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Words, Meanings, and Styles.

I.

FOR several weeks various opinions have been expressed in our correspondence columns as to the desirability or otherwise of using the word scientist to designate in a generic sense any one actively engaged in the advancement of natural knowledge by investigation. The term is not an Americanism, as is often supposed, but was introduced by Dr. Whewell in 1840 "to describe a cultivator of science in general." In a letter published in NATURE of November 29, Dr. Norman Campbell pleaded for approval of the word, and asked objectors to suggest a single substitute for it if they were not willing to adopt it. We invited opinions upon the question from a number of distinguished representatives of letters as well as of science, and have published some of the replies with which they have favoured us. The general attitude of scientific workers was clearly stated by Sir Ray Lankester in our issue of December 6; and it is one of dislike. Literary authorities, on the other hand, are prepared to give the word a legitimate place in the English language, and they point to many similar hybrids which have been admitted into our vocabulary without question.

It cannot be said that, as the result of the discussion, any single word has been suggested which is likely to come into general use as a substitute for scientist. Some of our correspondents have expressed complete abhorrence of this term, others have given unwilling acceptance to it, and a third group approves of it. While, therefore, we do not propose to depart from our custom of avoiding the word in our own practice, or in unsigned contributions for which we accept editorial responsibility, we are content to leave individual authors to use it or not, as they may prefer. Our opinion is that one of the main objections to the word is that it is too comprehensive in its meaning. Sir Israel Gollancz thinks the word should not be limited to workers in the field of physical or biological science, and Prof. Wildon Carr would make it imply philosophers as well as such workers. What they apparently desire is a word which is equivalent to the French savant or the German Gelehrte, but it can scarcely be said that the term scientist was coined with this intention.

The fact is that, in these days of specialised scientific investigation, no one presumes to be "a cultivator of science in general." A man is a chemist, physicist, biologist, botanist, or worker in one or more particular branches of science, and he prefers to be designated as such rather than to be placed in an indefinite group of "scientists." In an artificial language like Esperanto, it is easy to assign a single termination, such as "ist," to all professional occupations, but no hard and fast rule of this kind can be imposed upon the structure

of a living language. Certain words come into use, while others are discarded, and no purely logical or etymological plan of formation is practicable. "Mathist" and "electrist" may, as Sir Richard Paget suggests, be improvements upon "mathematician" and "electrician," and Prof. Armstrong's "sciencer" may be a suitable substitute for the word "scientist," but whether the termination be "ist" or "er," custom alone will decide which will survive. We have geographer and geologist, engineer and technologist, philosopher and physicist, astronomer and spectroscopist, all in common use, whether rightly or wrongly formed. The public has similarly accepted "scientist" to signify a follower of science of any kind, and will continue to use it even though it is not approved as good currency in the scientific world.

An inquiry of the secretaries of the leading British scientific societies shows that the word is very rarely used in their publications and is always avoided when it can be conveniently avoided. It is not used officially by the Royal Society of London or of Edinburgh, the British Association, or the Royal Institution, and each of these bodies often has occasion to refer to workers in science as a whole. The feeling of the Cambridge University Press is strongly against the use of the word scientist, and when, in one instance, it occurred in the title of a work submitted to the Syndics, a strong protest was raised and the title of the book was altered. On the other hand, the Clarendon Press, Oxford, does not object to the word being used in its books, and says: "Of course we avoid any attempt to legislate and are guided principally by usage." There is no doubt whatever that the balance of feeling in scientific circles is against the word. Whatever its future, therefore, we are not prepared to depart from our practice hitherto of avoiding the word, and we leave it to others to convert it into the currency of cultured usage.

The variety of opinion on the recognition of the word scientist enables a conception to be formed of the labour involved in providing a good technical vocabulary for a new subject such as aeronautics. There is, first of all, the difficulty of setting up a systematic nomenclature with reasonable claims to be logical without being pedantic. In addition, there is the still greater difficulty of obtaining general acceptance by such diverse people as mathematical physicists, technical engineers, constructors, pilots, mechanics, the Services, and last, adoption by the press, most influential of all. The Technical Terms Committee of the Royal Aeronautical Society, which was reconstituted in 1920 as a section of the British Engineering Standards Association, produced the present officially accepted glossary for aeronautics; and the Advisory Committee for Aeronautics in the U.S.A. has shown much broad-mindedness in adopting the great majority of the British findings. There are important exceptions, however. Dr. Alexander McAdie, director of the Harvard meteorological station at Blue Hill, in writing to us about the word scientist comments on the continued use of the form "aeroplane" in Great Britain, replaced by "airplane" in America.

Generally speaking, it will be found that, in the official glossary for aeronautics, *air-* is compounded with common English words, or with words derived through the French language, while *aero-* is compounded with technical terms of direct Latin or Greek origin. Thus: *Air- man, ship, craft, shed, screw,* but *aero- stat, naut, bate, dynamics,* etc. *Aerofoil* is an exception and should be either *airfoil* or *aerofolium*. *Aeroplane* is right by the rule, but *seaplane,* introduced by the Admiralty during Mr. Churchill's regime, and *landplane, floatplane, wheelplane* proposed but not yet accepted, all justify *airplane*. *Airplain* is ruled out by the lack of association of *plain* with wing-like structures; but the influence of the French word *aéroplane,* the interest vested in the title of our own liveliest of technical periodicals, and ingrained use, will prevent the giving up of the form *aeroplane* for a long time. A very stout battle has been fought over the introduction of *air-screw* to avoid such combinations as *tractor propeller* and *pusher propeller* which are retained in the U.S.A. vocabulary. The most awkward gap in the language of aeronautics is due to the want of words to denote aircraft both lighter than air and heavier than air. *Aerodyne* was proposed by analogy with *aerostat,* but nothing more has been heard of it; *H/A craft* and *L/A craft* beg the question, and it may be hoped that *lighter-than-air-craft* will not survive. In the face of these few examples of the difficulties which crop up in a technical vocabulary, it is a bold prophet who will predict the terms around which the language will finally crystallise.

In discussing the use or disuse in English of any particular word, the very mixed origin of our language must, of course, be borne in mind. Anglo-Saxon, Latin and Greek have all provided roots which appear in words in general use, while, if the vocabularies of the sciences and arts are taken into consideration, it is clear that a much wider range of languages has also been used. This may perhaps account for the ease with which foreign words are introduced, often as slang at first, and eventually adopted, with little if any change in spelling. It should also incline us to be tolerant of hybrid words, though, of course, the making of new hybrids, unlike the work of the plant-breeder, cannot be expected to be productive of beauty and increased usefulness, and should be discouraged.

The question is discussed in an interesting article

by Mr. George H. Bonner in the December issue of the *Nineteenth Century*. The real point is this: A word having crept into use, what is to be the ultimate authority for discarding or retaining that word as a definite part of the English language? In France the decision is in the hands of the Academy. A word is "adopted" or otherwise and the writers of the day follow, more or less, the recommendations made. But that will not prevent the use of a word in conversation and by the general public. After all, it is the growth of popularity of a word which is a factor in bringing it to the notice of the Academy. If a new word is useful in that it conveys an exact meaning not readily expressed in a word or concise phrase at present accepted as legitimate, it would seem that popular usage will gradually enforce its adoption. Thus the vocabulary of a language, if it is to meet the demands made upon it by a progressive people, must be continuously in a state of flux.

This may explain, in part, why so little progress has been made in the adoption of an international language. Apart from the claims of nationalism, which have been increasingly insistent during the past few years, "living" languages must, with the growth of new ideas and the introduction of foreign elements, be always developing. It therefore becomes difficult for those who are not, as it were, "living with the language," to keep pace with changes of meaning. As regard purely artificial languages, the question of following the dictates of an academic central authority again arises. The authority, in most cases, will trail behind popular usage.

There is, however, a further consideration, as Mr. Bonner points out in the article to which we have referred. The language of conversation is not normally the language of serious writing. In talking, the periods are generally comparatively short and the argument often gains by the use of terse and incisive expressions which would be totally out of place in written contributions. When it is a question of placing on record, for serious discussion and reflection, facts and thoughts which represent additions to the sum of human knowledge, then accuracy of meaning and dignity of expression should be the rule. Here again, in English, popular usage would seem to be the ultimate authority, though with the restriction that "popular usage" should refer to the diction and style of the better educated and more intellectual of the community. The language of a progressive people must itself be progressive; and as the word scientist expresses more clearly and with less ambiguity than any other single word the meaning it is intended to convey, it is likely to survive the dislike which scientific workers in general have for it.

Continental Drift.

The Origin of Continents and Oceans. By Prof. Alfred Wegener. Translated from the third German edition by J. G. A. Skerl. Pp. xx+212. (London: Methuen and Co., Ltd., 1924.) 10*s.* 6*d.* net.

THE wide appeal of Prof. Wegener's theory of the arrangement of ocean and continent is shown by the issue of a third greatly revised edition and of this excellent English translation. His theory is that the continents consist of rigid blocks of sial, or rock characterised by a high percentage of silica and alumina, which are floating partly submerged in a sheet of sima, or rock material composed mainly of silica and magnesia; that the existing continents are due to the breaking up of a once continuous sheet of sial, the fragments of which have drifted to their present positions in consequence of the earth's rotation; and that this drift occurs owing to the plasticity of the sima. Prof. Wegener believes that the continents have been moved for great distances even in geologically recent times, and he thereby, with great ingenuity and attractiveness, explains many problems of geography, geology, climatology, biology, and geodetics. The process offers an easy escape from difficulties and is not to be dismissed as impossible or scouted as fantastic; for in all probability sima is more plastic than sial, and the rotation of the world must make the continental masses tend to lag westward, and press centrifugally toward the equator. The view that the continental masses are subject to some horizontal drift has been often adopted, as, for example, by the reviewer in 1915 (*Scot. Geog. Mag.*, 31, pp. 258-60) to explain the folded nature of the Pacific margin of America, in contrast to the coastal structure on both sides of the Atlantic, and the prevalence of fiords on western coasts. There is no *a priori* objection to the principle, and the verdict on Prof. Wegener's theory will depend on whether it explains more difficulties than it creates.

The author's interesting discussion of the geophysical arguments shows that on this branch of the subject the primary facts are still uncertain. In spite of the apparent precision of mathematical methods, the data are so inexact that the results are inconclusive. Prof. Wegener's theory will, however, probably give a new lease of life to the explanation of the Carboniferous glaciation of India and of some parts of the Southern Hemisphere, by the shifting of the Pole; for arguments, which are unanswerable against that explanation with scattered continents, do not apply to Prof. Wegener's single continent.

The theory of continental drift was suggested by that coincidence in course of the opposite coasts of the

Atlantic, which is one of the best known of the geographical homologies. Its significance was remarked by Bacon. Prof. Wegener has the advantage over Lord Bacon that the geological evidence now supports the inferences from geographical shape; for the opposite parts of the Atlantic show remarkable resemblances in structure and composition. The agreements, according to Wegener, are due to the coasts having been originally in contact, and having been separated by a curved fracture which was widened into the Atlantic basin, owing to the land west of the rift having drifted away as America. The agreement in grain of the lands on the two sides of the Atlantic is, however, also capable of explanation by vertical movements of the crust. If two pieces of wood with the grain of each in line are seen in a sheet of water, it does not follow that they were originally in contact and have floated apart. They may be the ends of a warped plank, of which the middle has sunk beneath the surface. The Appalachian and Armorican Mountains may have belonged to a continuous mountain belt without their having been actually adjacent, just as the Pyrenees and the Caucasus are regarded as part of one mountain system although they have always been separated by the full width of Europe. In fact, the differences between the Appalachians and the corresponding mountains in Western Europe indicate that they were probably formed some distance apart. The problem is whether the corresponding structures on opposite sides of the Atlantic have been separated by a two-mile subsidence of the intervening area, or by the horizontal drift of America for 2000 or 3000 miles.

Individual judgments on this question depend upon the theory accepted of the structure of the earth; and long before any agreement is reached by this route, the displacement theory should be proved or dismissed by direct observation. According to Prof. Wegener, southern Greenland is moving away from Scotland at the rate of from 18 to 36 metres a year, and Iceland is drifting away from Norway from 18 to 19 metres a year. The estimate for Greenland rests on the difference of longitudes determined by the *Germania* expedition of 1870 and the Danish expedition of 1907; they were determined by lunars and are not convincing. Wireless determinations of longitude at intervals of five or ten years should soon provide an absolute test of the theory, as is remarked by Dr. Evans in his interesting introduction to the volume.

The movement in the central Atlantic is regarded as slower than in the north, yet as increasing the distance between Brazil and the Cameroons eight inches a year. The growth of the tropical Atlantic, according to Prof. Wegener's table, has taken about 20 million years, though at the rate of drift assigned to Brazil, the time should have been 40 million years; therefore, according to the geological dates accepted on p. 113, the formation of the tropical Atlantic began in the early Mesozoic. The westward drift of South America is regarded as a long-continued process, and its crumpling effect on South America should have been widespread and continuous. The folding of the Andean belt was intermittent and happened at distant dates; but the folding that made the existing Andes happened in a relatively short period. That condition is consistent with the explanation of the Andean folding by a western lag which has been previously referred to, as the lag was attributed to instability due to vertical movements in the crust at one geological period; but without some acceleration of the westward movement in the middle Kainozoic, Wegener's continental drift does not explain the formation of the western fold mountains of America. Moreover, as the author shows in the fifth chapter from the palæontological evidence, the land connexion across the Atlantic was established and broken several times; so the displacement theory requires a concertina-like movement, America being pushed first west and then east. A vertical oscillation of the crust presents no difficulty comparable to that of an oscillatory horizontal passage of the Americas to and fro across the Atlantic.

A horizontal oscillation of even that amount is, however, insufficient. The displacement hypothesis is advocated from biogeography on, amongst other grounds, the occurrence on both sides of the Atlantic of animals and plants which apparently crossed it in about their present latitudes, and that shallow water marine animals, to which the deep seas are almost as impassable as to land animals, show the former range of shallow water along the same zones. The argument based on the marine animals appeals to the reviewer as one of his earliest papers urged it from the evidence of the fossil Echinoidea. Prof. Wegener quotes the manatee, which lives in the estuaries of West Africa and South America and is not likely to have crossed an ocean so wide as the Atlantic. There is, however, similar evidence of land connexion across the Pacific. The alligator is now found only in the Yangtze Kiang in China, and in the warmer parts of America; and it is no more likely to have crossed the open ocean or rounded the Pacific by Bering Straits than the manatee is to have crossed the Atlantic via Iceland and Greenland. Some lizards, amphibians, and the main flora of China support the evidence of the alligator as to a former land route across the Pacific to America. It is, however, essential to Prof. Wegener's case that Western America and the eastern lands of the Old World should have been previously farther apart than they are to-day; for before the separation of the Americas from Europe

and Africa the Pacific must have been wider. Prof. Wegener remarks (p. 86) that some of the earthworms of Australasia and New Zealand not only reach India but also, "strange to say, occasionally the west coast of North America."

This range of Australasian worms to western America is one item in a mass of biological evidence inconsistent with the view that America has been drifting westward into the Pacific. For example, Pritchardia, the characteristic palm of the south-western Pacific, is known elsewhere only in the Sandwich Islands and in Cuba, where its unexpected occurrence was attributed by Beccari to its fruits having been hurled from Polynesia by a volcanic eruption. According to Dr. Scharff, one element in the flora of the islands off western Mexico represents the eastern range of a central Pacific flora which was partly of Australasian and Eastern origin. Similarly, according to Pilsbury, the distribution of the land shells demands radial migration from a central Pacific land. Its existence is also indicated by the coral islands and by the contours of the Pacific floor.

The existence of a land connexion from America westward across the Pacific is, however, wholly inconsistent with the present form of the displacement theory. If the pilgrims had been rafted across the Pacific on migrating lands, America, after its separation from the western side of the Old World, not only drifted westward until it bumped against eastern Asia, but also has floated back to its present position. Unluckily for this explanation, the trans-Pacific and trans-Atlantic connexions are required at about the same time. Hence it would be necessary to assume that the sial mass of America at one time lost its rigidity and, like a rubber bladder, spread out as a thin sheet over both the Atlantic and Pacific basins; and that afterwards it contracted and thickened to form a meridional bolster. The original theory has undergone so many modifications, and its author is so delightfully open-minded, that it may be changed to agree with a trans-Pacific land connexion. The theory at present is inconsistent with so many facts that Prof. Wegener's calculation, that the odds based on the grain of the Atlantic shores are a million to one in his favour (p. 56), do not hold for the whole of his case.

The favourable reception of Prof. Wegener's theory is significant of marked changes of opinion as regards the structure and history of the earth. It shows that the once widely adopted view that oceans and continents have always been in their present positions no longer hampers geological interpretation, and it marks the growing belief in the effective mobility of the earth's crust.

J. W. GREGORY.

Greek Alchemy.

