were concerned, took place. Sir Robert Hadfield went on to urge the need for a greatly increased output per worker, stating that it was only in this way that industry could be restored to an economic basis. In the latter part of his speech he dealt with technical problems, alluding particularly to corrosion, affirming that his study of this question, in so far as it related to iron and steel, had convinced him that the annual wastage was from 1·5 to 2 per cent.

AT a general meeting of the members of the Royal Institution held on May 9 Sir J. J. Thomson was elected honorary professor of natural philosophy and Sir Ernest Rutherford professor of natural philosophy.

AT the meeting of the Royal Society held on May 5 the following were elected foreign members:—Prof. Albert Calmette, Dr. Henri Deslandres, Prof. Albert Einstein, Prof. Albin Haller, Prof. E. B. Wilson, and Prof. P. Zeeman.

AT the annual meeting of the British International Association of Journalists, held on April 22, Mr. Leon Gaster, the hon. secretary of the Illuminating Engineering Society and editor of the *Illuminating Engineer,* was unanimously elected the honorary general secretary of this association.

BY invitation of the chairman of the Lawes Agricultural Trust Committee, Lord Bledisloe, and the director, Dr. E. J. Russell, the House of Commons Agricultural Committee and certain members of the House of Lords will visit the Rothamsted Experimental Station, Harpenden, to-morrow, May 13, to inspect the experimental farm and the laboratories.

THE last ordinary scientific meeting of the Chemical Society this session will be held at the Institution of Mechanical Engineers, Storey's Gate, on June 16 at 8 p.m., when Prof. Benjamin Moore will deliver a lecture entitled "The Natural Photo-synthetic Processes on Land and in Sea and Air, and their Relation to the Origin and Preservation of Life upon the Earth."

THE Empire Cotton-Growing Committee and the British Cotton Industry Research Association propose to award in July next about twelve studentships, each of the annual value of 200*l*., for the additional training of university graduates in scientific research bearing on plant genetics and physiology, entomology, physics, etc., or in special subjects relating to administration and inspection in tropical agriculture. Forms of application and further particulars of the studentships are to be obtained from the secretary of the Joint Standing Committee, c/o the Shirley Institute, Didsbury, Manchester, not later than July 18.

THE officers and council of the Manchester Literary and Philosophical Society for the new session 1921–22 were elected on April 26 as follows:—*President:* Mr. T. A. Coward. *Vice-Presidents:* Mr. R. L. Taylor, Mr. William Thomson, Sir Henry A. Miers, and Mr. W. Henry Todd. *Hon. Secretaries:* Dr. H. F. Coward and Prof. T. H. Pear. *Hon. Treasurer:* Mr. R. H. Clayton. *Hon. Librarians:* Mr. C. L. Barnes and Dr. Wilfrid Robinson. *Hon. Curator:* Prof. W. W. Haldane Gee. *Council:* Prof. Arthur Lapworth, Mr. C. E. Stromeyer, Dr. W. M. Tattersall, Mr. Leonard E. Vlies, Mr. F. W. Atack, Prof. F. E. Weiss, Mr. Francis Jones, Miss Laura Start, and Prof. Sydney Chapman. The Chemical Section on May 6 elected the following officers:—*Chairman:* Mr. Leonard E. Vlies. *Vice-Chairman:* Mr. J. H. Lester. *Hon. Secretary:* Mr. David Cardwell.

The London summer meeting of the Institution of Mechanical Engineers, which will be held on June 30 and July 1, will be devoted to subjects connected with the better utilisation of fuels. A novel feature of the meeting will be an exhibition of appliances connected with boiler-room economy and with the efficient use of steam- and internal-combustion engines. The exhibits will include feed-water heaters, combustion recorders, super-heaters, liquid fuel and powdered fuel burners, steam- and gas-engine indicators, etc. The institution desires that all who have exhibits to offer will communicate with the secretary at Storey's Gate, St. James's Park, S.W.1, as soon as possible. Apparatus and models are preferred, but drawings will be accepted and suitably displayed.

Arrangements have been made by the Institution of Civil Engineers to continue this year the series of conferences which were interrupted by the rebuilding of the institution premises and the war. A conference will be held on Wednesday, Thursday, and Friday, June 29 and 30 and July 1, the mornings being given to discussions upon selected topics, and the afternoons to visits to engineering works. For the purpose of the meetings the conference will be divided into seven sections: (i) Railways, Roads, Bridges, and Tunnels; (ii) Harbours, Docks, Rivers, and Canals; (iii) Machinery; (iv) Mining and Metallurgical Processes; (v) Shipbuilding; (vi) Waterworks, Sewerage, and Gasworks; (vii) Electricity Works and Power Transmission. The twenty-seventh James Forrest lecture will be delivered by Sir George T. Beilby on the afternoon or evening of Tuesday, June 28.

"The Physiology of Pain" is the subject of a paper in *Medical Science: Abstracts and Reviews* for April (vol. iv., No. 1). The reviewer concludes: "It is, at any rate, tempting to regard sensibility to pain as the survival in us of the primordial mode of sensation. Its urgency and tendency to evoke immediate motor response is the reproduction of the normal experience of the lower invertebrates. From it the discriminative forms of sensibility have been differentiated by the progressive increase of insulation. If we view pain as an exaggerated response by a physiologically irritated nerve, it is possible to get some conception why pain is the commonest of symptoms and why it is so apt to become inveterate. Pain is, as it were, physiologically only just not present in us all, and what appears to be a very slight disturbance pathologically may prove an effective and incurable excitant of it."

Dr. L. O. Howard's annual report of the Entomologist to the U.S. Department of Agriculture for the year ending June 30, 1920, is a record of a vast series of researches carried out for the benefit of the State. The European corn-borer is causing anxiety on account of the increasing area of country that is suffering from its ravages. With an appropriation of 400,000 dollars an energetic campaign is being conducted, and particular attention is being devoted to the natural enemies of the pest. A trained observer has been established in the south of France to study its native parasites, and Dr. Howard personally visited with the same object regions of Belgium, France, and Italy in which the corn-borer occurs. In connection with insecticides for orchard spraying, much experimental work has been accomplished with contact insecticides in an effort to find something to replace nicotine or tobacco extract. Special attention has been devoted to organic contact sprays, and a compound has been discovered of the pyridine series which offers hopes of success. As in previous years, work on the Gipsy and Brown Tail moths occupies a prominent place. During the spring of 1919 favourable climatic conditions for hatching out the eggs resulted in an unusual spread of the former insect in the caterpillar stage, and an increase in area of 4569 square miles is now stated to be infested. On the other hand, the area affected by the Brown Tail moth has been materially reduced, and 10,677 square miles have been released from the quarantine.

Mr. H. G. May has published (Proc. U.S. Nat. Mus., vol. lviii., pp. 577–88, 5 plates, 1920) useful notes on the nematode genus Nematodirus, which occurs in the small intestine of sheep, goats, cattle, deer, camels, and certain rodents. In addition to abundant material collected in the United States, the author has received material from France and Switzerland, and has been able to study some eight hundred male specimens for their spicules. He finds in this collection four species which have not previously been described. He gives a key to, and short descriptions of, the nine species of the genus, and figures the more important systematic characters, especially the bursæ and spicules of the males.

At a meeting of the Biological Society of Washington (Journal of the Washington Academy of Sciences, vol. x., No. 20, p. 580, December, 1920) Mr. T. E. Snyder directed attention to the extensive and serious injury caused to the lead sheathing of aerial telephone cables in California by the beetle *Scobicia declivis*, which normally breeds in recently felled wood piled for later use as fuel. In summer the beetle attacks the cable where it lies in contact with the metal suspension ring, which affords it leverage for boring. The hole allows moisture to penetrate the insulation, and numerous widely separated short-circuits are produced when rain falls in the autumn. A high percentage of "wire trouble" is caused by this beetle. No remedy has yet been found; chemical repellents, various types of suspension rings, and hard tin and antimony alloys have proved ineffective.

In the Report for 1919 of the Botanical Society and Exchange Club of the British Isles the secretary, Dr. G. C. Druce, provides a supplement entitled "The Extinct and Dubious Plants of Britain." Notwithstanding the great changes which have occurred in Britain during the period since 1597, only about half a dozen native species of flowering plants have ceased to exist, mainly as the result of drainage operations. The most notable are a Vetch (*Vicia laevigata*), which formerly occurred near the shore at Weymouth and Portland, but does not seem to have been found for nearly a hundred years, and two species of Senecio, formerly plentiful in the Fens, but destroyed by drainage operations. During the same period our flora has been augmented by a number of emigrants from other countries which have become more or less completely established. The dubious plants of Britain —that is to say, plants which have been reported as British—make a very long list. Some are mere casuals, many have been wrongly identified, and some, it is to be feared, were wilful impositions. The probability is that the majority were really erroneous, but Dr. Druce suggests that the publication of these records in an easily consultable form may, by directing attention to them, lead to one or two being re-discovered.

MR. N. H. DARTON (U.S. Geol. Surv., Bull. 701, 1920) has brought together "all available published data bearing on the rate of increase of underground temperature with increasing depth in the United States," including numerous original observations by the author and his colleagues. Some of the very deep wells drilled for oil give average rises of temperature of 1° F. for every 70 ft., the rise being near the surface, and in the deepest levels being about 1° F. for every 60 ft. The following records are of special interest:—McDonald, Pa. (6975 ft.), bottom temperature 144·9° F.; the Lake Well, West Virginia (7500 ft.), at bottom 168·6° F.; and the Goff Well in the same State (7386 ft.), temperature at 7310 ft. 158·3° F. The misleading nature of generalised calculations from depths of less than a mile is clearly shown by the fact that the Goff Well gives from 100 ft. to 7310 ft. a rise of 1° F. for every 70·2 ft., and from 4000 ft. to 7250 ft. of 1° F. for every 56·3 ft. The author reminds us that the workings in the Comstock Lode, Nevada, showed 170° F. at 3100 ft., the average increase in the district being 1° F. for 33 ft. The rate here decreases at similar horizons away from the lode, and local volcanic material is inferred.

THE Bureau of Standards at Washington has issued as Scientific Paper No. 406 a valuable review by Dr. Coblentz of the present position of our knowledge of the laws of radiation of a perfectly black body, and the values of the constants which enter into the numerical expression of those laws. He finds that a considerable proportion of the discrepancies between the results of determinations by different observers is due to the neglect of the absorption of the radiation on its passage from the furnace to the measuring instrument, and to its partial reflection at the receiving surface. On making suitable corrections for these losses he finds that the results are brought into close agreement. He gives as the best value of the coefficient of Stefan's law of total radiation $5{\cdot}72\times10^{-5}$ ergs per sq. cm. per second per fourth power of the absolute temperature. For the constant C of Planck's radiation formula he gives 14,320 micron degrees, and for the product of the wave-length for maximum radiation into the absolute temperature 2885 micron degrees. The mean value of Planck's constant $h$ by radiation and other methods he gives as $6{\cdot}55\times10^{-27}$ erg-seconds.

IN the April number of the Journal of the Franklin Institute, Messrs. Loyd A. Jones and C. E. Fawkes give the results of their investigations into the action of photographic reducers on the images produced on development printing papers. The course of the change is traced in each case by measuring the density of the image after subjecting it to the reagent employed for various times. It is possible to reduce so that the contrast is either unchanged, diminished, or increased. The chief point of novelty demonstrated is the action of ammonium persulphate, which in the presence of a little sodium chloride gives a nearly proportional decrease of density. But if the persulphate is dissolved alone in distilled water there is a certain critical point on the density curve, on the thinner side of which there is very little change, while there is very vigorous action on the denser side. Even in so short a time as three minutes, that part of the curve that lies above the point is reversed in its curvature, and parts of it become less dense than the critical point itself. The authors give the formulæ of the solutions that they used.

IN his presidential address delivered recently to the Institution of Mining and Metallurgy Mr. F. W. Harbord dealt with the chief metallurgical developments which have taken place in this country since 1914. According to him, the only new industries which were established as the result of war requirements were the manufacture of tungsten powder and of ferro-alloys generally. In regard to these products the country is now able not merely to supply its own requirements, but also to compete in the chief markets of the world. The output of carbon steel was increased by more than 2,000,000 tons in 1917 as compared with 1913. More than one-half of this increase was due to "basic" steel. In the years 1916–18 arrangements were made for the erection of 22 blast furnaces and 166 open-hearth steel furnaces with a producing capacity of more than 3,000,000 tons per annum. No branch of metallurgy received a greater stimulus and made greater progress than the art of making and heat-treating special steels, especially those containing nickel, chromium, and vanadium. For many years before the war the zinc industry was in a languishing condition. Here again the productive capacity of the country has been much increased by the erection of new plant and by extensions and improvements to existing plants. The present position of this industry is quite abnormal, but when the relation between cost of production and market price becomes normal Mr. Harbord is of opinion that this country will have two very strong points in its favour, owing to the Government control of Broken Hill ore supplies and the better equipment of the extraction works.

AT the eleventh annual May lecture of the Institute of Metals on May 4 Prof. T. Turner took as his subject "The Casting of Metals," which dates back to early antiquity. The quality of the older material cannot be equalled to-day, although output has been enormously increased and the percentage of "wasters" reduced. Aluminium presents special difficulty on account of its high coefficient of expansion; this leads to fracture during cooling unless proper precautions are taken. Gases in non-ferrous metals are not so important as in steel, and any metal or alloy which does not develop gas by reaction or does not unduly segregate can be cast in a satisfactory manner provided that a suitable temperature is employed, that the mould is properly designed and made, and that the metal is skimmed and poured in the right manner. Pure metals or single substances, as a general rule, possess the same density whether slowly or quickly cooled. Those alloys in which there is an interval between the liquidus and solidus solidify over a temperature range, and often expand when slowly cooled, as, for instance, when cast in sand. Extensometer tests by Prof. Turner have shown the nature and extent of such expansions in a number of typical alloys. These results agree with the density determinations, but the extensometer has the advantage of showing the sequence and amount of each volume-change. In practice one of the chief causes of failure is pouring at too high or too low a temperature. Other causes include such troubles as imperfect or badly fixed cores, faults in moulding, cracks, mis-runs or run-outs, and breakage in handling. In foundry work generally the losses from all causes reach about 10 per cent. of the output. Prof. Turner took the view that casting is fundamentally an art, and the part of the man of science will be to introduce new ideas and processes rather than to improve on present technique.

THE Oxford University Press is to publish under the title of "From a Modern University: Some Aims and Aspirations of Science" a volume of occasional addresses by Prof. A. Smithells.

A LENGTHY catalogue (No. 88) of botanical and horticultural works which are for sale by Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1, has just reached us. It gives particulars of no fewer than 3017 publications, including the library of the late M. Edouard André, of Paris. Many early printed and rare herbals are listed, and practically the whole range of botany and horticulture is represented. The catalogue should be seen by all who wish to augment their libraries in these branches of science.

MESSRS. G. BELL AND SONS are shortly adding a new volume to the advanced section of their mathematical series, namely, "A First Course in Statistics," by D. Caradog Jones. The fundamental importance of the right use of statistics is becoming increasingly evident on all sides of life, social and commercial, political and economic. It is hoped that a study of this book will enable the reader to discriminate between the masses of valuable and worthless figures published, and to use what is of value intelligently.