Union Académique Internationale. Catalogue des manuscrits alchimiques grecs. 1: Les *Parisini*. Décrits par Henri Lebègue. En Appendice, Les manuscrits des *Coeranides* et tables générales, par Marie Delcourt. Pp. x+320. n.p. 3: Les manuscrits des Îles Britanniques. Décrits par Dorothea Waley Singer, avec la collaboration d'Annie Anderson et William J. Anderson. En appendice, Les recettes alchimiques de *Codex Holkhamicus*, éditées par Otto Lagercrantz. Pp. vii+84. n.p. (Bruxelles: Maurice Lamertin, 1924.)

NO one who has not himself rummaged among the old chemical manuscripts in the great libraries can have any idea of the vast quantity of material which awaits investigation. Even the printed literature of the fifteenth to seventeenth centuries has been by no means fully studied, but of the earlier manuscript material only a fraction has hitherto been examined. This neglect is reflected in our histories of chemistry, which commonly begin seriously with Priestley and Lavoisier, by whose time chemistry was already well established on lines not widely different from those of to-day. The earlier periods are usually dealt with very summarily, since to give an adequate account of them, in the present state of our knowledge, would entail years of laborious work upon the original sources. The very ideas themselves, from their unfamiliar nature, often seem entirely unintelligible.

Any contributions, however small, to the accomplishment of the task presented to us by this unstudied material would therefore be certain of a warm welcome. When, however, they are of the standard and magnitude of the "Catalogue des manuscrits alchimiques grecs," it becomes difficult to express our thanks adequately. For our knowledge of Greek alchemy we have had to rely practically entirely upon the work of Berthelot and his collaborator Ruelle, whose "Collection des anciens alchimistes grecs" (3 vols., Paris, 1888) has been almost the sole source of our information on this subject. The recent revival of interest in the history of science has rendered it desirable to extend and amplify our knowledge of early chemistry, and it was very necessary to make a systematic investigation of all the extant manuscripts. Bibliographical research of this nature confers an inestimable boon upon later workers in the field, for it shows them at once what is and what is not available, and saves them more time than can readily be appreciated except by one who has suffered from the lack of such information.

That the present work is published under the direction of Profs. Bidez, Cumont, Heiberg, and Lagercrantz,

is a sufficient indication of its comprehensiveness and trustworthiness, two qualities which in an undertaking of this kind are absolutely indispensable. Unless one can be perfectly certain that a bibliography is full and accurate, one always has the uneasy feeling that something of importance may have been overlooked, and there is nothing more depressing.

Parts 1 and 3 of the Catalogue—all that are published so far—deal respectively with the Greek alchemical manuscripts in Paris and those of the British Isles. The first part, which is the work of M. Henri Lebègue, includes also a description of the MSS. of the Koeranides by Mdlle. M. Delcourt, who provides, in addition, comprehensive indices to the whole volume. On the Koeranides or Kiranides—a work on the virtues of plants and animals—reference may be made to Thorndike's "History of Magic and Experimental Science," 1923, ii. ch. xlvi., and to Ruelle's "Lapidaires grecs," Paris, 1898. The Greek alchemical manuscripts at Paris are 19 in number. They are carefully described folio by folio, in such a way that a good idea is given of the whole contents. When they have been edited, references are given to the edition. Scholars, therefore, who desire information on the MSS. will find, ready to hand, all that is necessary to enable them to form a judgment.

The third part, which deals with the manuscripts of the British Isles, is on similar lines. It includes also two papyri, one at the British Museum (Papyrus 121) and one in the Bodleian [MS. Gr. f. 73 (p) 3396]; a manuscript of the Koeranides; and the text of the Byzantine Greek manuscript on alchemy (290, ff. 186-194) preserved in the library of the Earl of Leicester at Holkham Hall. The last section is the work of Prof. Otto Lagercrantz; the main portion of Part 3 was compiled by Mrs. Singer, with the collaboration of Miss Annie Anderson and Mr. W. J. Anderson. Mrs. Singer's catalogue of the scientific manuscripts of the British Isles now includes about 40,000 items, and the present catalogue is the development of one of the sections of the general catalogue. Those who have had the privilege of using the latter—a courtesy which Mrs. Singer extends with unfailing generosity to all scholars—fully realise the tremendous assistance it will give to historical research in science, and will rejoice that this part of it is now in print.

The general impression gained from a perusal of the two parts is one of astonishment at the comprehensiveness of Berthelot and Ruelle's work. As M. Bidez says, "If the faults of Ruelle's work have become apparent, it is the result of a new scientific curiosity which he was one of the first to awaken." We cannot doubt that the publication of the present Catalogue will stimulate research into the origin of chemistry; it will certainly render the task of workers in this field very much easier. It is, moreover, not without interest to Hellenists themselves, for surely no student of Greece can afford to neglect this early scientific or quasi-scientific literature.

The important Holkham Hall manuscript, which, at Sir Frederick Kenyon's request, the Earl of Leicester kindly allowed to be published, was brought to light by Prof. Cumont. It has here been edited, with an introduction and critical annotations, by Prof. Lagercrantz. It is entitled "τῆς ἀλτεμίας ἡ διάταξις καὶ ἡ συμβολὲς καὶ ἡ κόπροι—alchimiae apparatio et compositiones et fimi"—and is interesting not only because of the strange substitution of ἀλτεμία for ἀλχημία or ἀλχυμία (a point which Prof. Lagercrantz discusses in his preface), but also because it shows that the Byzantines had original views on alchemy and did not confine themselves to reading and interpreting the works of the ancient Greek alchemists. We hope that it may prove possible to publish a translation of this MS. into English, French, or German, and so to make it more easily accessible.

E. J. HOLMYARD.

Our Bookshelf.

Introduction to the Theory of Spectacles. By Prof. Dr. Otto Henker. Translated by R. Kanthack. Pp. viii+336. (Jena: School of Optics; London: J. W. Atha and Co., 1924.) 13*s.* 6*d.*

THE book under notice follows the lines of Prof. Henker's courses of lectures on spectacles; the German edition from which the present translation by Mr. Kanthack is made was first published in 1921. Commencing from elementary principles, it gives an account of modern continental practice in spectacle optics, embodying the important work (in connexion with cataract lenses, telescopic spectacles, and other special aids to vision) of the Jena school under Prof. Moritz von Rohr. This has been mainly accomplished since the year 1908. While the War with its immense number of special cases of injuries to the eye undoubtedly gave a renewed stimulus to studies of this kind, many sufferers are still (as Prof. Cheshire points out in a foreword) ignorant of the aid which science can now give them. The present book should fill a great need if it gives information of this kind.

The mathematical theory goes no further than the usual Gaussian first-order treatment, but aberrational defects and means of overcoming them are explained with the aid of diagrams. The analogy between the action of the anastigmatic spectacle lens (with its stop at the centre of rotation of the eyeball) and the single photographic landscape lens, in securing freedom from the astigmatism of oblique pencils, emphasises the fact, not yet sufficiently appreciated, that a spectacle lens must be designed with the same understanding and similarly thorough analytical and trigonometric methods as for any other optical instrument. As

Gullstrand pointed out, such anastigmatism cannot be secured in high-power cataract lenses without the use of non-spherical surfaces. The design of such lenses by Prof. von Rohr and their production by Zeiss is one of the most interesting matters dealt with in the book. The importance of this work to ophthalmological science cannot be too fully emphasised.

A number of terms and phrases are found which should not be adopted in Great Britain without question. There are good reasons against the term "point-focal" as applied to any lens whatever, and there is no need to replace the familiar term "bending" (as applied to a lens) by "co-flexure." Other examples will be found.

The number of tables and charts which the book contains render it in fact a very useful work of reference for the ophthalmologist, though it is undoubtedly more than an "introduction to the theory of spectacles"; its scientific importance is unquestionable.

The British Journal Photographic Almanac and Photographer's Daily Companion; with which is incorporated "The Year Book of Photography and Amateurs' Guide" and "The Photographic Annual," 1925. Edited by George E. Brown. Sixty-fourth issue. Pp. 816. (London: H. Greenwood and Co., Ltd., 1925.) Paper, 2*s.* net; cloth, 3*s.* net.

THIS almanac continues to occupy the unique position that its editor has earned for it, and to have lived down all its previous contemporaries. Its general character is too well known to need description, and is maintained in the present volume, but a few welcome changes have been introduced. The most notable of these is the replacement of the tables of chemical formulæ by a series of short articles dealing with the properties of the commonest of the chemical substances used in photographic processes. These will be found of real practical utility, though they need a little revision. One might, for example, be led into error by the statement that iodine is insoluble in water or by the representation of oxalic acid as if its crystals were anhydrous. There does not seem any valid reason for calling ammonium, potassium, and sodium salts as ammonium, "potass," and soda salts respectively, and when uniformity means simplicity and offers no disadvantages, it is always desirable. The editor as usual contributes a long article, this year on "The Plain Facts of Lenses," which is eminently practical and easily understandable even by non-technical photographers. There is also a second article by Mr. T. L. J. Bentley on how to get the best results with the very small cameras that are now in vogue. It appears that $3\frac{1}{4}$ in. $\times$ $2\frac{1}{4}$ in. is by far the most popular size as compared with either larger or smaller sizes of spools of roll-film.

Life and Science. By Prof. David Fraser Harris. Pp. 204. (London: Andrew Melrose, Ltd., 1923.) 7*s.* 6*d.* net.

THE author, in this little work, describes in simple terms the scientific aspect of certain vital phenomena. Written in pleasant style, it appears suitable for the layman of an inquiring turn of mind, who wishes to know something of vital mechanisms without the need of a knowledge of physiology. The work opens with a chapter on the thesis that there is nothing new under the sun, and shows how man's inventions have been anticipated in the mechanisms found in his own body. After a chapter on mechanisms of defence, the author describes certain tissues which are characterised by possessing a rhythmic activity, thus leading up to a discussion of sleep, which is termed "life's great rhythm": stress is laid on the presence of fatigue products in the blood, a lessened blood supply to the brain, and a diminution in the number of sensory impressions reaching that organ. In the following chapter examples of "latent life," taken from both the vegetable and animal kingdoms, are described: in the next, the rather uncommon subject of "coloured thinking" is dealt with; in these persons certain words or sounds are associated with certain colours, especially when a concept has to be visualised: the condition occurs in perfectly normal people and has no relation to visual hallucinations. The book closes with a plea for a greater recognition of the mutual influence of the mind and body upon each other, illustrated by the subject of faith-healing.

Sunshine and Open Air: their Influence on Health, with special reference to the Alpine Climate. By Leonard Hill. Pp. vii+132+8 plates. (London: E. Arnold and Co., 1924.) 10*s.* 6*d.* net.

PROF. LEONARD HILL has brought together in small compass a mass of valuable material bearing on the health-giving properties of sunshine and open air. He analyses the scientific facts which explain the curative effects of the Alpine climate, contrasting the composition and physiological effects of high and low atmospheres. The value of this section is enhanced by a large series of comparative observations, not only on the hours of bright sunshine in numerous stations, but also by the exact measurement of the intensity of the sunlight and that of light reflected from the sky and the ground. These measurements are made both in terms of heat and of their biological action. The chapter on the influence of moisture, mist, temperature is well worthy of careful consideration, as it offers explanations of the morbidity of the town dweller and the risks of infection run in confined sunless communities. In the chapter on the biological action of light, the author has summarised a large amount of valuable work done under his supervision in the Department of Applied Physiology in the National Institute for Medical Research. This work comprises the development of instruments for the precise measurement of actinic light both chemically and by its action on protozoa, the depth of penetration of various radiations, and their influence on the blood of animals and man. The introductory chapter gives a practical account of the writer's personal experiences of the "sun cure," and the work is illustrated by some very clear half-tone reproductions.

The Chemistry of Crop Production. By Prof. T. B. Wood. Second edition. Pp. vii+193. (London: University Tutorial Press, Ltd., 1924.) 4*s.* 6*d.*

THE first edition of Prof. T. B. Wood's admirable little book on the scientific principles of crop production was reviewed in NATURE for March 24, 1921 (vol. 107, p. 101). We are glad to note that a second edition has been called for, and that the publishers have found it possible to reduce the price from 5*s.* 6*d.* to 4*s.* 6*d.* The text is unchanged, save that the examples are now based on prices current in 1924.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Solar Eclipse of January 24 and Wireless Signals.

DURING the solar eclipse of Saturday, January 24, the engineers of the Post Office and of the International Western Electric Company, at the instance of Admiral Sir Henry Jackson, measured the strength of wireless signals received from New York at Chedzoy in Somerset and at New Southgate, London. The results show that the signal strength rose to a sharp maximum and fell to a very sharp minimum during the progress of the eclipse.

At 14.12 G.M.T. totality occurred at New York and more than half of the trans-Atlantic track of the signals was in partial darkness; at this instant the strength of the signals received in England was observed to be about twenty per cent. above normal. At 14.52 first contact was visible in London, and by this time signals had increased to about double the normal strength. A few minutes later the centre of the total phase was in mid-Atlantic about 400 miles to the south of the wave track, and the whole of the track was now in partial darkness. The signal strength rose to a maximum first at Chedzoy and then at New Southgate. During the next half-hour the centre approached the wave track rapidly by moving in a north-easterly direction, and signal strength decreased greatly. At 15.30 the last contact occurred at New York, and at about 15.40 the signals received at both places of observation had fallen in strength to a minimum value less than one-fifth of the normal. At this instant about 300 miles of the western end of the wave track was in full daylight and the centre of the eclipse was crossing the wave track about 500 miles to the west of Ireland. By 15.45 the centre had moved beyond the Faroe Islands, daylight had returned, and at about 16.10 normal signal strength was regained. Throughout the eclipse directional measurements were made by the staff of the Radio Research Board, but no effect on bearings could be detected.

The occurrence of the maximum and minimum signal strengths on this occasion recalls the observations on the eclipse of Wednesday, April 17, 1912 (see NATURE, April 25, 1912, Vol. 89, p. 191). On that occasion, as there was no conveniently placed wireless station at work, the observations were made on "atmospherics" or "strays," which the meteorological conditions indicated were coming from Spain or North-west Africa. These earlier observations and also the new ones seem to be explained by the ionisation of the atmosphere by sunlight and the re-combination of the ions when the light is removed. This explanation was set forth in a paper read to the British Association in September 1912, as follows:—"My observations indicated that, firstly, when the penumbra stole over Western Europe and Western Africa propagation grew rapidly better; secondly, as the umbra itself crossed the Bay of Biscay towards France it began to hinder propagation, its interference being greatest after it had entered France near Les Sables, which means that at this moment it lay directly between London and the source of the strays; thirdly, that when the umbra passed on, the ionic medley it had created by re-combination of ions faded quickly" and propagation improved. The suggestion here is that the hurried and irregular re-combination of ions produced an ionic turmoil which obstructed electric waves. The obstruction arose, I suggested, not so much from absorption as from irregular refraction, the refraction being a consequence of the dependence of the velocity of electric waves through rarefied air upon the nature and concentration of the ions in it.

The interesting question now arises: What levels of the atmosphere are mainly concerned in these phenomena? Students of wireless telegraphy have long believed that there is an upper region in which free electrons exist more or less permanently and a middle atmosphere in which ions of molecular size are formed daily by sunlight. If I may quote again from my own writings: "Wireless investigators would suggest that the layer beneath the auroral layer is occupied by electrons that have come as beta-rays from the sun. The atmospheric pressure at above 50 kilometres is only about a millionth of an atmosphere; the mean free path of the electrons is therefore long and they may possibly remain permanently free in large numbers. It would seem that the base of this region charged with free electrons must be regarded as the ceiling usually known as the Heaviside layer." At night this ceiling reflects wireless waves of all lengths round the globe as a whispering gallery reflects sound. In the day the air below it is ionised, absorbs the waves in some degree, and gives to the rays a curvature which is greater as wave-length increases. To the Heaviside layer is attributed the "night effect" which afflicts direction finding. As no such effect was observed during the eclipse we may provisionally assume that the Heaviside layer did not come prominently into operation and that the middle heights of the atmosphere were responsible for the phenomena observed.

Sir Arthur Schuster, in his theory of the diurnal magnetic variations (Phil. Trans., A, 208, 1907, p. 182), requires that a portion of the upper atmosphere should possess a conductivity of 10^{-13} electromagnetic units in order to account for the usual variations. Prof. S. Chapman has of recent years elaborated this suggestion. But whether this portion of the atmosphere is above or below the Heaviside layer is not yet clear. It would seem that simultaneous observations of the effects of solar eclipses on the magnetic elements and on the propagation of signalling waves offers a means of solving this question.

W. H. ECCLES.

13 Catherine St., S.W.1,
February 11.

Polarisation of Light from the Sky during the Solar Eclipse of January 24.