## Our Astronomical Column.

ECLIPSE OF RHEA BY TITAN.—The computing section of the British Astronomical Association, recently formed under the directorship of Mr. L. J. Comrie, undertook an extensive examination of the phenomena of Saturn's ring and satellites about the time when their planes are turned edgewise. In the course of this work the prediction was made that the very rare phenomenon of the eclipse of Rhea by the shadow of Titan would take place on April 8. A number of members of the association, including the president, Major Hepburn, observed the phenomenon, and found a satisfactory accord with the prediction. Rhea faded rapidly at 10h. 22m., and became invisible for 50 minutes; the estimated time of mid-eclipse was 10h. 47·3m. G.M.T.; the corresponding predicted time was 10h. 38m., and predicted duration 44 minutes. Since the relative motion of the satellites was slow the error in their positions is small.

It would be well if the national ephemerides could publish predictions of interesting phenomena of this character, as there is a danger of their escaping notice if left to unofficial agencies. There is probably no other observation of the kind on record in the Saturnian system; even in the Jovian system, where mutual eclipses occur more often, very few have been recorded, obviously because they have never been systematically predicted.

COMETS.—*L'Astronomie* for April contains a re-discussion by Mr. G. Neujmin of the orbit of the comet (1916*a*) discovered by him in 1916. He finds:—

$$T = 1916 \text{ March } 11{\cdot}3239 \text{ G.M.T.}$$

$$\left.\begin{aligned} \omega &= 193^\circ\ 47'\ 33'' \\ \Omega &= 327^\circ\ 33'\ 0'' \\ i &= 10^\circ\ 37'\ 12'' \end{aligned}\right\} 1916{\cdot}0$$

$$\phi = 34^\circ\ 26'\ 33''$$

$$\mu = 655{\cdot}364''$$

Period 5·414 years.

The observations used extended from February 27 to June 5. The comet should be in perihelion again about August 10 of the present year, but so unfavourably placed that it is to be feared that it will escape detection.

Comet Pons-Winnecke has been deviating from the predicted path with unexpected rapidity, and M. Ebell has deduced the following revised orbit from observations on April 12, 16, and 26:—

| | |
|---|---|
| $T = 1921$ June 13·08 | $i = 18^\circ\ 15{\cdot}0'$ |
| $\omega = 171^\circ\ 43{\cdot}7'$ | $\log q = 0{\cdot}0152$ |
| $\Omega = 96^\circ\ 38{\cdot}9'$ | $\log a = 0{\cdot}4526$ |

The value of log *a* is almost certainly much below the truth, but the elements will probably represent the motion for the next few weeks. The ephemeris printed in this column needs to be corrected by −13m., −1° 11′ on May 14, and −25m., −1° 12′ on May 20. It will be noticed that the perihelion point is now placed well outside the earth's orbit, which makes the occurrence of a meteor shower somewhat doubtful.

*Ephemeris for Greenwich Midnight.*

| | | R.A. h. | m. | s. | Decl. ° | ′ | Log *r* | Log Δ |
|---|---|---|---|---|---|---|---|---|
| May | 14 | 18 | 5 | 51 | 47 | 36 N. | 0·0396 | 9·3772 |
| | 16 | 18 | 22 | 0 | 47 | 44 | 0·0355 | 9·3520 |
| | 18 | 18 | 39 | 51 | 47 | 38 | 0·0315 | 9·3260 |
| | 20 | 18 | 59 | 42 | 47 | 20 | 0·0277 | 9·2997 |
| | 22 | 19 | 21 | 5 | 46 | 40 | 0·0241 | 9·2724 |
| | 24 | 19 | 45 | 20 | 45 | 34 | 0·0207 | 9·2459 |
| | 26 | 20 | 10 | 39 | 44 | 1 | 0·0177 | 9·2193 |
| | 28 | 20 | 37 | 37 | 41 | 48 | 0·0149 | 9·1948 |
| | 30 | 21 | 5 | 2 | 38 | 56 | 0·0123 | 9·1725 |
| June | 1 | 21 | 32 | 26 | 35 | 22 | 0·0101 | 9·1541 |
| | 3 | 21 | 59 | 16 | 31 | 4 | 0·0082 | 9·1404 |
| | 5 | 22 | 24 | 46 | 26 | 17 | 0·0066 | 9·1333 |
| | 7 | 22 | 48 | 23 | 21 | 8 | 0·0053 | 9·1324 |
| | 9 | 23 | 9 | 58 | 15 | 50 | 0·0044 | 9·1391 |
| | 11 | 23 | 30 | 28 | 10 | 41 | 0·0037 | 9·1517 |
| | 13 | 23 | 48 | 27 | 5 | 45 | 0·0035 | 9·1695 |
| | 15 | 0 | 4 | 26 | 1 | 17 N. | 0·0036 | 9·1914 |
| | 17 | 0 | 18 | 52 | 2 | 45 S. | 0·0040 | 9·2158 |

## The Stone-axe Factory of Graig-lwyd, Penmaenmawr.

AT a meeting of the Royal Anthropological Institute held on April 19 Mr. S. Hazzledine Warren presented a report on the results of excavations at Graig-lwyd carried out in June, 1920, under a representative committee appointed by the Royal Anthropological Institute. The expenses of the excavation were met by grants from the National Museum of Wales, the Cambrian Archæological Association, and other public and private contributors.

The Neolithic workings follow the chilled margin of the Penmaenmawr intrusive rock for a considerable distance, but the excavation was mainly concentrated upon one important chipping "floor" associated with the site of a large hearth.

The workers made their stone axes either directly from the natural blocks of scree or indirectly by first striking off large flakes. These large primary flakes often weigh from 7 lb. to 14 lb., or even more, and their production in such a tough and intractable material is evidence of remarkable skill. "Core implements" and "flake implements" were made indifferently, according to convenience in working the stone. The stages of manufacture from the natural block to the finished axe may be grouped as (1) preliminary, (2) intermediate, and (3) advanced. The most characteristic forms arrested in the middle stage may be described as "intermediate ovates"; these might well be mistaken for Late Chelles and St. Acheul implements, while many of the smaller specimens in the preliminary stage resemble the earlier Chelles group. Pseudo-Mousterian flakes with faceted platforms, recalling the Levallois technique, were produced in large quantities as a waste product from the flaking of the axes. More than four hundred "ends of celts" (as they are usually called) were found, and thirty-two complete axes have been refitted from these halves broken during manufacture. The industry is essentially similar to that of Grime's Graves and Cissbury.

Four broken polished axes were recovered from the main "floor," and three of these had been rechipped after breakage into makeshift blades. One stone plaque engraved with a series of triangles was also discovered.

In opening a discussion on the report Sir William Boyd Dawkins said that a debt of gratitude was due to Mr. Warren for having brought these facts, the result of much hard work, before the institute. The subject was of the greatest interest and importance to British archæology at the present time. The finds at Graig-lwyd must be grouped with those from Cissbury and Grime's Graves. As a result of a careful comparison with the long series of finds from Cissbury in the Manchester Museum, he had come to the conclusion that every peculiarity in the Graig-lwyd specimens could be paralleled from Cissbury, the one difference being that the Graig-lwyd implements were made of igneous rock, while the Cissbury finds were flint. The Graig-lwyd specimens were consequently larger owing to the difference in material. The shape and the rude character of a specimen did not prove that it was not of Neolithic age. He himself had found at Trenton, New Jersey, side by side with typical Indian stone implements, specimens which in form belong to the Moustier and other European Palæolithic types. The lesson to be learned from this find was that age cannot be estimated from form. As regards the positive evidence for date of these *ateliers*, it was beyond question. At Cissbury Neolithic pottery and the remains of domestic animals had been found. The evidence from Grime's Graves was clear. There the flint from which implements were manufactured was taken from pits and galleries, and was therefore later in date than these, but the workings show that the greater number of these galleries had been excavated with polished stone axes, and therefore the implements of Chellean, Moustier, and other types found on this site were Neolithic. The conclusion to which this evidence pointed was supported by the types in Mr. Warren's find. The examples of specimens broken in course of manufacture in Neolithic times, of which the parts now reassembled by Mr. Warren exhibited differences in patination, were also a proof that patination was no criterion of age. The discovery of this factory had an interesting bearing upon the question of prehistoric trade and communication. Owing to the existence of a felsitic stone implement factory in the Lake District, he had hitherto derived the felsite axes found in the Midlands from this source, but in future the felsite at Graig-lwyd would have to be taken into account.