DURING the total eclipse on January 24, I was at New Haven, Connecticut, and thus very close to the middle line of the track of totality. For a portion of the period of totality I made a somewhat hasty survey of the state of polarisation of the light scattered by the sky, using for the purpose a Savart plate and Nicol prism. I was only able to cover the eastern sky from the zenith to the horizon stretching from north through east to south, and I was unfortunately not able to determine the plane of polarisation of the light scattered from the various parts of the sky. What I was able to note, however, with certainty was that there was no marked variation in the percentage of polarisation as one explored the eastward half of the sky—that is, there was no trace of the familiar maximum noted when the sun is not in eclipse.

As I am a physicist and not an astronomer I am not sufficiently familiar with the results of observations

of this sort at the time of previous eclipses to draw any conclusions from the fact I happened to note. It may be worth recording, however, as the conditions at the time of the eclipse of January 24 were somewhat unusual in that the entire country surrounding the path of totality was deeply covered with newly fallen snow, and it seems possible that a very large percentage of the diffused sky light may have come by previous scattering from the extensive snow fields on either side of the track of totality, and relatively very little from either the corona or the direct light from the sun on the edge of totality.

AUGUSTUS TROWBRIDGE.

Relativity referred to a Flat Space-Time.

As a preliminary communication, I wish to indicate briefly a few main results which could be made the starting-point of a general theory of relativity which shall fit in, in a natural way, with the Newtonian scheme and older physics and shall avoid the necessity of formulating with Einstein a space-time continuum "curved" by the existence of matter. It would be sufficient, as we shall show, to adopt a space-time continuum which is "flat," for the formulation of physical laws.

Now let us write, in the usual form, the expression for the invariant interval between two contiguous point-events as

$$ds^2 = g_{\mu\nu} dx_\mu dx_\nu, \quad . \quad . \quad . \quad . \quad (1)$$

adopting Eddington's summation convention that whenever a literal suffix appears twice in a term, that term is to be summed for values of the suffixes 1, 2, 3, 4. The $g_{\mu\nu}$, of course, have to satisfy the necessary and sufficient condition for "flat" space-time, namely, the Riemann-Christoffel tensor

$$B^{\epsilon}_{\mu\nu\sigma} = 0. \quad . \quad . \quad . \quad . \quad (2)$$

Having thus defined the geometry we shall use, we shall show now how a consistent formulation is possible of the laws of mechanics, of gravitation, and of electro-magnetism, so as to conform to the general principle of relativity, still adhering to the fundamental concepts of "inertia" and of "force" and the invariability of mass, of the dynamics of Galileo and Newton.

Let us define the mechanical force acting on a mass-particle, by the tensor F^μ, as

$$mc^2 \left\{ \frac{d^2 x_\mu}{ds^2} + \{\alpha\beta, \mu\} \frac{dx_\alpha}{ds} \frac{dx_\beta}{ds} \right\} = F^\mu, \quad . \quad . \quad (3)$$

where m is the mass of the particle, which is considered invariant, and c the velocity of light. This tensor, together with its associated tensors, shall form the mechanical-force tensor.

Now, on equating this tensor to zero, it easily follows that a mass-particle under no forces will describe a straight line in the space-time continuum; this, of course, corresponds to Newton's first law of motion, the law of inertia.

Then, turning to gravitation, we shall have to define the mechanical force due to gravitation acting on a particle. For this purpose let us define an invariant gravitation potential ϕ by the following tensor equation:

$$g^{\mu\nu} \left(\frac{\partial^2 \phi}{\partial x_\mu \partial x_\nu} - \{\mu\nu, \alpha\} \frac{\partial \phi}{\partial x_\alpha} \right) = \rho_0, \quad . \quad . \quad (4)$$

where ρ_0 is the proper-density of mass which can be expressed by the equation

$$\rho_0 = \rho \frac{ds}{dt}, \quad . \quad . \quad . \quad . \quad (5)$$

where ρ is the usual density.

Then the mechanical force due to gravitation may be defined by the tensor G^μ as

$$-m \left\{ g^{\mu\alpha} \frac{\partial \phi}{\partial x_\alpha} - \frac{d\phi}{ds} \frac{dx_\mu}{ds} \right\} = G^\mu. \quad . \quad . \quad (6)$$

This tensor, together with its associated tensors, shall constitute the gravitational force tensor.

Now let us see how the equations (3) and (6) reduce, under suitable conditions, to the equations of the Newtonian theory. For this purpose we shall equate the expressions in (3) and (6). Then we have

$$mc^2 \left\{ \frac{d^2 x_\mu}{ds^2} + \{\alpha\beta, \mu\} \frac{dx_\alpha}{ds} \frac{dx_\beta}{ds} \right\} = -m \left\{ g^{\mu\alpha} \frac{\partial \phi}{\partial x_\alpha} - \frac{d\phi}{ds} \frac{dx_\mu}{ds} \right\}. \quad (7)$$

This, being a tensor equation, will hold for all co-ordinate systems if it holds for any. Therefore let us take the Galilean system for which the line-element is

$$ds^2 = -dx_1^2 - dx_2^2 - dx_3^2 + dx_4^2. \quad . \quad . \quad (8)$$

Now, as the equations of the Newtonian theory hold only for velocities small compared with that of light, we have, if we introduce this restriction, approximately

$$ds = cdt.$$

Then the equation (7) reduces, in the Galilean system, to

$$\left. \begin{aligned} m \frac{d^2 x_\mu}{dt^2} &= m \frac{\partial \phi}{\partial x_\mu} + \frac{m}{c^2} \frac{d\phi}{dt} \frac{dx_\mu}{dt} \quad (\mu = 1, 2, 3) \\ \frac{1}{c} \frac{d}{dt} \left(\tfrac{1}{2} m v^2 \right) &= -\frac{m}{c} \frac{\partial \phi}{\partial t} + \frac{m}{c} \frac{d\phi}{dt} \quad (\mu = 4) \end{aligned} \right\}, \quad . \quad (9)$$

where v is the velocity of the particle.

Thus we see that if we identify ϕ with the Newtonian gravitation potential, the first equation of (9) gives the Newtonian equations of motion and the second equation of (9) leads to the equation of activity in a gravitational field. Obviously we can identify ϕ with the Newtonian gravitational potential, for the equation (4) reduces for the Galilean system to the well-known form

$$\frac{1}{c^2} \frac{\partial^2 \phi}{\partial t^2} - \nabla^2 \phi = \rho_0. \quad . \quad . \quad . \quad (10)$$

We have thus brought gravitational force under the general principle of relativity by expressing it consistently in the tensor form. The second term of equation (6) is the essentially new feature of this theory, and it is curious to note that while it becomes insignificant in taking the space-components of the gravitational force tensor, it becomes quite significant in taking the time-component. The fact that such a term has naturally to come in can be seen by multiplying both sides of the equation (7) by $g_{\rho\sigma} \frac{dx_\sigma}{ds}$ and contracting the product to an invariant, when both sides become zero. It may also be seen that the choice of a gravitational force tensor seems to be limited as we have at our disposal only ϕ, $g_{\mu\nu}$, and $\frac{dx_\mu}{ds}$, and it does not seem to be possible to construct an alternative tensor degenerating to the Newtonian equations unless it be that G^μ of (6) is multiplied by an invariant differing little from unity. But there is no justification for doing this at present.

There is also a striking resemblance between the second term of G^μ of (6), which we shall call the "velocity" term, and the electromagnetic force tensor E^μ, which can be defined as

$$E^\mu = e g^{\mu\alpha} \frac{dx_\beta}{ds} P_{\alpha\beta}, \quad . \quad . \quad . \quad (11)$$

where e is the invariant electric charge and $P_{\alpha\beta}$ is defined by the equation

$$P_{\alpha\beta}=\frac{\partial k_\alpha}{\partial x_\beta}-\frac{\partial k_\beta}{\partial x_\alpha}, \quad . \quad . \quad . \quad . \quad (12)$$

where k_μ is the electromagnetic potential tensor, having for its components the three components of the vector potential and the one scalar potential of the electromagnetic theory. Now it is interesting to note that if we combine the mechanical forces acting on a charged particle due to gravitation and electromagnetic forces into a single expression, and if we take them for the Galilean system, the values for the "velocity" term of equation (6) fit in the diagonal of zeros in the following array for $P_{\alpha\beta}$, leaving the other values of the array unaltered :

$$P_{\alpha\beta}=\begin{matrix} 0 & -\gamma & \beta & -X \\ \gamma & 0 & -\alpha & -Y \\ -\beta & \alpha & 0 & -Z \\ X & Y & Z & 0. \end{matrix}$$

Thus we have shown that if we adopt the scheme of equations given above, we can return to the mechanics of Galileo and Newton, with the suggested alteration in the law of gravitation, still holding fast to the ideas of inertia and force and the invariance of mass, without being obliged to make mass dependent on velocity and to obliterate the difference between mass and energy as the special and general theories of relativity would lead us to believe ; of course, the variable inertia of electrons at high speeds could well be seen to follow from equations (3) and (11), leaving the notion of the invariability of mass intact.

C. K. VENKATA ROW.

"Masthu Baug,"
St. George's Cathedral Road,
Cathedral P.O., Madras,
January 1.

The Biology of the Suez Canal.

THE Cambridge expedition, financed by the Royal Society, which left England in September last to study the migrations of marine organisms through the Suez Canal (see NATURE, vol. 114, pp. 520, 866) has returned on the Orient liner *Ormuz*. The members of the expedition were Messrs. H. M. Fox, R. Gurney, V. C. Robinson, and D. N. Twist. The full results will naturally not be known until the collections have been worked out, but certain general conclusions can already be drawn.

Since the communication to NATURE of December 13 last, the central and northern portions of the Canal have been studied. Lake Timsah in the middle region of the Canal near Ismailia is characterised by great variation in salinity, unlike the Great Bitter Lake farther south where a high salinity is constant. In the centre of Timsah, with a south wind and a current to the north, a density as high as that of the Great Bitter Lake is recorded. In other circumstances the density in the same situation is much lower. At the edges of Timsah, and in the lagoons communicating with it, all intermediate degrees of brackish water to pure fresh are found. The fauna in various portions of the lake is consequently diverse, and in the situations where rapid salinity changes occur must be resistant to these.

It is remarkable that whole large groups of animals, such as anthozoans, echinoderms, brachyuran crustaceans, ascidians, etc., which were absent from the Canal in 1882, are now abundantly represented. Yet the Canal was opened in 1869, and certain forms such as barnacles and cockles established themselves in the region of Lake Timsah from the very commencement. Why then did these other groups migrate in so late ? In Lake Timsah the contrary phenomenon is found in the case of Mytilus and Pholas, previously very common, now absent. An attempt is being made to correlate these arrivals and departures with changes in the Canal at different dates. The late immigration of the crab *Neptunus pelagicus*, for example, which started from Suez in 1893 and reached Port Said in 1898 (NATURE, vol. 113, p. 714), coincides with the first widening and deepening of the Canal. Again, when the water samples brought back by the expedition had been analysed and compared with past data, the proportions of the dissolved substances in the waters of the Bitter Lake may be found to have altered at a certain period owing to the upper layers of the bed of salt which forms the bottom of the lake becoming dissolved. Such a change could affect migrations. But it must be remembered that in general very little is known about the causes of the migrations of littoral marine animals. On a sand flat opposite Port Taufiq, Suez, for example, the writer observed large numbers of Synapta in 1920. At the same season in 1921 the ground was covered in addition by quantities of immature Centrechinus. In 1924 both were absent, although the conditions were apparently unaltered.

Between the Bitter Lakes and the Gulf of Suez the currents in the Canal are tidal, reversing their direction twice daily ; and they are rapid. Between the Great Bitter Lake and Port Said the currents are slow and seasonal, flowing to the north for ten months, to the south for two only, namely, August and September. The consequence is that the salter water from the Great Bitter Lake extends north to within 40 km. of Port Said (the total length of the Canal is 160 km., and the distance from the Bitter Lake to Port Said 98 km.) during ten months, while the less dense water of the Mediterranean penetrates south beyond Lake Timsah (to a distance of 90 km. from Port Said) during two months only. The results of this are, first, that for most of the year there is a barrier to the penetration from the Mediterranean of forms which cannot support very salt water, and second, that the salter environment of the Bitter Lake extends far to the north for most of the year with the following possible consequence. The fauna of the Bitter Lakes was found to be richer than that of the seas at the mouths of the Canal, but from a study of the Lakes alone it was uncertain whether the favourable factor is a more suitable bottom or the higher salinity. Now between the Great Bitter Lake and Port Said there is a rich fauna on the piers just as far north as the salter water extends during ten months, while between this point and Port Said the pier fauna is noticeably poorer. The substratum is the same throughout, but the salt-content of the water different.

The final field work consisted in an examination of the fauna and flora of Port Said harbour. Further, the bottoms of tugs and barges which had been employed at one end of the Canal were scraped as soon as they moved to the other end, and again after they had been there some time, in order to see what forms could remain alive in their new environment and possibly could have established themselves there in the past, brought through the Canal on the ships' bottoms.

An important side of the work is necessarily incomplete because a part of the Canal fauna is seasonal in its appearance or in its breeding. Large Aurelia-like medusæ, for example, are so common in August that they foul the screws of motor boats, yet they were not found by us. Many animals breed at a different period of the year, so that we will be unable to give a general answer to the important question

of whether this or that form breeds in its new environment or merely migrates in from the sea during the lifetime of the individual. These matters should be further studied by a future expedition working in the spring instead of the autumn.

In conclusion, we would like once more to thank the Canal Company for their great generosity in providing lodging and boats and for the unfailing help and kindness of their employés. At the same time we must repeat our thanks to the Egyptian Government, in particular to the Coastguards service, for their very willing assistance. H. MUNRO FOX.

Zoological Laboratory, Cambridge,
February 6.

Short-period Variations of the Wind.

IF one examines the autographic records of wind velocity and direction obtained at any inland observatory on a summer's day, it will be found that both traces are markedly different during the day-time as compared with the night. An occasion on which this effect was very well developed is represented in the traces obtained at Porton on July 5-6, 1923. The anemometer vane is mounted at a height of 13·5 metres and has an excellent exposure. The direction chart shows that during the day-time the wind is characterised by very large variations in direction. These variations are, moreover, of a peculiar type. It is observed that the wind assumes a fairly steady and definite direction for an interval of the order of ten minutes. It then suddenly swings through an angle of perhaps 60° or even 90°. After maintaining this new direction for some minutes, the wind shifts again with equal suddenness. Regarded as short-period variations, these shifts are quite irregular in occurrence, although when considered over a period of some hours, the mean direction agrees with that demanded by the pressure gradient. In contrast with this behaviour we may compare the trace obtained during the night. This is the normal type of trace in which deviations from the mean direction are both small in amplitude and of short duration. The wind velocity record also shows a characteristic effect during the day-time: short intervals of nearly dead calm alternate discontinuously with intervals during which the velocity is nearly constant with a value of two or three metres per second. It may be noted that the durations of these lulls and gusts are about the same as those of the changes in wind direction. At night-time the velocity trace becomes normal like the direction trace.

The effects described above are much more marked in summer than in winter; they occur during the day and not during the night; and the stronger the sunshine the more pronounced the effect. Moreover, an examination of the Shoeburyness records shows that the phenomenon is strongly developed in off-shore winds, but only very slightly in off-sea winds.

Attempts to explain this phenomenon in terms of the interchange of masses of air at different heights appear to be unsatisfactory for the following reasons. In the first place, observations at Porton tend to show that lulls of this type extend from the ground up to a height of at least 15 metres, and it is difficult to understand how a thin layer of air lying on the ground can be extended to this height. In the second place the experimental evidence seems to indicate the non-existence of descending currents which would be adequate to cause the gusts. In this connexion Mr. C. E. Britton has kindly examined the pilot-balloon observations made at Shoeburyness, and he finds that, under conditions of strong convection, descending currents are conspicuous by their absence. (The vicinity of cumulus clouds is, of course, not being considered.) Thus in all probability the cool descending currents are comparatively slow and are spread over wide areas. In this event they will not retain their initial high velocity in the manner necessary to produce the observed gusts.

As an alternative to this explanation, it occurred to Mr. O. F. T. Roberts and the writer independently that the phenomenon might be caused by small travelling zones of reduced pressure. Such areas of reduced pressure are presumably to be found at the base of columns of ascending air on days of strong convection. The inflow of the surrounding air towards such centres will necessarily constitute miniature cyclones. These miniature cyclones will travel with the general air movement, and their passage will produce, on the present view, the particular type of gustiness which we are here considering. Thus, if one of them passes an anemometer so that its own circulation assists the general air movement, then a gust will be produced; and similarly if its circulation opposes the general air flow, then a lull will result. It will also be seen that the passage of miniature systems of this type will give rise to the particular kind of direction variation which is associated with this form of velocity gustiness.

Considering the duration of this type of gust in conjunction with the wind velocity, it appears that a common value for the "diameter" of these miniature cyclones is of the order of a kilometre. By the aid of Ferrel's equation, it is possible to calculate the reduction of pressure necessary in one of these systems to produce a gust of 2 metres per second in an otherwise still air. In this case the cyclostrophic term is far more important than the geostrophic term, and it is found that a pressure difference of about one-twentieth of a millibar is required. Conditions corresponding approximately to this case occurred between 1100 h. and 1300 h. on the date already referred to. The microbarograph trace for the same period shows quasi-periodic variations of about one-twentieth of a millibar, and of roughly the same "frequency" (about 8 to 10 per hour) as the gusts. Similar results are found on other days of strong sunshine and light winds.

It is interesting to observe that, since the geostrophic effect is so small in pressure systems of this size, the direction of circulation within them will not necessarily always be that of full-sized cyclones in the same hemisphere. The direction of rotation will rather be determined by the initial velocity of some part of the air which goes to form the new miniature cyclone. For this reason gusts and lulls will sometimes be accompanied by temporary veerings in the wind direction and at other times by backings.

Interpreted in terms of eddy-diffusion, the effect described above may be regarded as implying a very large value for the horizontal components of the coefficient of eddy-diffusion if considered over a long time interval. But if considered over a period of say half an hour, then the effect can only be regarded as irregular. The special characters assumed by the wind velocity and direction in these circumstances may also be regarded as special types of variation in the longitudinal and lateral components of the wind. It is a matter of some interest to ascertain whether, under the same conditions, the vertical component of the wind acquires any corresponding peculiarity. Although it has been shown by Taylor (Advisory Committee for Aeronautics, Reports and Memoranda, No. 345) that in general the longitudinal, lateral, and vertical components of gustiness are

approximately equal, it was thought worth while to construct an instrument which will provide continuous records of the vertical component of the gustiness of the wind. Such an instrument is now in operation at Porton, and it is hoped that it will throw further light upon the nature of the short-period variations of the wind near the earth's surface.

N. K. JOHNSON.

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Estimating the Qualities of a Photographic Plate.

THE testing of photographic plates presents to-day a number of complexities, and is so wholly unsatisfactory from a technical point of view that two special meetings have been convened by the Royal Photographic Society, held on January 7 and February 10, at which discussions have been held, and suggestions made, by leading authorities for a better system of estimating the speed and general characteristics of sensitive emulsions. A special committee has also been appointed to consider the suggestions resulting from these discussions, which are to be forwarded to an international gathering in Paris next June, where it is hoped that some new system may be generally agreed upon.

The accepted method of plate-testing, devised by Hurter and Driffield in 1890, is to expose sections of a plate to a standard light source for times increasing geometrically, and after development under standard conditions to measure the densities of these strips and to plot them as ordinates against log exposure. The result is a curve of the well-known form shown in Fig. 1, *PQRS*. But with the very great increase in speed of modern plates these "characteristic curves" often show a type of curve like *XYZ* in Fig. 1.

In curve *PQRS*, *PQ* is termed the under-exposure

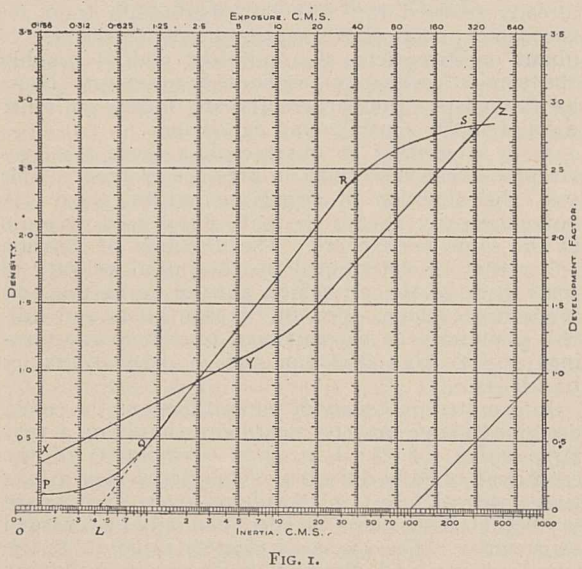

FIG. 1.

portion, *QR* the straight-line portion, representing the "period of correct exposure," and *RS* the over-exposure portion. With many high-speed plates *PQ* stretches out to *XY*, *i.e.* the under-exposure portion becomes straight, and indeed most studio negatives as made by the professional photographer of to-day utilise only this part of the curve; on higher exposures the curve may jump upwards, as shown by *YZ*, such a plate giving good density in the extreme "high-lights," but soft, uniform gradation in the half-tones and "shadows."

If the straight-line portion of curve *PQRS* be produced to cut the log exposure axis at *L*, *OL* represents the inertia of the plate, and its reciprocal represents the speed; $34/OL$ gives the accepted H. & D. speed number.

Nietz has, however, shown that if several plates,

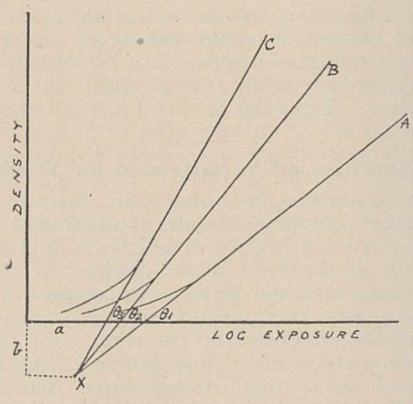

FIG. 2.

given the same exposure, be developed for different times, and their curves plotted, such curves, *A*, *B*, and *C* for example in Fig. 2, may intersect at some point *X*, *below* the log *E* axis if there is free bromide present in the silver bromide emulsion, as is almost invariably the case. In such a case the inertia, as seen, will vary according to the time of development, and he suggests using the co-ordinates *a* and *b* in making the speed determination.

The contrast-giving power of the plate is measured by the steepness of the curve, and is called the development factor, γ. This is proportional to $\tan\theta$, and clearly γ will be different for different times of development, being $k \tan\theta_1$ for *A*, $k \tan\theta_2$ for *B*, and $k \tan\theta_3$ for *C*.

Here, then, are some of the difficulties with which we have to deal, and on which some general convention is so urgently needed. Take curve *XYZ* in Fig. 1, for example. Shall we extend *ZY* to meet the log *E* axis to give the inertia, or shall we extend *YX*? Shall we plot a family of curves developed for different times, and use the co-ordinates *a* and *b*, where the speed number *H* could be obtained independent of the contrast-giving powers of the plate by using an equation of the form

$$\log H = \log k - a + b\ ?$$

Another difficult problem is to express the under- and over-exposure parts of the curve simply. *PQ* (Fig. 1) is of paramount importance to photo-engravers in the making of half-tone and line reproductions, as on it depend the "woolliness" of the dots and diffuseness of edge of a line. *PQ* and *RS* are of vital importance to the physicist where he is attempting to measure either light intensities or radiations by means of *density*,—the only portion of the curve that may be used is that in which log density/log exposure is absolutely constant; *i.e.* he must use *QR* only.

The wave-length limits of the light source also affect gradation to some extent, and some primary and secondary source of light, universally adopted, is most desirable.

The position may be summed up by saying that, in view of the very extended applications of photography to science and industry, and the extensive

use of half-watt lighting for studios by the portrait photographer, some fuller means must be found for expressing the characteristics of a plate and for interpreting its properties. T. THORNE BAKER.

Research Laboratory,
Imperial Dry Plate Co., Ltd.,
Cricklewood, N.W.2.

Excitation of Forbidden Spectral Lines.

HANSEN, Takamine, and Werner (*Kgl. Danske Videnskab. Selskab Mathfys. Medd.* 3) have observed the line $1S - 2p_1$ (Paschen's notation) of mercury in a condensed discharge, and Takamine and Fukuda (*Phys. Rev.* 25, p. 23, 1925) have found the line strongly developed in the glow of a branched arc. We have excited this line, the corresponding line of zinc, and both $1S - 2p_1$ and $1S - 2p_3$ of cadmium in the positive column of a hot-cathode discharge. The positive column was viewed end-on while the cathode glow was confined to a side tube. The potential difference across the entire tube was of the order of 100 volts, but the tubes employed were of such length, 30 to 100 cm., that the voltage drop per mean free path of an electron was quite small. The spectrum is strictly of the arc type, only a few of the more readily excited spark lines appearing, and these in comparatively low intensity.

The cadmium lines, λλ 2239, 2267, 2307 and 2329, were sharply absorbed by the positive glow, a spark under water or discharge in a hydrogen tube being used as the continuous background. These lines have been independently classified by both Ruark and Paschen (unpublished) as belonging to the group $2p - 2p^1$. Other members of this group involving transitions from the $2p_1{}^1$ level were definitely not present in absorption. An unknown line at λ3086·7 appeared on some of the exposures as a weak but sharp absorption line.

PAUL D. FOOTE.
T. TAKAMINE.
R. L. CHENAULT.

Bureau of Standards,
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Radio Reception on Frame Aerials.

EXPERIMENTS in the reception of medium-powered distant broadcast stations on small frame-aerials of particularly small high-frequency resistance, with the use of correspondingly light reaction-coupling of the type usually associated with the name of Reinartz, appear to indicate that the commonly-accepted ideas as to the magnitude of the high-frequency voltages which can be registered on such aerials with small total tuning capacities across them, in these circumstances, require some modification.

With a frame of approximately circular form and 1 m. diameter, with 11 turns of thin bronze strip 6 mm. wide, spaced at 8 mm. in the form of a flat spiral (2 extra turns providing the Reinartz reaction-coil); and using a detector-valve and one transformer-coupled audio-frequency amplifying valve, both of amplifying factor M = 20, I was able to observe clearly intelligible speech and music from about thirty British and Continental stations, ranging from Aberdeen to Rome, in the course of one Sunday evening, in a quiet high point 35 miles N. of London, and on the first floor of a substantially-built house. Many of these stations, including the last mentioned, were later audible on a loud-speaker in a very quiet room; corresponding to a R.M.S. audio-signal-voltage of an average order of 0·3 volts. I had previously observed that, with an additional high-ratio transformer-coupled audio-frequency amplifying valve (three valves in all), at least two American broadcast stations could occasionally be heard, subject to the usual fading, on an even smaller aerial.

The tuning and reaction-control were of an unusually fine order; and oscillation-hysteresis had to be carefully eliminated. The signal-voltages observed here appear to be inconsistent with the usual estimates, and suggest also a revision of current practice in "radio-frequency amplification."

A. D. COWPER.

An Experiment with a Stroboscope.

ON page 543 of vol. III. of the "Dictionary of Applied Physics," an experimental arrangement is described where the stroboscope disc is illuminated by an intermittent light, using a neon-tube, an induction coil, and an electromagnetically controlled tuning-fork. The same experiment can be performed in the light of an ordinary neon filled 110-volt Osglim lamp to which current is supplied from an alternating-current lighting circuit. If the laboratory supply is of continuous current, then the arrangement can be considerably improved with the use of a rotary convertor the speed of which can be regulated so that the frequency of the intermittent light can be ascertained directly with a speedometer and stop-watch. As a demonstration experiment this arrangement is particularly convenient, since both the stroboscopic disc and the frequency of the source of light can be varied at will, and very interesting effects may be observed. G. R. PARANJPÉ.

Royal Institute of Science,
Bombay,
January 2.

The Crisp Collection of Microscopes.

MAY I add a note to the brief statement referring to the Crisp collection of microscopes in NATURE of February 14, p. 241? Doubtless it is true that on occasion the late Sir Frank Crisp may have led the authorities to believe that he contemplated leaving his collection to the Science Museum at South Kensington, but it is equally true that his chief desire was to see his collection used for the preparation of a comprehensive history of the microscope in amplification of Mayall's Cantor Lectures, printed in 1886. Some years ago he asked me whether I would be willing to compile such a history, and he gave me a few notes on his instruments for the purpose. Last week I received a letter from my friend Prof. Poulton, in which he recalled a conversation with Sir Frank Crisp. "I remember his telling me that he did not know what to do with it (the collection), and I tried to persuade him to leave it to the Pitt Rivers Museum. If the collections now in the Old Ashmolean had been there, then I expect he would have left it to Oxford." This I believe to be the truth. Sir Frank Crisp did not desire to duplicate the series in the possession of the Royal Microscopical Society, or that his collection should be merged in a larger one, and only be partly exhibited. But the facts that many of the parts of the instruments have got mixed, that historic examples have been divorced from their history, that the collection has been distributed without having been properly catalogued, is an international calamity.

R. T. GUNTHER.

Magdalen College,
Oxford,
February 14.

The Investigation of the Properties of Thin Films by Means of X-rays.[1]

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

THERE are a number of problems of the highest importance which are, or can be, contained in the study of what we often call the "thin film." They are linked together by the fact that most reactions between bodies are largely determined by what takes place at their points of contact, and therefore by the nature of their surfaces. What is to be found in the interior of the body is often of much less importance than the composition and state of its surface film. The immensely varied problems of surface tension are examples of one kind: the phenomena of catalysis, of friction and lubrication are examples of other kinds.

Though the thickness of the surface film is so important, it is often very small—beyond the limits of direct optical measurement. The X-rays measure more minute quantities than the microscope, and we may well ask if they can carry us any further. They measure only, it is true, the spacing of a stratification, and a stratification cannot consist of a single layer or film: so that the rays cannot be applied directly to the examination, for example, of the black spot on a soap film. But they are able to help in an indirect yet effective way. For they deal with problems of the arrangement of molecules, and all these manifestations of surface action are directly dependent on the arrangement of the surface atoms and molecules. Also the substances, the actions of which in single thin films are of great interest, are often found multiplied into crystals which actually can be examined by the X-rays.

The soap bubble and soap film have long been studied for their beauty and their interest. Since they have so large a surface in comparison with their volume content, they offer special advantages for the examination of surface actions. Yet they are so full of detail that even with the last few years new and most interesting discoveries have been made with respect to them. It will be convenient to review some of these briefly as illustrations of the facts that have to be accounted for.

When the bubble is near its end a black patch often appears, and soon afterwards the bubble bursts. The patch is black because it is so thin, and therefore reflects little light. It might be thought that the "black spot" represents a breakdown in the structure, a forerunner of collapse. But it is in reality a relatively stable affair: in proper circumstances it can be maintained for hours and days, as Sir James Dewar loved to show. Reinold and Rucker, Rayleigh, Johannot, and many others were greatly interested in the sharpness of its outline, its thinness, and the uniformity of its texture. They recognised two degrees of blackness, as Newton had done long before; they supposed them to represent a single film and its duplication. They succeeded in measuring the thickness, and estimated it to be about 60 Ångström units in the case of the thinner and twice as much in that of the thicker.

When a film is correctly prepared and mounted, the black spot appears at once at the top of the film, a horizontal line separating it sharply from the rest with its horizontal bands of colour. Small black spots are continually forming at various points of the coloured film and rushing up to join the main spot: it is, of course, the downward movement of their surroundings which makes them move in the opposite direction. Sometimes minute points of light like stars appear, moving about on the surface and especially at the edges of the black spots—drops of water apparently.

When observations of this kind are made in the quiet of a laboratory, with small and more manageable films and with special instrumental facilities, a fineness of detail is revealed which cannot be followed on the screen. Our knowledge of these details is due to the beautiful work of Perrin, published in 1918, and to its repetition by Wells in 1920. To state Perrin's results very briefly, it appears that the two degrees of thickness first observed are due to the existence of a very thin uniform film and its doubling, as had already been shown; that the existence of three more degrees of blackness observed by Johannot was due to further repetitions of the same layer, and that a close examination revealed the existence of dozens of these layers, all multiples of the same fundamental thickness. In the blackest spot there was but one layer, and this was, strangely enough, the most stable of all. Other similar layers could be found superadded, like sheets of paper of the same uniform thickness, until the film was thick enough to show the rich colours of Newton's rings which the soap film ordinarily displays. As we know, the colour of the film is an indication of its thickness. For example, the colours proceed from black through greys, becoming lighter and lighter as the thickness increases, then to a nearly pure white, then through straw-yellow, yellow, orange-red, dark red to a violet, which always changes very quickly with alteration of thickness, and so forms a definite stage. The thickness has now reached (for water) about 2100 Å.U. Perrin counted 37 to 38 steps by which the superimposed sheets mounted to the full thickness that gave the violet tint. He made measurements also with monochromatic light and as his final result arrived at the conclusion that the thickness of the single film was about 52 Å.U. Wells found a somewhat smaller value, namely, 42 Å.U. Perrin, and Wells after him, concluded, on evidence which we have not time to consider, that the single film was composed of a double layer of oleic acid, arising from the hydrolysis of the sodium or potassium oleate in solution.

Now Rayleigh, Devaux, and more lately Langmuir, Hardy, and Adam have measured the thickness of an oil film spread on the surface of water. It appears that in the case of a fatty acid such as stearic or palmitic, when the surface is fully charged, the long chains stand on end, their carboxyl terminals rooted in the water, for which they have a great attraction, and their methyl terminals are turned outwards. The length of the oleic acid molecule is about 23 Å.U. It is clear that this length can easily be in agreement with the suggestion made by Perrin. His film of 52 Å.U., or 42 Å.U. according to Wells, would consist of two layers of oleic acid molecules, the carboxyl ends meeting in the centre. The molecules are held together, side by side, to form a strong sheet, while the methyl groups form a surface reacting very slightly with anything outside.