The implements from the Graig-lwyd excavations, which will be reproduced in illustration of the report when it is printed *in extenso*, were exhibited at the Royal Anthropological Institute on April 20–22. A larger and more representative collection is to be exhibited at the rooms of the Society of Antiquaries, Burlington House, on May 23–25.

## Descriptive Botany.

UNDER the title "The Leguminous Plants of Hawaii" (issued by the Experiment Station of the Hawaian Sugar Planters' Association), Mr. J. F. Rock gives a systematic account of the native, introduced, and naturalised trees, shrubs, vines, and herbs belonging to the family Leguminosæ. Detailed descriptions are given of all the native and established species, with notes on distribution and economic uses; keys to the genera and species are also included. In all, 200 species belonging to 71 genera are described, and there are 93 excellent full-page photographic reproductions of the more important species. The percentage of indigenous species in this family is very small, and of these only six are trees, one is a shrub, and the remainder are, with few exceptions, usually shore-plants or grow near the shore, and are distributed over most of the Pacific Islands. This poor representation of one of the largest families of flowering plants contrasts remarkably with its rich representation in tropical Asia, and is a strong argument against the existence of any previous land connection with the Asiatic continent. The writer regards the Leguminosæ as a strong factor in proving the assumption that the Hawaian islands are purely oceanic in character; he proposes to discuss thoroughly the origin of the flora in a work on the phytogeography of the islands which he has in preparation.

In "Icones Plantarum Formosanarum," vol. ix.

(Bureau of Forestry, Government of Formosa), Bunzo Hayata continues his descriptive account of the flora of this island. The volume contains studies of genera of a large number of families of flowering plants, and includes descriptions of 139 new species; the arrangement follows the system of Bentham and Hooker's "Genera Plantarum." The descriptions (in Latin) are full and clear, and the volume is remarkably well illustrated with text-figures and plates. Two new genera are established, one, Dolichovigna, a climbing bean near Phaseolus and Vigna; the other, Pseudosmilax, a member of the family Liliaceæ, and intermediate between Smilax and Heterosmilax. Nine genera are also recorded as new to the flora of the island, which so far as is at present known includes 3608 species of flowering plants representing 1185 genera and 169 families.

In the *Journal of Ecology* (vol. viii., No. 1) Miss L. S. Gibbs gives an account of the phytogeography and flora of the mountain-summit plateaux of Tasmania based on her own observations and collections. The vegetation of the island may be divided into three principal plant formations: (1) The austral-montane flora of the mountain-summit plateaux, which represent the remains of the huge lava plateau of which the island formerly consisted. The major and most interesting portion of the endemic flora is entirely limited to these summit plateaux; one of the peculiar features is the almost complete absence of herbaceous plants. (2) The mixed forest of the west coast, not very rich in species and characterised more by denseness of growth than by height. There is a marked endemic element in this flora which probably originated on the higher lands. (3) Eucalyptus formation, occupying the greater part of the island, consisting mainly of secondary open forest, and purely Australian in type. A description is given of the various portions of isolated tableland which form the mountains of the island and at no point exceed 5000 ft., and the writer describes the chief plant-associations, enumerating the plants which she collected in each. On the most exposed and highest levels a mosaic of small moss-like plants is developed, with inconspicuous flowers, forming a hard, even surface. This is succeeded by a mountain shrubbery, the dominant association of the more exposed portions of the plateau summits. Lower come forest-associations in succession, namely, dwarf mountain forest, low mountain forest, and Eucalyptus scrub. In conclusion, the author refers to the marked relation between the mountain flora of North-West New Guinea, the subject of a former paper, and the so-called "Antarctic flora" of the southern hemisphere. Recent work on meteorological conditions provides an explanation of this relation, namely, in the persistent north-west wind of high altitude over the mountains of New Guinea and across the Australian continent. Seeds transported by this agency would be precipitated in southern latitudes, where they remain within the radius of the persistent westerly winds and gales of the Antarctic seas.

A systematic enumeration is given of the species collected on the mountain-summit plateaux and in the mixed forest from September, 1914, to March, 1915.

## Origin of Petroleum and Cause of Gas Pressure.[1]

THE important volume referred to below is bountifully illustrated with photographs, sections, and maps, and gives a comprehensive account of some 150 square miles in the midst of the Californian oilfields, a territory which provides nearly half the oil which the State produces, and includes its greatest oilfield. Here, too, is the famous "Lakeview Gusher," which yielded 8,000,000 barrels of oil in eighteen months. The area has been discussed previously both by State and Federal geologists, notably some ten years ago by R. Arnold, H. Johnson, and R. Anderson in Bulletins 406 and 471, but since that time there has been much further development, and many new facts are available.

The work contains a wealth of information which is rendered easily accessible by its systematic arrangement and clear table of contents. The book commences with a brief "Summary of Results," which is followed by an informative bibliography. "Stratigraphy," which occupies 34 pages, is dealt with under the headings of the various formations. Then follow "Structure" (pp. 54–63) and "Petroleum" (pp. 63–87), whilst a detailed description of the "Productive Field" occupies the latter half of the book. In the pocket at the back of the volume is a geologic map of the region and large-scale topographic and structure maps of the oilfield, together with many sections across the productive area.

The main scientific inferences differ little from those set forth in the earlier bulletins. It is made clear that the petroleum was generated within the Tertiary deposits, which are at least 18,000 ft. in thickness, ranging from Eocene to Pliocene. Regarding the origin of the oil, the author's explanation is that previously formulated by Arnold and Anderson; but he does not ascribe the source of the carbon wholly to the diatoms and foraminifera. "The petroleum has originated in the diatomaceous shale formations, chiefly from the alternation of organic matter contained in diatoms and foraminifers, but probably in part *also from the alteration of terrestrial vegetal débris.*" Later "the oil has collected in part in sandy beds that are intercalated with the [diatomaceous] shale, but chiefly in the porous beds of younger formations that rest unconformably upon the shale."

With reference to migration and accumulation, the author affirms that much of the oil in the pools "has migrated from the beds beneath the San Joaquin Valley to the foothills and collected in the small anticlines that extend from the hills out into the valley." The reservoirs of oil are now chiefly in the later Tertiary "[Miocene or Pliocene] sandy beds that rest unconformably upon the diatomaceous shale."

Some interesting matters are discussed in connection with the gas pressure and concerning chemical reactions on the petroleum within the oilsands. The pressure in these fields is not proportionate to depth, and usually is considerably in excess of the theoretical "hydrostatic pressure." The author holds that the oil, whilst within the reservoirs, has been affected by chemical reactions with minerals. In particular, oxidation by sulphate-laden waters has produced a marginal ring of heavy tar around the pool where its bottom rests upon the under-water. This tar seals the oil pool within a definite space, and any further quantities of gas generated from the oil can be accommodated only by increase of pressure. Such conditions probably account for the great gusher-wells of this region.

T. O. B.

[1] United States Geological Survey, Professional Paper No. 116: "The Sunset Midway Oil Field of California." Part i., "Geology and Oil Resources." By R. W. Pack. Pp. 179.

## The University of London.

PRESENTATION DAY.