[1] Discourse delivered at the Royal Institution on Friday, January 16.

The examination of crystal forms by means of X-rays shows that the peculiar arrangement of the molecules in these films on water extends also to the solid crystal in a great number of cases, and may probably be considered as characteristic of the structure of a large and important class of substances. It is in the first place to be found in the solid forms of the fatty acids, hydrocarbons, alcohols, and other long-chain molecules. These have been examined by Piper at Bristol, and by Muller and Shearer in the Davy Faraday Laboratory. I referred to a few of these a year ago. The number examined has been largely increased during the last twelve months, and the results that have been obtained are ready for publication.

When a small quantity of one of these substances is placed upon a plate of glass or mica, either by melting or by pressing, a formation of layers results, much more so by the latter operation, for it would appear that the pressing and working encourage the arrangement of the molecules and the regularity of the layers that are formed. The material is now placed on an X-ray spectrometer, and a photograph is taken by the method of the revolving crystal. The photographic plate shows usually a number of lines which clearly represent the orders obtained by reflection from the plane of the layers. In this way the thickness of the layer can easily be measured with an accuracy of about 1 per cent. Ten or more orders are often observed. The cleavage plane of many crystals, especially of the class I am describing, often gives several orders, but not usually so many as in this case: other reflecting planes may give only one, perhaps two, higher orders of moderate strength, more often only very weak reflections, except in the first order. No doubt the case is parallel to the well-known effect in optics, where a grating yields many orders of spectra when the lines are sharp and fine. The "line" in this case is a well-defined discontinuity in the distribution of scattering centres which occurs at the ends of the long molecules; a defect would be caused by the presence of the hydrogens of a methyl group, an excess by the oxygens of a carboxyl group. We may suppose the planes which separate layers of these molecules to be well marked in this way, and that otherwise there is a fairly even distribution along the body of the molecule.

If we plot the spacing of each substance of any one series against the number of carbon atoms in the chain, we find at once that the indicating points lie exactly on a straight line, except when the chain is short. This has been proved by Muller and Shearer for the fatty acids, hydrocarbons, alcohols, ketones, and in other cases, and the regularity of the results leaves no doubt as to facts. The increase for each carbon atom is either about 1·0 Å.U. or 1·3 Å.U., the former occurring in the fatty acids, for example, and the latter in their esters.

If we may assume that the molecules lie perpendicularly to the layer, the numbers found for the thicknesses are actually the lengths of the molecules, and there is some ground for supposing this to be often true. But, of course, the molecules might *not* be normal to the layer, in which case the length of the molecule would be more than the thickness of the layer. It is certain that this may sometimes be so. Small crystals of substances of this class have been obtained and successfully measured in these laboratories by R. E. Gibbs, in spite of the fact that they each weighed only about a hundredth of a milligram. Gibbs finds that the crystals are of monoclinic prismatic form.

In this instance, then, the molecule is not upright but sloping. It is difficult to imagine that the molecules all slope one way in the oil films on water; there would surely be some unique and recognisable direction in the film. It is possible that the explanation may be found in the fact that there are actually two ways, perhaps several ways, in which the molecules arrange themselves. Gibbs has found an orthorhombic as well as a monoclinic form; and Muller has observed that a hydrocarbon gives a somewhat different value for the spacing when it is only a few degrees below its melting-point. The physical appearance is different in the two cases. In the latter the film is translucent: in the usual case it is opaque, probably on account of minute crevasses formed during shrinking. This may be the cause of the change we see passing over cooling candle grease: it is transparent one moment, and suddenly clouds over.

The inclination of the molecule to the plane of cleavage must be finally settled before we are quite sure that we are measuring the actual lengths of the molecules, but we may hope for an early solution.

The fatty acid molecules are in double layers, but the hydrocarbons are not. We know this in two ways. In the first place, the actual increase in length for each carbon atom is twice as great in one case as in the other. In the second place, the even orders of the fatty acid spectra are very weak compared to the odd orders.

Such an effect can be produced in an optical grating by an alternation of white and black lines on a grey ground. An alternation of strong and weak black lines gives strength to the even orders: substituting white for one of the blacks is equivalent to changing the sign of its contribution. Gratings can be so made as to illustrate the point. If molecules pointing opposite ways are joined by their carboxyl terminations, then the methyl ends of the molecules are weaker in scattering centres than the general average along the molecule, but the parts where the carboxyl groups join together are above the average in strength.

Shearer finds another illustration of this effect in the case of hydrocarbons which form a single layer, but are converted into ketones by the substitution of oxygen for hydrogen at some point of the length. When the substitution is at the middle of the chain, there is at that point an excessive number of scattering centres, and we have again the circumstances that cause reinforcement of the odd orders. But if the substitution is not at the middle of the chain, the odd orders are no longer strong compared to the even.

We have, therefore, in these stratified layers which we are examining by the X-rays, the very same formation that Perrin has observed in the liquid films. The molecules are found, without exception, to be extended to their full length, and linked together by their carboxyl terminals. Shearer finds the length of the double molecule of oleic acid to be about 36, which is to be compared with the 52 of Perrin and the 42 of Wells.

The conditions which lead to the formation of films on a water surface, and layers in the fatty acids and similar bodies, are operative also in the case of a large

number of more solid crystals. A certain flakiness is the result, the crystals cleaving very easily into thin layers which slide readily on one another, and often give a greasy feeling to the crystal.

Naphthalene and anthracene are cases in point. Their molecules are long and narrow, and are arranged side by side like the oleic acid molecules on water. A single layer is like the corn in a field; but they lean over like the corn when a wind is blowing. They are not perpendicular to the layer. The bonds that tie the molecules side to side must be stronger than those that tie them end to end, because the flakes are so easily parted from one another. The naphthalene molecule contains two hexagonal rings of carbon atoms and the anthracene molecule is extended by the addition of a third, so that the layer is thicker in the latter case. In both cases the molecule has a centre of symmetry, and in each layer the molecules are divided into two classes in respect to their orientation. Any member of one class is joined up by ties of some sort to several (probably four) members of the other class, which immediately surround it in the flake; and it would seem that this cross linking holds the flake together and gives it its strength.

It is likely that a very large number of other substances are built on the same plan. Even when their examination has not yet been attempted by means of X-rays, their crystallographic measurements suggest the fact.

In other substances a similar external form is attained by a somewhat more complicated internal arrangement. The molecule has of itself no centre of symmetry, in fact no symmetry at all, and twice as many are required in the construction of the monoclinic prismatic unit of pattern. This is the case, for example, with benzoic acid, and probably with many of its derivatives. But there is the same flakiness which may be put down to the same causes: (1) the general orientation of the molecules so as to lie across the flake, and (2) the hydrogen terminations. In all these cases we find that the crystal is tied together by links extended from each molecule to neighbours of the other possible orientations: this seems to be an essential feature of crystal construction. It cannot, of course, be followed in the lowest type of crystalline symmetry, where there is but one orientation possible, and every molecule is arranged exactly as every other. But though this arrangement can be conceived, it is doubtful whether there is a known case: it has been shown by Astbury that calcium thiosulphate, generally quoted as the solitary example, has probably the symmetry of Class 2, which contains two orientations, connected by a centre of symmetry. Whether this is so or not, it is certain that in at least the vast majority of cases, cross linking is an important feature. It may very likely be a factor in the determination of the faces that appear on a crystal. A face will naturally contain specimens of more than one molecular orientation, so that the elements of the face may be tied together strongly. For example, in naphthalene, as in many other cases, all the usual faces contain equal numbers of molecules of the two orientations: one might even predict the arrangement from the knowledge of the form.

If, therefore, we survey the general characteristics of this large class of flaky crystals, we observe that the monomolecular films of Langmuir and the multiple stratifications of Perrin, and the whole range of "thin films," have much in common with the solid members of the class. Yet there are significant differences. It seems possible by studying both resemblances and differences to obtain some fresh light on the properties of the more "liquid" films.

With these facts before us we may perhaps formulate a more detailed theory of the black spot on the soap film. The ordinary thick film is bounded on each side by the monomolecular film of oleic acid. In this film there is certainly arrangement. Adam, in particular, has examined the compression of the film under applied forces, and his observations and conclusions fall in naturally with the ordered array that we should expect to be there. But the film is imperfectly crystalline. It is compressible up to a certain point, and during the range of compression may be considered as a two-dimensional gas. The perfect crystal of this class of substance is found in the films studied by Muller and Shearer, and in the minute crystal which Gibbs has measured. The perfect crystal of oleic acid contains twice as many orientations as the film of oleic acid on water: the molecules on the water are only one way up, and the reversed molecules are required to complete the structure.

Suppose, however, that the oleic acid films on the two sides come into contact anywhere; the conditions for the completion of the crystalline structure are now all present. The carboxyl groups not only meet, but interlace: each molecule in the upper group linking together two or four molecules in the lower, and vice versa. This is doubtless a far more stable form of arrangement than that of the single film. The two outside single films, once united in one place, must increase their area of contact, and will drive the expelled water before them until the accumulating heap becomes too great for them to push any further, the action being assisted by the tension of the rest of the film.

The film thus formed is a real crystal, because it contains all the molecular orientations. The black spot is simply the thinnest possible flake of oleic acid. It is true that oleic acid melts at 11° C., but the crystalline structure is there, in a mobile state. Solution cannot be made to enter between the two surfaces now united in crystalline fashion. Other films may be formed and float about on it, holding on by virtue of the feeble attractions of the methyl groups on one another: even the pressure of the air must help in keeping them together. These added films will slide about easily; they also will be true crystals of oleic acid, probably without any water.

The differences between the conditions and structure of the black spot on one hand and the neighbouring thick film on the other are so great that we may cease to wonder at the sharpness of the boundary and the enormous change in thickness: on one side of the boundary the thickness may be hundreds of times as great as on the other.

When the black spots appear and rise through the thick part of the film to join the general black area at the top, they leave trails behind them: they look like tadpoles swimming up to the top of the water. When the motion becomes less violent the tails shrink into small circular spots. On the other hand, if a thick

patch is forced by the general turmoil into the middle of a black film, it tends also to a circular shape.

We come now to another of the important surface effects, namely, that of friction, or, stated inversely, of slipperiness. These flaky substances are in general slippery and greasy to the touch. The greasy feeling seems to be due to the ease with which the flakes are split from the main body of the substance, and then slide over it. Graphite is an extreme example of the flaky state: and without forcing its inclusion in the class of substances we are considering, we observe that the atoms in each flake are tightly tied together, and that there is a very weak linkage between a flake and its neighbours. It is the combination of these conditions that makes for good lubricating qualities. Now in these substances the same conditions hold to a greater or less extent: the molecules of stearic acid, for example, are tied together more tightly side to side than across the ends at which the methyl groups are attached. If, therefore, stratification exists to any considerable degree, the same consequences follow as in the case of graphite. In general, stratification is incomplete, which is another way of saying that a large perfect crystal of stearic acid is never seen. Pressure is one agent that causes stratification, so that if one presses a piece of stearic acid or other material, the very pressure produces the conditions for easy slipping. I have already mentioned that Shearer and Muller have often found that a portion of the material melted on to a piece of mica or glass, and placed on the spectrometer in the necessary position for giving reflections from planes parallel to the glass, was comparatively ineffective in this respect. It would give clear evidence of those two spacings which are found on all the plates, and are ascribed to the widths of the molecules and are independent of their lengths. When the specimen was pressed, or rubbed down on to the plate, the stratification spacing appeared at once, and the others disappeared, thus showing the nature of the rearrangement that had taken place. It may be that this effect explains other properties of greases. I am told that the special grease used in binocular fittings is made serviceable by working with a palette knife.

We must recognise, however, that the layers built into the crystal are not at all times ready to slide, otherwise a mere tilt of the crystal would cause them all to slide off one another like a pack of cards. There is a sticking friction to be overcome, exactly as in graphite. It is only possible to speculate as to the cause: perhaps it is a real molecular effect, and sliding only occurs when the bonds, weak as they are, are further weakened, as if the substance was about to melt: perhaps it is rather a mass effect and due to imperfect crystallisation.

It seems not unlikely that, at its best, slipperiness in these cases is almost perfect. Between two perfectly formed methyl layers there is very little friction indeed, perhaps none at all. The methyl layer is seen at its best on the surface of the black spot in the soap film, and various writers have noted that one layer slides very easily over the other. Perrin, in fact, has directed attention to this remarkable effect, as shown in the Brownian movement of fragments of one layer, lying on and sliding over another.

In some of the experiments of Sir William Hardy and Miss Doubleday the condition of nearly complete slipperiness is attained. Their beautiful researches on "boundary lubrication," that is to say, the slipperiness of very thin films, have established certain rules of surprising simplicity. They have found cases in which friction nearly vanishes, and in general accordance with the above, they frequently occur when a solid lubricant is practically wiped and rubbed off the surface, a true stratification in a very thin film being probably left.

Not only the phenomena of surface tension and of lubrication, but also those of catalysis, must be intimately connected with the actual arrangement of molecules. We speak of stereochemistry as showing the relations of the atoms in the molecules to one another, their mutual orientation and distances. To deal with these subjects we shall have to extend stereochemistry to cover the mutual distances and orientations of molecules as well as of atoms. We see that we must not treat a molecule as if it were simply a sphere attracting according to gravitational laws: it is not even sufficient to speak of an atom in this way, except as an approximation in the case of ionic substances like rock-salt. If some super-Brobdingnagian inquirer were to argue from effects observed on the surface of the earth as to the nature of the human beings to which the effects were ascribed, and being unable to detect a single individual by the most refined methods of which he was capable, should say, "Let us provisionally assume the human being to be a sphere, having similar properties in all directions and no special points of attraction," he would not get very far towards a satisfactory explanation of his subject. It would be an advance should he recognise the existence of two types of opposite sign, and lay the foundations of an ionic theory of heteropolar assemblages, but even then he would fall far short of the truth. In the same way, when we try to explain surface tension as the result of the mutual gravitational attraction of spherical atoms or molecules, we cannot make much progress. Indeed, we sometimes arrive at consequences that appear startling, as when we determine their attractions by measuring the energy required to tear surface molecules away in the process of evaporation, and then proceed to deduce the existence of pressures of thousands of atmospheres within the body of a liquid. So we may measure the force required to tear away the fringing links of a piece of chain mail, take them to be due to mutual attraction between the links, and thence deduce the existence of an enormous pressure within the piece.

It is when we consider a catalytic surface as possessing active centres on its surface, the relative positions, magnitudes, and mutual distances of which are such that two wandering molecules of different kind, attracted by these points, may be held together in a special way, that we get some idea of the fundamental action of catalysis. It is important to consider, as the basis of surface actions, the arrangements of the molecules at a surface, both arrangements that actually exist, and those that are predisposed to exist. This idea runs through all the work of those experimenters, Langmuir, Harkins, Hardy, Adam, Perrin, and many others who have made such progress of recent years: the X-ray studies emphasise this view and supply many quantitative measurements by which it may be shaped and strengthened.

Biographical Byways.[1]

By Sir ARTHUR SCHUSTER, F.R.S.

8. THREE GÖTTINGEN PROFESSORS, AND AN ADVENTURE.

WHEN I went to spend two months at Göttingen in the summer of 1874, Wilhelm Weber (1804–1891) had just retired from the professorship. I doubt whether the present generation of physicists are familiar with his work, though there was a time when electricians talked about weber-currents, galvanic-currents, and faradic-currents as if they were different things. I feel sure, however, that chemists have not forgotten Friedrich Wöhler (1800–1882), who occupied the chair of chemistry at the University of Göttingen during forty-six years. Both men were Copley medalists. Wilhelm Klinkerfuss (1828–1884) stands on a somewhat lower level of distinction, though he did meritorious work, was amongst the first to recognise the importance of Döppler's principle, and discovered six comets.

When Weber was first appointed to the chair of physics at Göttingen in 1831, that University formed part of the kingdom of Hanover. When its connexion with England was finally severed in 1837 by the accession of Ernest August to the throne of Hanover, the new king repudiated the constitution which the country had enjoyed for a considerable time. Seven professors of Göttingen protested against this autocratic action and had to leave the country. They included, besides Wilhelm Weber, his brother, the physiologist, and Jacob Grimm, the writer of fairy tales. Weber was offered a chair at Leipzig, where he remained until he was reinstated at Göttingen in 1849. In 1874, at the age of seventy, he was still full of vigour. A short man with a clean-shaven, round, and smiling face, he was ready to discuss the current scientific problems with freedom and sagacity. I much enjoyed the two occasions on which he invited me to join him in his walks along the walls of old Göttingen.