PRESENTATION DAY of the University of London, which was held at the Albert Hall on May 5, was memorable in many ways, but in two especially: by the admission of the Prince of Wales as an honorary graduate and by the large number of successful graduates who were presented to the Vice-Chancellor for their degrees. The honorary degrees of the University are very jealously guarded; until now the names of Kelvin and Lister have been the only additions to those of the King and Queen. The Prince was admitted to the degrees of Master of Commerce and Doctor of Science. The Chancellor, Lord Rosebery, who was prevented by illness from attending, sent a message in which he made a felicitous reference to the "incomparable Prince," who, he said, had merited a travelling fellowship for the services he had performed in the cause of the Empire. The long procession of graduates in their brilliant robes was an impressive sight, and brought home to the vast audience the magnitude and variety of the work of the University.

The Principal Officer of the University (Sir Cooper Perry) read his report for the year 1920–21, which was written in his accustomed distinguished style. The preamble to the effect that if the "normal year" is still in the distant future, the University is struggling through this "difficult period of strain and stress" with unimpaired strength and a quickened insight into the needs of the community, is fully corroborated by some remarkable statistics, particularly the increase in matriculations from 6638 in 1913–14 to 15,539 in 1920–21. The number of candidates for degrees, 1746 (1036 internal and 710 external), is slightly below the pre-war total, but it is noteworthy that the internal candidates considerably exceed the external, though in 1913–14 the two categories were about equal. The number of internal students is now 7870, and candidates for the new Ph.D. degree already amount to 179. Except for the benefaction of the Government—if such it can be called—of the site of $11\frac{1}{2}$ acres in Bloomsbury for new headquarters, upon the question of accepting which the Senate deliberated, as the Principal plaintively remarked, from May to October last year, the University, apart from its colleges, has not benefited greatly during the year from public or private generosity; but the super-benefaction of the Rockefeller Foundation to University College and Hospital for medical education, amounting to 1,250,000*l.* sterling, beats all previous records in this country. The obituary of the year is short, but includes some outstanding names—Dr. Ronald Burrows, Lord Moulton, Lord Cozens-Hardy, Sir John Macdonell, and Sir Felix Semon.

It was originally proposed that, as last year, a graduation dinner should be held at the Guildhall, but in view of the existing situation this was abandoned and a daylight conversazione substituted. The function was very successful. An interesting presentation was made to the Prince by Sir Israel Gollancz on behalf of graduates of the University. This took the form of a beautiful fifteenth-century MS. containing the signature of the Black Prince and a variant of the historic motto "Ich dien" which throws considerable light on its origin. The Prince returned thanks in a happy and characteristic speech, and afterwards received all the newly made graduates and other members of the assembly.

The advanced public lectures in scientific and other subjects arranged under the auspices of the University are extremely interesting to students and workers in the various branches of knowledge with which they deal. They are given for the most part by distinguished men of science and scholars who are not teachers of the University, and are open to the public without fee. Mr. J. H. Jeans, secretary of the Royal Society, is attracting crowded audiences to King's College, where he is delivering a course on cosmogony and stellar evolution. Prof. Cohen, of Utrecht, is announced to give two lectures (in English) at University College on the metastability of matter; Sir Napier Shaw is delivering an historical course on meteorological theory at the Meteorological Office, and Prof. H. E. Armstrong two lectures on enzymes in relation to plant growth at King's College.

There has been recently an exchange of lectures in medical subjects between London and the Dutch universities, which has been a conspicuous success and may well prove to be the beginning of a complete scheme of exchanges. Under the scheme Dr. Hamburger, the distinguished professor of physiology at Groningen, will lecture at the Royal Society of Medicine on permeability in physiology and pathology on June 8. Dr. Kappers, the director of the Central Institute for Brain Research at Amsterdam, is also giving a course of four lectures on the interpretation of the structure of the brain. All these lectures will be delivered in English.

## University and Educational Intelligence.

CAMBRIDGE.—A memorial has been presented to the council of the Senate for a syndicate to be appointed to consider possible alterations in the Mathematical and Natural Sciences Triposes with the object of facilitating the acquisition by candidates in one subject of a knowledge of the other.

It is proposed to appoint Prof. H. Lamb, now in residence in Cambridge, to an honorary University lectureship to be called the Rayleigh lectureship in mathematics.

The Humphry Owen Jones lectureship in physical chemistry is to be revived.

Mr. L. A. Pars has been elected to a fellowship at Jesus College.

LONDON.—The following advanced lectures in physiology and medicine are announced:—A course of eight lectures on "Metabolism of Cholesterol and the Sterols," by Mr. J. A. Gardner, at the London (R.F.H.) School of Medicine for Women, at 5 p.m. on Tuesdays, May 17, 24, 31, June 7, 14, 21, 28, and July 5, 1921. A course of eight lectures on "Experimental Studies in Vegetable Physiology and Vegetable Electricity," by Dr. A. D. Waller and Mr. J. C. Waller, in the Physiological Laboratory of the University, South Kensington, S.W.7, at 5.15 p.m. on Wednesdays, May 18, 25, June 1, 8, 15, 22, 29, and July 6. A course of four lectures on "The Interpretation of the Structure of the Brain," by Dr. C. U. Ariens Kappers (director of the Central Institute for Brain Research, Amsterdam), in the Department of Anatomy, University College, at 5 p.m. on May 13, 17, 19, and 20. These courses are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

The semi-general election of members of the Senate for the period 1921–25 has resulted in the appointment of the following representatives of science:—By Convocation: G. D. Dunkerley, Sir Philip Magnus, Bart., M.P., and Dr. R. M. Walmsley. Faculty of Science: Prof. A. Dendy and Prof. A. N.

Whitehead. Faculty of Engineering: Prof. H. C. H. Carpenter. Faculty of Economics: Prof. Graham Wallas.

Until recently the degrees of Master of Science and Master of Arts were granted to both internal and external students of the University on a thesis embodying the results of research, but, if thought necessary, an examinational test might also be imposed. Last year, however, the Senate resolved that on the external side these degrees should be given in and after 1923, not for research, but on the results of an examination. This was felt in many quarters to be a retrograde step, and at the meeting of Convocation held on May 3 Mr. Plymen moved and Major Church seconded the following resolution:—"That in view of the importance of research in the national interests and its value in post-graduate training, it is a matter of deep regret that external students of the University should not be permitted to take the Master's degree by means of research." After an animated discussion the resolution was passed, *nemine contradicente,* in an unusually large house, only three of those present refraining from voting in its favour.

MANCHESTER.—The University Court has agreed to the conferment of the following honorary degrees:—*Litt.D.*—C. H. Haskins, Gurney professor of history and political science, and Dean of the Graduate School, Harvard University; S. Reinach, Membre de l'Institut de France, Conservateur du Musée de Saint Germain, professeur à l'Ecole du Louvre; J. T. Sheppard, fellow and tutor, King's College, Cambridge. *D.Sc.*—R. Kidston, author of numerous investigations in palæobotany; C. S. Sherrington, professor of physiology, Oxford, and president of the Royal Society.

The following degrees were conferred on May 7:—*Litt.D.*—Sir Sydney J. Chapman, formerly Stanley Jevons professor of political economy in the University; Dr. C. H. Herford, professor of English literature in the University; Dr. T. W. Rhys Davids, formerly professor of comparative religion in the University; Dr. G. Elliot Smith, formerly professor of anatomy in the University. *D.Sc.*—Dr. Horace Lamb, formerly Beyer professor of mathematics in the University; Sir Ernest Rutherford, formerly professor of physics in the University. Dr. Horace Lamb, Dr. T. W. Rhys Davids, and Sir William Thorburn have been appointed professors emeriti.

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THE University of Glasgow is to confer the honorary degree of LL.D. upon Mr. Laurence Binyon, of the British Museum, Sir Dugald Clerk, and Principal J. C. Irvine, of St. Andrews.