A man's mentality often finds significant expression in the way in which he shakes hands. Kopp, of Heidelberg, used to raise the proffered hand slowly to the level of his short-sighted eyes, and keep it there for a few seconds as if wondering what to do with it. Weber raised his arm vertically upwards and swung it down in a swift and forcible sweep, as if he really meant it. I was told that, under the influence of Zöllner, Weber had taken up spiritualism, but I never knew that side of him.

In contrast with Weber, Wöhler seemed to live entirely in the past. I only spoke to him twice, but while fond of relating old reminiscences, his conversation generally ended in a recital of his personal ailment. I can only remember one of his tales. He had an official residence above his laboratory, and one night he was awakened by the noise of an explosion. He gave a graphic description how, with a candle in his hand, he went down to see what had happened. At the point of opening the door—he hesitated. Could there still be some explosive gases hovering round the laboratory? He blew out the candle and entered the room, and found indeed that he had narrowly escaped losing his life by a second explosion. There is not much in this story, but Wöhler seemed to be very proud of this testimony to his presence of mind.

I had called on Wöhler at the express wish of Roscoe, who sent him, through me, a small flask filled with vanadium salt. Wöhler was delighted, and could scarcely believe that this was for him to keep and not only to look at. He had been doing some work on vanadium himself with only a small quantity at his disposal, and on every occasion that I met him he always expressed surprise that Roscoe could spare so much of it. The day following my first call, on returning to my lodgings, I found a visiting card with his name neatly written on it.

Klinkerfuss was a man of different type and calibre. He generally took his meals in common eating-houses surrounded by students, and occasionally I was one of the party. He used to entertain us with inferior jokes. One example must suffice. "I have always had a remarkable memory for numbers," he said. "At school in the history lesson I could remember every date. Unfortunately, I always forgot what happened on the dates." It was said of him that when he received his salary he spent his money lavishly eating and drinking in the most expensive places, and when he had spent nearly everything he lived mainly on sausages and beer. His duties sat lightly upon him. By a general rule of the German universities, a professor is not obliged to lecture to less than three students (*tres faciunt collegium*), and when at the beginning of term one of them called to inscribe himself for the course which had been announced, Klinkerfuss told him that he would have to find two others who also desired to attend. It was said that if half an hour later another man came with the same request, he received the same answer, and it was only when the term was in full swing that the disappointed students became known to each other. I do not vouch for the story. The facts that the fees go to the professors, and the well-known impecuniosity of Klinkerfuss, speak against it. He ultimately ended his life by committing suicide.

There was another professor at Göttingen, a philosopher and theologian, with whom I had some acquaintance. When I called on him, he warned me that the life in Göttingen was different from that at Heidelberg. The students were more formal, and inclined to take offence if one did not conform with their codes of behaviour. It was not many hours before I had occasion to regret that I did not attach more importance to his warning. The evening of my visit to him I went to some open-air place of entertainment where I met an acquaintance, who was accompanied by three other students. He asked me to join his party, but I told him that I was on my way home. Ultimately, he persuaded me to sit down for a few minutes. While I was talking to him I overheard remarks, made by his companions, about the impertinence of sitting down at a table without a proper introduction. I knew I was in for it, but awaited developments. Suddenly one of the men got up, placed himself right in front of me, clicked his heels together, and said, "My name is von

[1] Continued from p. 234.

Eberstein" (the names are imaginary). I gave him my name in return. After a minute or two the second man got up: "My name is Goldschmidt." I gave him my name. When the third man got up I fortunately remembered that I had a trump card to play, and after he had gone through his ritual I replied, "My name is Dr. Schuster," laying stress on the title. Whereupon all three silently left in a body. My degree was a sufficient distinction in rank to justify me in dispensing with the formality of asking for an introduction to them. I asked my friend what would have happened if I had not been a graduate: his reply was, that I should have had either to fight at least one duel or been treated as an outcast by German universities. All this happened fifty years ago, and must not be considered to apply to the present day.

Obituary.

SIR JAMES MACKENZIE, F.R.S.

BY the death of Sir James Mackenzie the medical profession and the world at large has lost a physician whose life was devoted to the advancement of our knowledge of practical medicine. His researches on diseases of the heart effected nothing less than a revolution in this branch of medicine, which had been stagnant for nearly a century.

Sir James Mackenzie was born at Scone in 1853, and received his medical education at the University of Edinburgh, where he graduated in 1878. After extending his training by resident appointments in the Royal Infirmary he took his M.D. in 1882. Then followed twenty-eight years of busy general practice in Burnley, and it was during these years that he made the greater part of the observations which made his fame. It soon struck him, as it must strike many medical men, that for the diagnosis and treatment of a vast proportion of illness, his teachers had been unable to give him anything like adequate guidance. Mackenzie, greatly stirred by discontent, set himself to the filling of some of the gaps, and two examples of this pioneer work may be mentioned. The value of pain as a guide to diagnosis was realised when he found that it was referred from the offending organ to particular areas of the surface of the body through the agency of the nervous system, and that the organ was not itself painful. This fundamental change in the conception of pain was independently discovered and extended by Dr. Henry Head. Another gap so brilliantly, almost completely filled, was the classification of the irregularities of the heart. For this purpose Mackenzie invented a clinical polygraph for recording not only the pulse but also simultaneously the venous pulse in the neck. It thus became possible for the first time to observe the action of the auricle, which proved a key to the elucidation of arrhythmia. Irregularities and murmurs were shown to be significant or insignificant by the rational, though laborious, method of following cases exhibiting them for years until their degree of importance became manifest.

Great interest was aroused at home and abroad by the immediate value of these discoveries, and when Mackenzie relinquished his general practice at Burnley in 1907 to take up consulting work in London, he was recognised as the foremost investigator and authority in the world on heart disease. His popularity as a consultant was not allowed to interfere with research, which was continued first at the Mount Vernon Hospital and later at the London Hospital. The action of digitalis in disease was studied to such purpose that, as Prof. Cushny has said, "more progress was made in fifteen years than in the preceding century." The impetus of progress was given to disciples from all over the world, and to them were opened fields of thought and work which seem sufficient for a generation.

When the War came, Mackenzie initiated through the War Office a special hospital for the elucidation of problems connected with "soldier's heart." In 1918 he retired from consulting work and went to St. Andrews, where he founded the Institute for Clinical Research. He had realised that attention was habitually directed to fully developed disease, so that, as he said, patients seemed to be admitted to hospital when they had the physical signs of obvious disease and might almost be described as incurable. He determined to study afresh the nature of symptoms as met with in practice, so as to learn of disease in its early and perhaps curable stage. As time went on, he foresaw that the phenomena of disease might be governed by simple laws which he formulated as a basis for further examination by his colleagues at the Institute. Then his health failed, but not his faith and courage, and he finally retired to London, where he died on January 26.

Mackenzie's personal qualities were an ornament to the greatness and originality of his mind, and endeared him to all his pupils. He was indefatigable himself, an inspiring and generous master, a superman, but none was more human. His personality will remain as worthy of admiration as was his relentless pursuit of knowledge, not only for its own sake but also for its application in the relief of suffering humanity.

In 1911 Mackenzie was appointed physician to the cardiac department of the London Hospital. In 1915 he became a fellow of the Royal Society, and received the honour of knighthood; later he was appointed honorary consulting physician to the King in Scotland. His most important works are "The Study of the Pulse" (1902), "Diseases of the Heart" (1908), "Symptoms and their Interpretation" (1909), "Principles of Diagnosis and Treatment in Heart Affections" (1916), and "Angina Pectoris" (1923).

MR. WILLIAM WATSON.

WE regret to announce the death of Mr. William Watson, which occurred at St. Albans on January 30. He was well known in botanical and horticultural circles through his long tenure of the curatorship of the Royal Botanic Gardens, Kew, a position he held from August 1901 until June 1922.

Mr. Watson was born at Garston, near Liverpool, on March 13, 1858, and received his first appointment at Kew in 1879, following several years' experience in trade establishments. His knowledge of tropical and sub-tropical plants was probably unrivalled. For many years he was a regular contributor to the

horticultural press, and so long ago as the eighties of last century wrote a valuable series of articles on the Palmaceæ in the *Gardener's Chronicle*. These articles it was hoped might have been republished in book form as a monograph of this natural order, thereby bringing Berthold Seemann's work on the same family up-to-date. This hope, however, was never fulfilled. To vol. 15 of the *Annals of Botany* he contributed an illustrated paper "On the germination of *Bertholletia excelsa*," the Brazil nut.

In later years Watson took a keen interest in the Cactaceæ and succulent plants generally, and his "Cactus Culture for Amateurs" is the standard work on its subject. He also wrote books on "Climbing Plants," "Rhododendrons and Azaleas," and, in collaboration with W. J. Bean, "Orchids, their Culture and Management," all of which met with success. On horticulturists in general he conferred a great boon by editing a new edition of "Thompson's Gardener's Assistant," so much improving it that it became practically a new work. For upwards of twenty years he was editor of the garden section of the *Field*. His life's work, however, was centred in Kew, an institution which owes very much to his forty-three years' devoted service. He was elected an associate of the Linnean Society in 1904.

THE *Chemiker-Zeitung* reports the death on January 6, at the age of sixty-eight, of Dr. Wilhelm Borchers, professor of metallurgy and electrometallurgy at the Technische Hochschule of Aix-la-Chapelle. Borchers was born at the university town of Erlangen, and after completing his studies there, he spent the next four years in a chemical factory as process chemist. The experience thus gained was of immense value to him in his later career as an investigator, for it enabled him to bring to a successful conclusion many difficult researches in the field of electrometallurgy. In 1891 he was appointed lecturer in chemistry and metallurgy at Duisburg, and six years later he was transferred to the Hochschule at Aix-la-Chapelle. His chief interest lay in the application of electrolytic processes to metallurgical problems, such as the production of metallic calcium, strontium, titanium, cerium, etc. He also conducted numerous researches on the preparation and properties of alloys. Prof. Borchers was the author of several books on electrochemistry, and in 1894 he founded the *Zeitschrift für Elektrochemie*, which he edited until 1900. He also collaborated with Nernst in publishing the *Jahrbuch der Elektrochemie*.

WE regret to announce the following deaths:

Prof. Walther Dieckmann, of the Department of Chemistry in the University of Munich, on January 12, whilst carrying out a research in organic chemistry in the State laboratory.

Miss Lilian Suzette Gibbs, known for her work on the mountain flora of Australasia and on problems relating to the geographical distribution of plants.

Dr. E. E. Klein, F.R.S., formerly lecturer on advanced bacteriology in the Medical School, St. Bartholomew's Hospital, on February 9, aged eighty.

Current Topics and Events.

INTEREST in the therapeutics of consumption has again been roused by the reports of successful treatment, this time by a chemotherapeutic agent which, under the name of sanocrysin, has been investigated by Møllgaard, a professor in the Landbohojskole of Copenhagen. There is no mystery chemically about sanocrysin. It is sodium aurous thiosulphate ($Na_3Au(S_2O_3)_2$) which has long been known as Fordos and Geles salt. Years ago it was shown that gold salts have a powerful action on tubercle bacilli *in vitro* and several gold preparations, simple and complex, have been tried therapeutically with indifferent success. Møllgaard affirms that sanocrysin inhibits the growth of tubercle bacilli in a dilution of 1 : 1,000,000 and that their progress may be completely arrested in a concentration of 1 : 100,000. In non-tuberculous animals sanocrysin is said to be relatively harmless, whereas in tuberculous subjects very stormy reactions follow its exhibition and may actually end in death. It is believed by Møllgaard that these violent effects are to be attributed to certain poisons, of a tuberculin character, which are liberated from the dying and dead tubercle bacilli from the action of the sanocrysin rather than to a direct toxic action of the thiosulphate. It is said that the violent reactions can be lessened or prevented by the administration of an anti-serum produced by the injection of tubercle bacilli or its products. The sanocrysin treatment is really a twofold process. There is supposed to be the direct bactericidal action of sanocrysin and the neutralisation of its poisonous results by an antitoxin of sorts. The Møllgaard treatment has been applied for a considerable time both in cases of tuberculous human beings and animals, but judgment must at present be reserved as to whether it is likely to occupy a permanent place in tuberculo-therapy.

IN the course of his fourth talk on "Ether and Reality" given under the auspices of the British Broadcasting Company at the London station, 2LO, on February 17, Sir Oliver Lodge discussed magnetism and its analogies with life and knowledge. Sir Oliver stated that electrification is a matter of transfer, a transfer of pre-existent charges, a disturbance of equilibrium. When equilibrium is established, opposite charges are close together and disappear from our ken. They never go out of existence: we neither create nor destroy. The same is true for magnetism: we can make a magnet, but the magnetism was there beforehand. Magnetic lines of force differ from electric lines in being always closed loops; all we do is to open them out. They tend to shrink, and thereby pull together two things round which they are looped, like an indiarubber ring. They never shrink up to nothingness. One magnet can produce any number of others, for there is no limit to the amount of magnetisation; what one body gains, the other does not lose. In that respect it is analogous with life. Knowledge in this respect is like life and magnetism: there is an unlimited reservoir from

which to draw, and the imparting of knowledge does not lessen the amount possessed by the imparter; it is transferred without loss, though doubtless with the expenditure of some energy. Knowledge grows from more to more. By diffusion it is increased; what one gains, another does not lose. A magnet which has excited other magnets may be even stronger than before; life which has excited other life may still be vigorous. So far as we learn from science, nothing goes out of existence; it only changes its form and may become inappreciable to our senses.

A COGENT restatement by Dr. R. P. Scott of the case for co-operation between England and China on certain lines and under certain safeguards appears in the current issue of the *Contemporary Review*. Those who are best acquainted with conditions in China are by no means so pessimistic as to the outcome of the present situation as the political news appearing in the Press might appear to demand. Private advice from China, however, indicates that this news is by no means exaggerated and that the social and commercial situation is serious. Dr. Scott lays great stress upon the pre-revolutionary character of Chinese ideals in pressing that side of his argument which rests upon the fundamental similarities between the English and Chinese mentality. These, he holds, find their most significant expression in the qualities characteristic of the English "gentleman" and the Chinese "princely man," as well as in business faculties, and in humour. Granting that co-operation is both possible and desirable, of the various suggestions put forward there is much to be said in favour of education as the field. Dr. Scott points out that it is the only one in which continuity can be obtained, and further, it is one to which each of the parties brings something distinctive—the Chinese, a thoroughness of mental grasp, and the English, breadth of outlook. Without attempting to displace literary studies, we could add instruction in those branches of science, especially the higher branches of physics and of surgery, for which the racial characteristics of the Chinese are peculiarly apt, but in which at present they lack opportunities of training. Dr. Scott quotes a letter from the Chancellor of the National University of Pekin which should set at rest any doubt as to the willingness of the Chinese themselves to co-operate in this field. While Chinese ethical standards must be respected, what is needed in the opinion of the Chinese themselves is the spirit and tradition of our best public schools. Dr. Scott concludes by indicating in outline the means of attaining this object through joint membership of the Foreign Office Advisory Committee contemplated by the Bill for dealing with the Chinese Indemnity now before Parliament, and by joint committees in China itself.

IN the *Electrician* for February 6 some results are given of radio signal measurements between Great Britain and the United States made during the eclipse, which supplement the communication from Dr. W. H. Eccles on p. 260 of this issue. The experiments were carried out in Great Britain by the General Post Office, the Radio Research Board, and the International Western Electric Co. In the United States the Radio Corporation transmitted special signals from an experimental station situated at Rocky Point, Long Island. In Great Britain the Leafield and Northolt stations sent signals. Similar observations were made on the day preceding and the day following the eclipse. Measurements were made both of the intensity and the apparent bearing of the signals. On the day of the eclipse, there was a well-defined rise to a very sharp maximum of the signal intensity. This was followed by an equally well-defined minimum. The rise corresponded approximately to the intersection of the path of the beginning of the eclipse with the great circle passing through the transmitter and the receiver. The minimum of signal intensity coincided to within one or two minutes with the intersection of the path of totality with the corresponding great circle. The radio bearings of Rocky Point were observed at Slough on January 24 and 25 and were found to be very steady in each case. There was no appreciable effect that could be attributed to the eclipse. Observations were also carried out at Slough on the signal intensity and bearings of Leafield, which is distant 48 miles. In this case the erratic behaviour of both measured quantities was very marked. These variations are a normal daily occurrence at this period of the year and neither of the measurements seemed to be affected by the eclipse.

THE Wireless Telegraphy and Signalling Bill which has been introduced in the House of Commons by the Postmaster-General, Sir William Mitchell-Thomson, is a measure of such questionable quality and scientific detriment that it is scarcely likely to pass through Parliament without substantial change. The Bill is particularly objectionable from the point of view of the scientific investigator and inventor, as by it officials from the Post Office may demand, under heavy penalties, to enter any laboratory and inspect apparatus and experiments even though these do not involve any outside transmission. True, this oversight of experimental work is claimed already as being in departmental regulations, but these could never be upheld. The new Bill, however, would make it possible for the Postmaster-General to impose them on any experimenter or inventor. What the Bill provides for specifically is control of "the installation and working of apparatus for utilising etheric waves . . . as they apply to the installation and working of apparatus for wireless telegraphy." Mr. A. A. Campbell Swinton points out in a letter in the *Times* of February 17 that a candle or any other source of radiation is producing "etheric waves" and that, as the existence of the ether itself is now questioned in certain scientific circles, much interesting litigation might be anticipated if the words now in the Bill are retained without statutory qualification. So many objections have, however, been raised to some of the clauses, as they stand at present, that the measure must meet with considerable opposition when it is under discussion in Parliament.