PROF. A. D. ROSS, professor of mathematics and physics in the University of Western Australia, Perth, has been elected a member of the governing body of the University. He formerly held office as Vice-Chancellor, but resigned from that post some little time ago.

THE Universities Institute and Institute of Lecturers are issuing a periodical, the *Platform Review,* the first number of which has reached us. The objects of the institute are to foster popular lecturing of an educational nature and to organise courses of such lectures. The first issue of its publication is a special lecturers' number, in which brief paragraphs appear giving accounts of the types of lectures which may be expected from a number of men who will be lecturing during the coming winter. All communications should be addressed to the Editor, 35 Cambridge Road, Seaforth, Liverpool.

## Calendar of Scientific Pioneers.

**May 12, 1684. Edmé Mariotte died.**—An independent discoverer of Boyle's or Mariotte's law, Mariotte was prior of St. Martin-sous-Beaune. He was one of the earliest members of the Paris Academy of Sciences, and wrote on percussion, heat, colour, and hydraulics.

**May 12, 1884. Charles Adolphe Wurtz died.**—President of the Paris Academy of Sciences and holding the chair of organic chemistry in the Sorbonne, Wurtz wrote more than a hundred memoirs, and during 1869–78 published a great dictionary of pure and applied chemistry.

**May 12, 1910. Sir William Huggins died.**—The son of a London linendraper, Huggins after a few years in business retired and built an observatory at Tulse Hill, where he carried out pioneering work in astronomical spectroscopy and photography. He received the Rumford and Copley medals, and in 1900 became president of the Royal Society. Lady Huggins, who was his devoted assistant, died on March 24, 1915.

**May 13, 1832. Léopold Chrétien Frédéric Dagobert, Baron Cuvier died.**—Foremost among comparative anatomists, Cuvier was born in 1769. In 1795 he became a professor in the Jardin des Plantes, and in 1803 permanent secretary to the Paris Academy of Sciences. His most famous work, "Le Règne Animal distribué d'après son Organisation," appeared in 1817.

**May 13, 1878. Joseph Henry died.**—An indefatigable experimentalist, Henry made some of the earliest discoveries in electro-magnetism and electrical induction. He was professor of natural philosophy at Princeton from 1832 to 1846, and then became secretary to the Smithsonian Institution, which under his direction became one of the most important scientific institutions in the world.

**May 13, 1891. Alexandre Edmond Becquerel died.**—Professor of physics in the Conservatoire des Arts et Métiers and in the Musée d'Histoire Naturelle, Becquerel collaborated with his father in much of his work, and made independent researches on phosphorescence and on the electrical and magnetic properties of substances.

**May 14, 1734. Georg Ernst Stahl died.**—After holding the chair of medicine in the University of Halle, Stahl became physician to the King of Prussia. To explain the phenomena of combustion and calcination he formulated the theory of phlogiston.

**May 14, 1893. Ernst Eduard Kummer died.**—Born in 1810, Kummer was professor of mathematics in the University of Berlin. His writings referred mainly to branches of pure mathematics such as the theory of numbers.

**May 14, 1899. Lars Fredrik Nilson died.**—While professor of analytical chemistry at Upsala Nilson studied the rare earths, and in 1879 isolated scandium, an element identical with Mendeléeff's hypothetical element ekaboron.

**May 16, 1830. Jean Baptiste Joseph Fourier died.**—One of the savants who accompanied Bonaparte to Egypt in 1798, Fourier for some years was Prefect of the Department of the Isère. He succeeded Delambre as secretary of the Paris Academy of Sciences. His fame rests chiefly on his "Théorie Analytique de la Chaleur," containing the well-known Fourier's series so constantly used in modern analysis.

**May 17, 1765. Alexis Claude Clairaut died.**—A writer of mathematical papers at twelve and a member of the Paris Academy of Sciences at eighteen years of age, Clairaut has been called by Comte the principal constructor of celestial mechanics.

E. C. S.

## Societies and Academies.

LONDON.

**Royal Society**, May 5.—Prof. C. S. Sherrington, president, in the chair.—Dr. H. **Head**: Release of function in the nervous system (Croonian lecture). Hughlings Jackson's law that destructive lesions do not cause positive effects, but induce a negative condition, which permits positive symptoms to appear. Control of higher over lower centres. Structural lesions may remove this dominance and so reveal the activity of subordinate centres; this is "disintegration" of function. Should the stimulus become abnormally intense or central resistance be weakened, forms of reaction may break through which are normally suppressed; this is "escape from control."

**Physical Society**, March 22.—Prof. W. Eccles, vice-president, in the chair.—W. N. **Bond**: The effect of viscosity on orifice flows. Determinations were made of the coefficient of discharge through an orifice 0·1469 cm. in diameter of solutions of glycerine and water, varying in kinematic viscosity from 0·01 to 7. The results are plotted in a manner which combines both purely viscous and purely turbulent flows in one graph. The effect of slight viscosity is to increase the coefficient of discharge.—Dr. A. **Griffiths** and Constance H. **Griffiths**: Viscosity of water and low rates of shear. The determination of the coefficient of viscosity of water by a method in which water is forced along glass capillary tubes of 1·5 to 2·0 mm. bore at rates of flow varying from 1 litre in two years to 1 litre in twenty-four years. The liquid fills a closed tubular circuit which for purposes of description may be said to be rectangular in shape, two of the tubes being horizontal and two vertical. The circulation is caused by a difference of density obtained by having a weak solution of uranine in one vertical tube and pure water in the other. Values for the coefficient of viscosity are given. There is no experimental evidence that at the extremely low rates of shear the viscosity of air-free water in glass capillary tubes differs from its value at normal rates of shear.—B. S. **Smith** and G. F. **Partridge**: A method of measuring frequencies. A heterodyne method of measuring frequency by comparison with a calibrated valve oscillator. Calibration is performed by means of two valve oscillators capable of giving frequencies of 1000/sec. upwards. The frequency of the oscillations is raised alternately to give a beat note the pitch of which is determined by comparison with a fork. Intermediate frequencies are found by interpolation on the calibration curve. For the measurement of acoustic frequencies the sounds are converted into alternating currents by a suitable transmitter.

**Geological Society**, April 20.—Mr. R. D. Oldham, president, in the chair.—J. A. **Douglas**: Geological sections through the Andes of Peru and Bolivia. III.: From Callao to the River Perene. The zone of Mesozoic rocks extends to the Pacific coast, which is here formed of shallow-water deposits of Lower Cretaceous age. The granodioritic batholite which forms the core of the Andes is encountered in the neighbourhood of Lima, and again near the summit of the range. The western flanks of the Cordillera are characterised by a great development of Cretaceous porphyritic agglomerate; while the normal calcareous facies is the dominant feature of the high-level regions. The intensity of the Tertiary folding has obscured the effects of the post-Jurassic uplift previously shown to occur in the south, and it is only on palæontological evidence that a break in the sequence of Mesozoic deposits can be determined. The rocks of Palæozoic aspect which form the eastern flanks of the Cordillera are mostly unfossiliferous, and have largely been converted into phyllites and mica-schists, penetrated by granite. On the Rio Perene a bigger mass of red granite is found, which is essentially a rock of "alkaline" character. It is suggested that its origin is antecedent to the uplift of the mountain ranges.—Prof. O. T. **Jones**: The Valentian series. The history of the nomenclature from the time of Murchison onwards was traced and the relation of the Tarannon to the Llandovery and the Birkhill-Gala rocks discussed in detail. In view of the occurrence of two distinct facies (graptolitic and shelly) of the Valentian rocks, two separate classifications are in use. The succession of graptolites is made the basis of one of these, the series being divided into a Lower or Birkhill stage and an Upper or Gala stage, each of which is further divided into sub-stages and zones. The mixed facies of Girvan allows certain shelly horizons to be brought into relation with the graptolitic scale. The fauna of various districts where the shelly facies prevails is compared with the Girvan succession and a general correlation-table of the Valentian rocks proposed, the rocks of the shelly facies being divided into two stages—Lower and Upper Llandovery. The base-line of the Valentian series was discussed, and in most districts evidence is found of an abrupt lithological change at a certain horizon, which in some cases amounts to a palæontological break. The phenomena at that horizon suggest arrested sedimentation, if not also actual erosion.