WE have received from Prof. G. Friedel, of Strasbourg, a somewhat lengthy communication in which he maintains that his classification of Lehmann's so-called liquid crystals is valid. He calls this state of matter "mesomorphic" and so early as 1911 recognised that this embraced two distinct forms which he then called "liquides à conique" and "liquides à fils." He supposes that in the former there is a kind of periodicity in the sense that the molecules are distributed irregularly in parallel equidistant layers. In the latter there is no periodicity at all, but only a general parallel orientation of the molecules. These valuable conceptions sharply differentiate the mesomorphic states from the complete periodicity of true crystals on one hand and from the complete irregularity of amorphous bodies or liquids on the other. In 1922 he re-named the two states "smectique" and "nematique" (from σμῆγμα, soap, and νῆμα, thread, from the thread-like appearance of the sharp boundaries of different portions observed in polarised light under the microscope). He suggests that the English name for the former should be derived from the French rather than that the existing English word "smegmatic" (derived from the original Greek) should be used. He differs strongly from McBain in holding that such bodies as soap curds do not consist of crystals but are mesomorphic, and it is for this reason that he no longer uses the designation "liquid." If, as affirmed by McBain (see photograph in NATURE of July 12, 1924, p. 49), there is at least one other form of soap which may be described as a "conic anisotropic liquid," this would merely show that the same body can exist in several different "smectic" forms. This, however, leaves scope for speculation as to how to explain these different varieties.

ALTHOUGH a number of investigators using X-rays have failed to obtain radiograms with any liquid crystals except for soap curds, the classification of which is in dispute, Friedel maintains that this is due to faulty technique in the case of smectic bodies such as transparent soap solutions, whereas no nematic body should give such a radiogram. He announces that his son, E. Friedel, has now obtained such a radiogram with ethylazoxybenzoate. Publication of this evidence will be awaited with interest. Friedel appears, however, to be mistaken in his assertion that radiograms of soap curds disclose only one set of planes; Piper (J. Phys. Soc., 1923, 35) found three spacings; namely, one wide spacing of the order of 4Å and two of the order of 4Å. R. E. Gibbs (J. Chem. Soc., 1924, 125, 2625), referring to the higher fatty acids, the X-ray photographs of which resemble the soap curds, remarks: "Owing to the doubt that has existed as to the nature of the fatty acids, it is of interest to note that, since this paper was written, further work has been done with stearic acid showing it to be of a true crystalline nature and demonstrating its extinction directions and brush figures. Several single crystal X-ray photographs of it have already been taken."

THREE Cantor Lectures, on January 19, 26, and February 2, were delivered at the Royal Society of Arts on "Radiological Research—A History," by Mr. V. E. Pullin, Director of the Radiological Research Department, Woolwich. Mr. Pullin said that radiological research may be said to have begun in the year 1705 with the experiments by Mr. Hawksbee, F.R.S., on electrical discharges in vacua, followed by those of Mr. William Morgan in 1785, the latter probably the first experimenter to produce X-rays. The great advance in knowledge made by scientific workers during the nineteenth century, particularly Faraday and Sir William Crookes, paved the way to the sensational discovery of X-rays by Röntgen at the end of 1895. The controversy as to the nature of the cathode stream was eventually settled by the classical work of Sir J. J. Thomson in 1897. The nature of the X-rays was finally determined when, aided by Planck's theory of radiation, Prof. von Laue was able to show that X-rays could be diffracted by means of crystals. The accidental discovery of X-rays by Röntgen in 1895 was due to his use of fluorescent screens. Much important research during the next crowded years resulted in Sir Herbert Jackson's use of a concave cathode, Mr. Campbell Swinton's platinum target, and the introduction of the vacuum regulators gave us the modern gas-tubes, leading up finally to the introduction in 1913 of the Coolidge tube. To-day it is possible to operate a tube on 200,000 volts and to examine castings 3 in. thick. Voltages up to 400,000 are already available at Woolwich, but no X-ray tube can stand up to more than 200,000 volts owing to vacuum and other difficulties. These difficulties may call for a new type of tube, and research on this subject is now being carried out at Woolwich. Modern research is also being directed on the problem of focussing, and design of very high tension direct current electrical machines. Radiology should be the indispensable adjunct of all modern engineering practice, owing to the great saving that can be effected by detection of flaws in heavy castings, before expensive machining has been done. During the previous week, with some new apparatus, designed and made at Woolwich, a mass of steel 4 in. in thickness was penetrated. This constitutes a record in penetration.

DR. J. H. JEANS, secretary of the Royal Society, and Sir William Henry Ellis have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

SIR WILLIAM HARDY and Miss Ida Bircumshaw will deliver the Bakerian Lecture at the meeting of the Royal Society of March 19. They will take as their subject "Boundary Lubrication. Plane Surfaces and the Limitations of Amontons' Law."

THE Council of the Chemical Society has nominated Dr. Arthur W. Crossley as president, Dr. T. Slater Price as secretary, and Prof. F. G. Donnan as foreign secretary. The annual general meeting will be held on March 26 at 4 P.M., and the anniversary dinner will be held the same evening at the Hotel Victoria, Northumberland Avenue.

SIR THOMAS H. HOLLAND has been elected president, and the Rt. Hon. Viscount Cowdray of Cowdray, Sir John Cargill, Bart., Mr. Alfred C. Adams, Mr. Alexander Duckham, Mr. Arthur W. Eastlake, and Mr. Robert Redwood have been elected vice-presidents of the Institution of Petroleum Technologists for the ensuing year.

THE International Health Board of the Rockefeller Foundation has made a grant of 1,100,000 kröne (about 62,000*l.*) to the Danish State Serum Institute at Copenhagen for the purpose of extending the building and laboratories. This is the third grant made to Denmark by the Rockefeller Foundation during the last year or two. Previous grants were allocated to the Veterinary School and to Prof. Niels Bohr.

THE following officers of the Royal Astronomical Society were elected at the anniversary meeting on February 13: *President*, Dr. J. H. Jeans; *Vice-Presidents*, Dr. A. C. D. Crommelin, Dr. J. L. E. Dreyer, Prof. A. Fowler, Dr. J. W. L. Glaisher; *Treasurer*, Lieut.-Col. F. J. M. Stratton; *Secretaries*, Dr. J. Jackson, Rev. T. E. R. Phillips; *Foreign Secretary*, Prof. H. H. Turner.

ON Thursday next, February 26, at 5.15, Sir Arthur Smith Woodward will deliver the first of two lectures at the Royal Institution on dinosaurs, and on Saturday, February 28, at three o'clock, Sir Ernest Rutherford will begin a course of four lectures on the counting of the atoms. The Friday Evening discourses on February 27 and March 6 will be delivered by Sir James Irvine, on sugars from the point of view of the organic chemist, and by Sir Arthur Keith, on the rate of man's evolution, respectively.

AT the annual general meeting of the Meteorological Society on January 18, the following officers were elected: *President*, Mr. C. J. P. Cave; *Vice-Presidents*, Dr. C. Chree, Mr. J. S. Dines, Mr. L. F. Richardson, Mr. Gilbert Thomson; *Treasurer*, Mr. Francis Druce; *Secretaries*, Mr. Richard Corless, 21 Wimborne Gardens, W. Ealing, W.13; Commander L. G. Garbett, Meteorological Office, Air Ministry, Kingsway, W.C.2; Major A. J. H. Maclean of Ardgour, Ardgour, Argyllshire; *Foreign Secretary*, Mr. R. G. K. Lempfert, 24A Trebovir Road, S.W.5; *Assistant Secretary*, Mr. A. Hampton Brown, 49 Cromwell Road, South Kensington, S.W.7.

THE discovery of a new urinary antiseptic by the Johns Hopkins School of Hygiene and Public Health is announced in the *Times* of February 12. Hexylresorcinol, as the new compound is named, is the outcome of several years' work by Dr. Leonard, of the National Research Council, in collaboration with Dr. Treat Johnson, professor of organic chemistry in Yale University. It is stated to be a potent antiseptic for the treatment of infections of the kidneys and urinary tract, long-standing infections of the kidneys clearing up under its use in 48 hours. The cures appear to be permanent, and no ill effects were observed.

THE Royal Society has now been notified that His Majesty's Treasury proposes to make provision in the Estimates for 1925–1926 for an increase of the Royal Society Publication Grant from 1000*l.* to 2500*l.* in the current year. This grant is available for helping the publications of other scientific societies as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grants for the current year will be considered by the Council of the Royal Society at its meeting early in July. Applications from societies will be received by the secretaries of the Royal Society; those from individuals should be brought forward by members of Council.

Two noteworthy gifts, for research and for education, are announced by the New York correspondent of the *Times*. A fund of 600,000*l.* has been raised for the establishment at Johns Hopkins University of a centre for ophthalmological research to be called the Wilmer Institute. The General Education Board has given half the money and the remainder has been subscribed by friends and former patients of Dr. William Holland Wilmer, of Washington, who will retire from private practice to assume direction of the new centre. The other announcement is of a gift of 100,000*l.*, by Mr. Cleveland H. Dodge, of New York, to the fund for the Near East Colleges. The institutions which benefit by the gift are the Robert College, Constantinople, the American University of Beirut, the Constantinople Women's College, and other institutions at Smyrna and Sofia. The gift is sufficient to cover a fifth of the working expenses of the colleges for the next five years.

A MEMORANDUM on the probable character of the weather in north-west India in January, February, and March has recently been issued by Mr. J. H. Field, the officiating Director-General of Observatories for the Government of India. The forecast states that "the winter rainfall of north-west India together with the snowfall on the western Himalayas may be expected to be normal or in slight excess." These winter rains are brought by a series of depressions from south-west Europe and the Mediterranean. The tendency for persistence in the winter affords indication for the later months to be based on the weather in December. The application of statistical methods to seasonal forecasting in India has been very definitely studied, and with considerable success. In addition to the factors which have been in use for some time past, another feature which seems likely to prove of importance is the seasonal change of the upper air currents in northern India at a height of 4 miles above ground obtained from observations at Agra.

THE report of the Council of the Optical Society submitted to the annual general meeting of members on February 12 shows that the efforts of the Society to promote and advance the theory and practice of optical science are being well maintained. The steadily increasing interest that is being taken in this subject is evidenced not only by the nature and number of the papers presented to the Society, but also by the interest taken in the Society's Transactions, in which these papers are printed. By means

of special exhibits and demonstrations at recent meetings, attention has been directed to instruments and apparatus of historic interest as well as to modern developments of various optical instruments. The financial position is now so satisfactory that a further extension of the Society's activities is under consideration. The following officers have been appointed for the current session: *President*, Mr. T. Smith; *Vice-Presidents*, Instr.-Comdr. T. Y. Baker, Prof. Archibald Barr, Sir Frank Dyson; *Hon. Secretaries*, Mr. F. F. S. Bryson, Prof. A. F. C. Pollard; *Hon. Treasurer*, Major E. O. Henrici; *Hon. Librarian*, Mr. J. H. Sutcliffe; *Editor*, Dr. J. S. Anderson.

"TAKING a Museum to School" is the heading of an article in the *Manchester City News* of February 7. It describes a scheme which has been inaugurated by the Salford Museum for the distribution to schools of portable cases containing natural history specimens, photographs of trees, types of architecture, furniture, etc. The underlying principle is sound though by no means new. The idea has been greatly elaborated by the American Museum of Natural History, and in 1922, 475 schools were supplied with sets. Of course, in a large museum where the staff is adequate, or when there are official guide lecturers, it were better to bring the classes to the museum. When such is not possible, then exhibits may, with great advantage, be sent to the school. The cases thus supplied may show birds, animals, and so on, which children would not otherwise see, and may encourage them to visit the museum itself and so extend their knowledge. But the great difficulty is the "text" accompanying the cases. Such exhibits placed in the hands of teachers having no special knowledge of the subject may tend to grave misconceptions, whereas a stereotyped lecture may become irksome. Children have a way of asking peculiar questions. Before receiving such cases the teachers should have a "lesson" themselves, given by the person responsible for the exhibit.

ON February 26 occurs the bicentenary of the birth of Nicolas Joseph Cugnot, the French military engineer who built the first vehicle driven by a steam engine. Born at Void in Lorraine in 1725, Cugnot joined the French army, served in the Low Countries, and afterwards in Paris gave lessons in military affairs. In 1766 he published his "Éléments de l'art militaire ancien et moderne" and three years later a volume on fortification. He appears to have made two steam vehicles, the first in 1769 and the second in 1770. The earlier was put into motion in the presence of the Duc de Choiseul, then Minister of War, and of General Gribeauval, and it carried four persons. Its steaming capacity, however, was very small, and it had to stop at short intervals to allow the steam pressure to rise. The demonstration led to the construction of a second vehicle at the Paris Arsenal, and this is now preserved in the Conservatoire des Arts et Métiers. It is doubtful if this vehicle ever ran. Intended for the transport of artillery, it was designed to carry a load of about 4½ tons at a speed of 2¼ miles per hour and cost 800*l*. Though designed by Cugnot it was made by Brezin. General Morin in 1851 gave an interesting account of the machine to the Paris Academy of Sciences. Cugnot continued to reside in Paris until the Revolution, when he went to Belgium. Poverty appeared to have dogged his steps, but under the Consulate he was given a small pension of 1000 livres, and he returned to Paris, where he died on October 4, 1804.

IN a discourse delivered before the Royal Institution on February 13 on the forces of law and order in a primitive community, Dr. B. Malinowski gave an account of his conclusions in regard to primitive law arrived at during his years of field-work among savages in Melanesia. In his opening remarks he referred to the Imperial value of anthropological studies for the government of savage races, and said that such studies must be directed to the actual and practical problems of savage life in order to be useful. The real task of the administrator is legislation and the meting out of justice to the natives, and the most important practical subject of anthropology should be primitive jurisprudence. Upon this question anthropology hitherto has often been silent and sometimes even incorrect. Nothing could be more misleading than the statement frequently made that "all societies have passed through a stage of communal ownership and communistic sexual relation." Taking Melanesia, Dr. Malinowski showed that, in spite of most illusive appearances, the ownership of property is strictly defined and there is no trace of real communism. The so-called communism is the result of the observers looking at native custom through European eyes. Another legal dogma constantly used by some modern anthropologists is: "The clan or kin is the unit in primitive law and not the individual." Exogamy is usually quoted as the most perfect index of the homogeneity of the clan. This again is an illusion. Dr. Malinowski urged that it is in this type of anthropological analysis of savage institutions that the anthropologist can join hands with the administrator in working out a practical science of administrative anthropology.

ARRANGEMENTS are in progress for the next annual meeting of the British Association, to be held in Southampton on August 26-September 2, under the presidency of Dr. Horace Lamb, formerly professor of mathematics in the University of Manchester. Presidents of the several sections have been appointed as follows: *Mathematics and Physics*, Dr. G. C. Simpson, director of the Meteorological Office; *Chemistry*, Dr. C. H. Desch, professor of metallurgy in the University of Sheffield; *Geology*, Prof. W. A. Parks, of the University of Toronto; *Zoology*, Mr. C. Tate Regan, keeper of zoology in the British Museum (Natural History); *Geography*, Mr. A. R. Hinks, secretary of the Royal Geographical Society; *Economics*, Miss Lynda Grier, principal of Lady Margaret Hall, Oxford; *Engineering*, Sir Archibald Denny, Bart.; *Anthropology*, Dr. Thomas Ashby, director of the British School at Rome; *Physiology*, Dr. A. V. Hill, professor of physiology in University College, London; *Psychology*, Dr. C. E. Spearman,

Grote professor of the philosophy of mind, University of London; *Botany*, Prof. J. Lloyd Williams, of University College, Aberystwyth; *Education*, Dr. W. W. Vaughan, headmaster of Rugby; *Agriculture*, Dr. J. B. Orr, head of the Rowett Research Institute, Aberdeen. Among the principal items already set down for discussion are transport problems, to which the Sections of Economics and Engineering will devote two days, with special reference to the railway centenary of the present year; the cost of farming and the marketing of agricultural produce (Sections of Economics and Agriculture); the functional significance of size (Zoology and Physiology); the ignition of gases (Chemistry and Engineering); tidal lands (Geography and Botany); variations in gravitational force and direction (Physics and Geology); recent investigations upon vocational guidance (Psychology and Education); the distribution of animals and plants in relation to continental movements (Geology, Zoology, and Geography); the acquisition of muscular skill (Physiology and Psychology), and discussions on health in schools, the disciplinary value of subjects, the training of teachers, and the teaching of biology. Prof. Parks, of Toronto, as president of the Geological Section, succeeds the late Dr. Willet G. Miller, the Ontario Government mineralogist, who was to have occupied the chair of the Section.