PARIS.

**Academy of Sciences**, April 18.—M. Georges Lemoine in the chair.—J. **Boussinesq**: The flattening along the polar axis, by surface tension, of a liquid drop, of revolution and without weight, possessing a given angular velocity $\omega$ of rotation round this axis.—E. **Bourquelot** and M. **Bridel**: The application of the biochemical method of research on glucose to the study of the products of fermentation hydrolysis of inulin. By the hydrolysis of inulin by the inulase from *Aspergillus niger* reducing products are obtained which possess the rotary power of *d*-fructose, and do not combine with methyl alcohol under the influence of emulsin. It is concluded that the hydrolytic fermentation of inulin gives no glucose.—L. **Cuénot**: Regeneration of claws in the place of antennæ removed by cutting in a Phasmid.—B. **Gambier**: Non-unicursal algebraic curves with constant torsion.—L. **Montangerand**: Observation of the eclipse of the sun on April 7, made at Toulouse Observatory.—A. **Véronnet**: The constitution and formation of the spiral nebulæ. A mathematical investigation of the conditions under which a double star formed of two components of large, homogeneous, and approximately equal masses may lead to the formation of a spiral nebula.—H. **Chipart**: The homologues of a permanent uniformly magnetised magnet. The law of the ellipsoid.—L. and E. **Bloch**: The spark spectra of gold and platinum in the extreme ultra-violet. Tables of wave-lengths of the lines of the spark spectra of these two metals are given between the limits 1843 and 1402.—A. **Portevin**: The use of very slow cooling for the micrographical study of alloys and the structure of the tungsten steels. The advantages of the very slow cooling are that the structure of the alloys appears on a larger scale, permitting projection on the screen with relatively low magnification, and sometimes new, unsuspected equilibrium structures are shown The case of tungsten steels is considered in detail, and two photomicrographs of these alloys are reproduced.—M. **François**: A microscopic arrangement for the examination of opaque crystals.—G. **Dubreuil**: The principle of a new method of graphical stereoscopic reconstruction of magnified microscopic objects.—A. **Duboin**: The constitution of smalt. Details for the preparation of this colouring matter are given, the analysis of which leads to the formula $K_2O,CoO,3SiO_2$ as representing its composition.—G. **Claude**: The manufacture of hydrogen for the synthesis of ammonia. With a view to the utilisation of hydrogen from water-gas, experiments on the solubilities of hydrogen and carbon monoxide in various solvents at high pressures (up to 1600 atmospheres) and at varying temperatures were carried out. A diagram is shown giving the results of the solubility experiments for hydrogen and carbon monoxide at 20° C. and −40° C. in ether. It is concluded that by using ether the commercial separation of these two gases under pressures of about 100 atmospheres and temperatures of the order of −50° C. would easily give hydrogen containing less than 0·2 per cent. of carbon monoxide.—M. **Vèzes**: The composition of French turpentine. The proportions of pinene and nopinene are determined by a polarimetric method.—L. **Palfray**: The cresyl cyanocampholates and their reduction product.—R. **Cornubert**: The oxidation with permanganate of αα-methylallyl*cyclo*hexanone in alkaline solution.—E. **André**: The determination of the acetyl figure of fatty materials. A simplification of the Lewkowitsch method.—L. **Cayeux**: The existence of numerous halcyon spicules in the Jurassic iron minerals of France.—P. **Russo**: The geological situation of the volcanoes of Oudjda, eastern Morocco.—M. de Montessus **de Ballore**: The longitudinal depression of Chile.—L. **Blaringhem**: The variations and fertility of the hybrid *Primula variabilis* compared with those of its parents, *P. vulgaris* and *P. officinalis*.—P. **Dangeard**, jun.: The evolution of the aleurone grains in ordinary vacuoles and the formation of tannins.—L. **Destouches**: The prolongation of life in *Galleria mellonella*. At the most favourable temperature, 37° C., the total evolution of the caterpillars of Galleria from the egg to the butterfly is about fourteen days. This period can be progressively lengthened by lowering the temperature. By submitting the caterpillars for periods of twenty-four hours alternately to temperatures of 1° C. and 37° C. the life can be prolonged to thirty-five days, and at the same time the production of eggs is more than doubled.—L. **MacAuliffe** and A. **Marie**: An anatomo-physiological study of a Japanese method of abdominal massage.—A. **Peyron**: The mode of development and the varieties of tumours of the ovotestis.—J. **Legendre**: The biology of the Madagascan perch.

ROME.

**Reale Accademia nazionale dei Lincei,** February 20.—Original papers by fellows:—G. **Castelnuovo**: Abelian functions, ii.: The geometry of Abelian varieties.—C. **De Stefani**: Ligurian siliceous sponges, iv.: Eocene, lower strata, valley of the Iso and Cairo (Italy).—A. **Issel**: First steps in the systematic arrangement of geological marks. The author proposes to divide them into nine classes, namely, cosmic marks (meteorites), atmospheric marks, hydrospheric marks, hydro-mineral marks, volcanic marks, tectonic marks, plutonic marks, glacial marks, and physiological marks.—Papers communicated through fellows:—L. **Tonelli**: Two propositions of Lindeberg and Levi in the calculus of variations, ii.—O. **Lazzarino**: Variations in kinetic energy of a semi-rigid rotating system.—M. **Pascal**: Superficial circulation, ii. Vectorial expressions and general theorems analogous to ordinary circulation theories.—C. **Perrier**: The true nature of Rosasite. This mineral, discovered in a mine at Rosas, in Sardinia, in the form of crystals, is mainly compounded of copper oxide, copper carbonate, and zinc carbonate.—E. **Bora**: Contributions to the natural history of Anopheles and their extermination (in connection with Prof. B. Grassi's anti-malaria campaign at Fiumicino, near Rome), iii. The author gives statistics regarding the hours of the day and night at which the mosquitoes enter buildings and commence their attacks. It appears that they rarely attack until some time after their entry. In a second part of the note the author gives evidence in support of the view that fishes and ducks are inefficacious in attacking and keeping down the larvæ.—A. **Lo Surdo**: Binaural localisation of pure sounds. In order to test the theory according to which perception of the direction of a source of sound is due to the difference of phases of the waves as they reach the two ears, the author has constructed an experimental apparatus in which a source of sound is connected with the ears by two tubes, one of which at least can be varied so as to be made longer or shorter than the other at will. If the difference of path is less than half a wave-length, the sound appears to come from a source in the direction of the shorter path; if the difference is exactly equal to a wave-length, the source appears to be in front, and, as should be expected from theory, the apparent direction of the source now varies when one path is increased or decreased in just the same way as it would vary if we started with the two paths equal.—The Secretary (Prof. Castelnuovo) announced that ten candidates submitted works in competition for the prize for physical and chemical sciences offered by the Minister of Public Instruction, and one candidate for the Carpi prize.

## Books Received.

The Man who Did the Right Thing: A Romance of East Africa. By Sir Harry Johnston. Pp. vii+444. (London: Chatto and Windus.) 8*s*. 6*d*. net.

The Elements of Illuminating Engineering. By A. P. Trotter. (Technical Primers.) Pp. xi+103. (London: Sir I. Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

Cours de Physique générale. By Prof. H. Ollivier. Tome premier. Deuxième édition. Pp. 749+iii planche. (Paris: J. Hermann.) 45 francs net.

The New Philosophy of Modern Science. By Dr. W. W. Strong. Pp. viii+194. (York, Pa.: Kyle Printing Co.)

Hiroshige. By Yone Nogouchi. Pp. ix+38+xix plates. (New York: Orientalia; London: Elkin Mathews.) 25*s*. net.

The Electrical Transmission of Photographs. By Marcus J. Martin. Pp. xi+136. (London: Sir I. Pitman and Sons, Ltd.) 6*s*. net.

The Extra Pharmacopœia of Martindale and Westcott. Revised by Dr. W. Harrison Martindale and W. Wynn Westcott. Seventeenth edition. Vol. ii. Pp. xxxii+688. (London: H. K. Lewis and Co., Ltd.) 17*s*. 6*d*. net.

Laboratories: Their Planning and Fittings. By Alan E. Munby. Pp. xix+220. (London: G. Bell and Sons, Ltd.) 25*s*. net.

A New British Flora: British Wild Flowers in their Natural Haunts. Described by A. R. Horwood. Vol. v. Pp. xi+234+l-lxiv plates. Vol. vi. Pp. xix+232. (London: Gresham Publishing Co., Ltd.) 12*s*. 6*d*. net each vol.

Storia della Geometria descrittiva dalle Origini sino ai Giorni Nostri. By Prof. Gino Loria. (Manuali Hoepli.) Pp. xxiv+584. (Milano: U. Hoepli.) 25 lire.

Famous Chemists: The Men and their Work. By

Sir William A. Tilden. Pp. xvi+296. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co.) 12s. 6d. net.

A Handbook of Laboratory Glass-Blowing. By Bernard D. Bolas. Pp. vii+106. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co.) 3s. 6d. net.

The West Riding of Yorkshire. By Bernard Hobson. Pp. xii+188. (Cambridge: At the University Press.) 4s. 6d. net.

Mededeelingen van de Landbouwhoogeschool en van de Daaraan verbonden Instituten. Deel xix., Bijdrage tot de Kennis der Zuidelijke Zwerfsteenen in Nederland en Omgwing. By C. H. Oostingh. Pp. iv+165+iv plates. (Wageningen: H. Veenman.)

## Diary of Societies.

*THURSDAY*, MAY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. C. S. Myers: Psychological Studies: (2) The Appreciation of Music.

HARVEIAN SOCIETY OF LONDON (at Paddington Infirmary), at 4.30.—Clinical Meeting.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, Paddington), at 4.30.—Sir James Mackenzie: The Opportunities of the General Practitioner are Essential for the Investigation of Disease and for the Progress of Medicine.

ROYAL SOCIETY, at 4.30.—G. W. Walker: The Problem of Finite Focal Depth revealed by Seismometers.—E. A. Griffiths: A Liquid Oxygen Vaporiser.—Dorothy M. Palmer and W. G. Palmer: Some Experiments on the Catalytic Reduction of Ethylene to Ethane.—W. G. Palmer: The Catalytic Activity of Copper. Part II.—Prof. J. F. Jenkin and D. N. Shorthose: The Total Heat of Liquid Carbonic Acid.—Dr. A. O. Rankine: The Viscosity and Molecular Dimensions of Gaseous Cyanogen.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—H. W. Turnbull: Invariants of Three Quadrics.—G. H. Hardy and J. E. Littlewood: (1) Some Problems of Diophantine Approximation; (2) The Lattice Points of a Right-angled Triangle (Second Paper).

CHILD-STUDY SOCIETY (at 90 Buckingham Palace Road), at 6.—Discussion on Individual Training.—Miss F. E. Webb: Individual Training in the School.—Miss Sabina Salt: Preparation in the Training College for Individual and Group Work in the School.—Miss C. M. A. Coombs: Vertical Classification in an Infants' School.

SOCIOLOGICAL SOCIETY AND REGIONAL ASSOCIATION (at 65 Belgrave Road), at 8.15.—Prof. P. Geddes: Co-operation in Social Studies.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (Annual General Meeting), at 8.30.—Prof. Marinesco: Encephalitis Lethargica.

*FRIDAY*, MAY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—A. N. Brown: Observations of V Cassiopeiæ (Ch. 8324) in 1916-21.—A. A. Rambaut: Observations of the Solar Eclipse of 1921, April 7, at the Radcliffe Observatory, Oxford.—W. H. Van Den Bos: The Orbit of Σ 554=80 Tauri.—Rev. A. L. Cortie and Rev. J. Rowland: The Partial Eclipse of the Sun, 1921, April 7.—C. Martin and H. C. Plummer: Magnitude Curves of Three Short-period Variable Stars, RR Leonis, Y Aurigæ, and UU Cassiopeiæ.—Royal Observatory, Greenwich: Observations of the Solar Eclipse of 1921, April 7.—Royal Observatory, Greenwich: Observations of Comets, 1921, *a*, *b* (Reid and Pons-Winnecke).—L. J. Comrie: Eclipse of Rhea by the Shadow of Titan.—Dr. T. Royds: Lantern Slides illustrating Recent Work at the Kodaikánal Observatory.—Prof. W. H. Pickering: Observations of the Moon at the Harvard College Observatory, Jamaica.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—L. Hartshorn and E. S. Keeping: Notes on Vacuum Tubes used as Detectors of Electrical Oscillations.—B. W. Clack: The Coefficient of Diffusion of Certain Saturated Solutions.—Dr. G. D. West: Experiments on Thermal Transpiration Currents.

INSTITUTE OF TRANSPORT (at Royal Society of Arts), at 5.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS, at 8.—H. G. Brown: Scientific Developments in Gas Measuring Instruments.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Dr. D. L. Davies: Lachrymal Obstruction, Results of Anastomotic Method of Treatment (Toti).—E. Clarke: Lessons from Forty Years of Refraction Work.—Miss J. C. Mann: Aphakia in a Human Embryo of Five or Six Weeks.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. W. Bateson: The Determination of Sex.

*SATURDAY*, MAY 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. C. C. Baly: Chemical Reaction.

*TUESDAY*, MAY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—E. Clodd: Occultism: Its Origin and Development.

*WEDNESDAY*, MAY 18.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark and H. B. Adames: Report on the Phenological Observations for 1920.—Dr. E. J. Salisbury: Phenology and Habitat, with Special Reference to the Phenology of Woodlands.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section) (Annual General Meeting), at 5.—Dr. C. G. Cumston: A Brief Historical Summary of the Treatment of Trachoma, with Special Reference to the Arabian School and the Writings of Ali Ibu-el-Aïssa.

ROYAL SOCIETY OF MEDICINE (Surgery Section) (Annual General Meeting), at 5.30.

ROYAL MICROSCOPICAL SOCIETY, at 8.

*THURSDAY*, MAY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—E. Law: The Architecture and Art of Hampton Court Palace: In Tudor Times.

INSTITUTE OF PATHOLOGY AND RESEARCH (at St. Mary's Hospital, Paddington), at 4.30.—Dr. H. H. Dale: Anaphylaxis and Immunity.

ROYAL SOCIETY OF MEDICINE (Dermatology Section) (Annual General Meeting), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—E. H. Clifford: Scheme for Working the City Deep Mine at a Depth of 7000 ft.—The following Papers will be submitted for Discussion:—F. P. Caddy: Stope Measuring at the Passagem Mine of the Gold Mines of Ouro Preto, Ltd.—J. A. P. Gibb: Notes on Some Useful Alignment Charts.

CHEMICAL SOCIETY (Informal Meeting), at 8.

RÖNTGEN SOCIETY (in Physics Lecture Theatre, University College), at 8.15.

*FRIDAY*, MAY 20.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 5.—F. J. Cleminson: Sinusitis in Children.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (Annual General Meeting), at 8.30.—Discussion: The Stomach.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. H. Starling: The Law of the Heart.

*SATURDAY*, MAY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—F. Legge: Gnosticism and the Science of Religions.

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