WITH the January number the *Illuminating Engineer* begins a new stage of its existence. Formerly it was merely the official organ of the Illuminating Engineering Society; it has now been extended so as to appeal to a much wider class of reader. This number is brightly written and shows that good methods of illumination are of general interest. During last year no very striking progress was made in inventing new lamps or incandescent mantles, but considerable progress was made in the methods of applying illuminants. It is considered that the time has come to enlighten the public as to what is being done. Playing games by artificial light, lighting developments at the Zoological Gardens in Regent's Park, the psychology of illumination, lighting and tobacco, inadequate lighting and defective vision, illuminated name plates for motor cars, and artistic illumination are only a few of the subjects discussed. We were specially interested in the "possibilities and limitations" of motor-car headlights. It is pointed out that the glancing beam of the headlight does not show to the driver puddles of water in the road. During the floods of December, inability to locate fairly deep water ahead often proved embarrassing. This shows that headlight illumination is far from perfect.

IN our issue of February 14, p. 242, reference was made to an article by Mr. F. W. Shurlock on the Rev. A. Bennet, F.R.S., in the January number of *Science Progress*. Mr. Shurlock writes to point out that the statement that Bennet died at Fenny Bentley is inaccurate. He held the rectory of Fenny Bentley concurrently with the curacy of Wirksworth, where he lived, died, and was buried; a memorial tablet is in the church, on the south wall of the nave.

AN assistant is required in the new chemical laboratory of the City Analyst for Leicester. The work of the person appointed will be mainly in connexion with the analysis of food and drugs, water and sewage effluents. The latest date for the receipt of applications by the Medical Officer of Health, Leicester, is Thursday, March 5.

ERRATUM.—In NATURE of February 14, p. 236, column 2, line 46, for words "that is" read "at all events."

Our Astronomical Column.

THE LUNAR ECLIPSE OF LAST AUGUST.—*C.R. Acad. Sci.* of Jan. 19 contains a research on the brightness of the moon at this eclipse, made by J. Dufay and A. Conder at St. Geniez (height 3500 ft.) in a clear sky. They used the Dufay photometer, which gives results that are independent of the diameter of the body measured. The moon was compared with Mars and Jupiter, the magnitudes of which were taken as $-2{\cdot}6$ and $-1{\cdot}8$. In the following table D is the distance in minutes of the moon's centre from the centre of the shadow, V its visual and P its photographic magnitude, C the colour-index.

D	V	P	C	D	V	P	C
10′	$-0{\cdot}9^m$	.. m	.. m	18′	$-1{\cdot}35^m$	$+0{\cdot}7^m$	$2{\cdot}05^m$
12	$-1{\cdot}0$	$+3{\cdot}2$	$4{\cdot}2$	20	$-1{\cdot}65$	$0{\cdot}0$	$1{\cdot}65$
14	$-1{\cdot}1$	$+2{\cdot}3$	$3{\cdot}4$	22	$-2{\cdot}1$	$-0{\cdot}7$	$1{\cdot}4$
16	$-1{\cdot}2$	$+1{\cdot}4$	$2{\cdot}6$	24	$-2{\cdot}7$	..	..

The increase of red in the centre of the shadow is very noticeable, and was also observed in the telescope, the outer portion of the umbra being greenish grey, the next zone orange-red, the centre brownish red.

The colour-index of Mars was determined as $1{\cdot}37^m \pm 0{\cdot}06^m$. It presumably varies with the character of the markings on the disc at the time.

Comparison was made with the eclipse of Oct. 16, 1921, observed by M. Danjon. It was concluded that the moon in 1921 was four times as bright as in 1924, presumably owing to greater cloudiness in the earth's atmosphere in 1924.

ASTROGRAPHIC ZONE 21° SOUTH (HYDERABAD).—The Hyderabad Observatory (Director, T. P. Bhaskaran) has shown most praiseworthy zeal and energy in completing not only the zone originally undertaken but also the zone $-21°$ to $-23°$, which had been undertaken by two other observatories in turn, but abandoned by both of them. It was thanks to the liberality of the Nizam and his Government that this extension was possible. The present volume contains the measures of stars on the plates the centres of which are in declination 21° south. The average number of stars per plate is 491, a higher average than in previous zones; this is ascribed to improvement in the quality of the plates. Plates were rejected that did not show at least twice as many stars as Schönfeld's map. In the galactic zones, some fifteen times as many stars are measured as are contained in the map, although the measurers were instructed to pass over the very faint stars in these regions.

The catalogue contains the measured diameters, with data for deducing the magnitude, and the x, y co-ordinates to 3 decimals of a réseau interval; also provisional plate constants for reducing to R.A. and decl. The plates in the present volume were exposed between Dec. 1920 and June 1923.

Research Items.

PSYCHO-ANALYSIS AND MOTHER-RIGHT.—In *Psyche* for January, Dr. B. Malinowski concludes his examination of the applicability of the Freudian theory of the Œdipus complex to a society organised on a matrilineal basis. In his previous contribution to this subject (*Psyche*, April 1924) it was shown that whereas under the *patria potestas* the conflict is concerned with father and mother, in the matrilineal family of the Trobriands, it affects the sister and the mother's brother. Turning now to the question of disease and perversion, it appears that among the Trobrianders, where sexual desires are allowed a natural outlet at an early age, perversions and neurotic affections are comparatively rare, while in the Amphletts, where sexual license is repressed, they occur with frequency. The evidence of dreams, distinguishing "free dreams" from "official dreams" of a divinatory or magical character, points to repressed desire in the direction of the sister. This form of incest is regarded with such horror that at first sight it might appear never to occur, but careful investigation has revealed that it does exist. Both obscenity and myth bear this out. Abuse by attribution of mother and sister incest, though both actions are abhorrent to the Trobriand mind, in the degree of resentment it arouses indicates that there is a real temptation to break the strong taboo against the sister. In the same way, throughout the myths of the Trobrianders there runs a strong matrilineal complex; in the tales of origin, no father appears, and when a male member of the family is mentioned in such a manner as to indicate a conflict of some kind, it is the maternal uncle.

THE PROBLEM OF ARISTOTLE.—Prof. Burnet's British Academy "Master-mind" Lecture ("Aristotle," Oxford University Press, 1*s*.) is of more than usual interest, not only to classical and philosophical students but also to men of science. Aristotle's real greatness, Prof. Burnet tells us, was as a biologist. The most important formative period of his life was the middle period, the years when he was lecturing at Assos and afterwards when he removed to Mytilene in Lesbos, where he made his careful observations and studies of marine forms of life. Prof. Burnet refers to the recent important work of Prof. Werner Jaeger of Berlin ("Aristoteles, Grundlegung einer Geschichte seiner Entwicklung"). The conclusions of this book are in accord with Prof. Burnet's own independent studies of the problem, though he differs from the author on some points of minor importance. The curious problem about Aristotle is that scarcely any of the works we possess, and none of the important ones, were published in his lifetime or intended for publication, or in a form in which he would have acknowledged them or consented to their publication. Yet it seems certain that they represent his mature views in a way which his published works did not. They are his written lecture notes, and they have been preserved by a strange accident, while his own published works, by which alone he was known in the first two centuries after his death, are lost. What Prof. Burnet brings out with exceptional clearness is that the contrast between Plato and Aristotle and the latter's criticism of the former's doctrine of forms is explained by the fact that, while Plato was exclusively interested in mathematics, Aristotle's attention was directed towards biology.

TERTIARY MAN IN ENGLAND.—A review of the evidence bearing upon the question of tertiary man in Britain by Mr. J. Reid Moir, appears in vol. xxiv., No. 6 of *Natural History* (American Museum of Natural History). The vast geological age of the Kentian eoliths finds support in East Anglia. There the White Coralline Crag, which is definitely earlier than the Red Crag, was laid down in a warm period, the deposition of the Red Crag beginning with the irruption of arctic waters. The Red Crag detritus contains material of different periods due to denudation, including eoliths of Kentian type, much rolled and abraded, and later forms of which the rostro-carinate is the outstanding implement. The Red, and Norwich Crags, and their underlying detritus bed, represent the first glacial deposit in East Anglia. The Foxhall implements belong to the Crag itself and are clearly later than the detritus bed implements, as is shown in the variation in patination when, as in several cases, the former has been made out of the latter; but implements of the same kind as are found at Foxhall occur at Thorington Hall *beneath* the Crag, where man evidently lived on a surface of London clay instead of Crag. The Cromer implements are to be regarded as Early Chellean, a classification supported by the fauna. In an appended note in the same publication, Sir E. Ray Lankester questions the use of the term "quaternary" to describe the strata later than pliocene, on the ground that they are adequately described as tertiary, as there is no separation of later deposit from pliocene as there is of tertiary from secondary and secondary from primary. The term pliocene should be applied to the White Coralline Crag on the ground of its Molluscan fauna in many respects identical with that of deposits distinguished by the marine "Pliocene"; while the Red Crag should be assigned to the Pleistocene, it being recognised that the shells, bones, and teeth of cetaceans and terrestrial mammals in the Suffolk Bone Bed, which were assigned by Lyell and his followers to the Red Crag, and its sea are derived from earlier strata and are not contemporary with the Red Crag.

THE PLEISTOCENE VERTEBRATE FAUNA OF NORTH AMERICA.—The Carnegie Institution of Washington has published (October 1924) an account, by Dr. O. P. Hay, of the pleistocene vertebrate palæontology of the region west of the Mississippi, a continuation of a previous account which dealt with the regions east and north of the river. The volume deals with the discovery of various groups of mammals, each group being taken separately, and the places where species of the group have been found are detailed in order for each province. More than a quarter of the account concerns the places where Proboscidea have been found, mastodons and, in particular, *Elephas boreas*, *E. columbi*, and *E. imperator*. Other groups detailed are the Xenarthra, horses, tapirs, peccaries, camels, deer, bison, and beavers. Twenty-nine maps illustrate the positions where material has been found, and an index, which is very complete, gives reference both to the animals and their localities. The work will be very useful for reference by any one studying the Pleistocene of North America as well as for purposes of comparison with the corresponding faunas of the Old World in questions of migration and distribution.

CARBONIFEROUS ROCKS IN CENTRAL JAPAN.—A recent issue of the Scientific Reports of the Tôhoku Imperial University at Sendai (vol. viii., No. 1) contains an important paper by Ichirô Haysaka "On the fauna of the Anthracolithic Limestone of Ômimura in the western part of Echigo." The paper has had a chequered career; originally written in 1920, the MS. was destroyed in the Tokyo fire that followed the earthquake of September 1, 1923, and

the whole work has been courageously rewritten since. The locality considered lies on the northern side of the Central Island, almost due north-west of Tokyo. The formations represented by the thick mass of almost vertical limestone, about 2 km. in thickness, there developed probably include the Permian down to the Tournaisian. The fossil fauna comprises Foraminifera (including, of course, the well-known Fusilina), corals, Brachiopoda, Bryozoa, a crinoid, and a very few mollusca. Altogether, 41 species are recorded, but only four are regarded as new, while several are indeterminate. Representative specimens receive illustration on six plates of that standard of excellence which we have come to associate with Japanese productions, whilst there is, further, a map of the district giving the geological details. The author points out that the Lower Carboniferous formation of marine origin is almost absent from continental Eastern Asia—China, Korea and Manchuria—although it seems to be recognised in the province of Yun-nan, and has been reported from Central Asia. What was the relation between the Lower Carboniferous waters of Central Asia and of the eastern border land is, as he remarks, a very interesting question.

CHROMOSOMES OF WHEAT HYBRIDS.—Mr. A. E. Watkins (*Journ. of Genetics*, vol. 14, No. 2) has made an important investigation of the chromosome behaviour in certain hybrid wheats. From earlier work of Sakamura, Kihara, Sax and others, the wheats are known to fall into three groups having chromosome numbers which are different multiples of 7. An intensive study was made of the chromosome distribution in the pollen mother cells of F_2 and F_3 plants derived from crossing Rivet wheat (*Triticum turgidum* var. $2n=28$) with varieties of *T. vulgare* ($2n=42$). The F_1 plants have 35 chromosomes, and two plants from later generations were especially studied, one having 31 chromosomes ($14\times2+3$) and the other 38 ($=17\times2+4$). The history of the unpaired chromosomes is followed and the mathematical probability of the various types of pollen grains which will be formed, based on random distribution, is worked out. From these observations and those of Kihara, it is found that plants with less than 35 chromosomes never have more than 14 bivalents, and in plants with more than 35 chromosomes the sum of the number of bivalents and univalents is always 21. One tentative explanation offered is that in these hybrid plants only pollen grains with 14 or 21 chromosomes function. There is evidence from other plants that the unpaired chromosomes are frequently or usually lost.

THE CARBON BLACK INDUSTRY.—A few years ago the carbon black industry of the United States was one of the minor "side-lines" of natural gas production, and some peculiar state legislation very nearly killed it altogether, especially in Louisiana. A new demand for this commodity, however, has arisen and has influenced operations to such an extent that the output for 1923 (during which year 138,262,648 pounds were produced) represented an increase of 104 per cent. over that obtained in the previous year. The cause of this remarkable spurt is the demand by the rubber companies manufacturing pneumatic tyres for motor vehicles; carbon black is thus employed with considerable advantage both to manufacturer and to user. Mr. G. B. Richardson, in Mineral Resources of the United States, 1923, part 2, gives figures to show that the average yield per thousand cubic feet of gas is 1·3 pounds of carbon black, and the estimated quantity of gas used for the purpose in 1923 was 109,096,000 thousand cubic feet. Louisiana, the most important producer in America, was responsible for practically 75 per cent. of the total amount, West Virginia and Kentucky yielding the next largest outputs. It is interesting to note, however, that during the latter part of 1923 a state of over-production of this substance was reached, and as this corresponds with a period of great activity in the pneumatic tyre industry, we may gauge to some extent the possible economic limit to the manufacture of carbon black for this purpose and to the expansion of the industry. The price of carbon black at the plant averages about 8·5 cents per pound.

PHYSICAL CONSTANTS OF ICE.—The specific heats and latent heats of fusion of ice have recently been determined by O. Maass and L. J. Waldbauer (J. Amer. Chem. Soc., Jan. 1925). The method used enabled measurements to be carried out at low temperatures. The specific heat of ice, determined at ten-degree intervals from $-180°$ to $0°$, was found to be accurately represented by the equation: $c=0{\cdot}485+0{\cdot}000914t-0{\cdot}00000546t^2$; the latent heat of fusion is 79·42 cal. per gram. The specific and latent heats of some organic liquids were also determined; the results indicate that atomic heat is a highly constitutive property when the specific heat of a compound varies greatly with the temperature.

THE SUN AND ATMOSPHERIC ELECTRICITY.—In the March and December 1924 issues of *Terrestrial Magnetism and Atmospheric Electricity*, Dr. Louis A. Bauer has collected together and discussed the observations on atmospheric electricity made on undisturbed days during the past seven sunspot periods. He concludes that the atmospheric potential gradient and its daily and seasonal variations, and the air-earth electric current, are influenced by sunspots. As a rule the gradient and the ranges of its daily and seasonal variations are increased about 30 per cent. by the change from minimum to maximum sunspot frequency, but there have been periods in which they have decreased, and in these periods terrestrial magnetic activity has also decreased. The gradient and the ranges of its variation are greatest near the equinoxes and least near the solstices.

GUN WIRE.—The system of wire-winding of guns first proposed in 1855 was introduced about 1890 with the object of effecting a distribution of the firing stresses in a more uniform way than could be attained by shrinkage alone. The steels employed usually contained from 0·6 to 0·7 per cent. of carbon, and British gun wire is in the form of a tape or ribbon 0·25 in. wide by 0·06-0·04 in. thick with rounded edges. The steel is severely cold-worked, and exhibits a comparatively low elastic limit in spite of its high tensile strength, but it has long been recognised that this condition of imperfect elasticity in the wire under tension can be removed by a low temperature heat treatment. We have received from the Research Department, Woolwich, R.D. Report No. 60 entitled "Gun Wire. The Effect of Low Temperature Heat Treatment on the Properties of Cold-Strained Steel and Its Behaviour under Stress at Raised Temperatures." The work described was undertaken with the object of providing a material which would maintain a condition of constant stress with constant strain at a given temperature whatever the variation (within certain limits) of strain and temperature to which it was subjected in use. The author, Dr. Greaves, as a result of his investigations, concludes that if it is required to ensure a constant tension in the wire at atmospheric temperature, in

spite of considerable variation in the temperatures to which it may be subjected in use, the wire must be heat-treated at a temperature not below 200° C. The lower limit of the temperature of preliminary treatment (in excess of 200° C.) is fixed by the fact that it must be above any temperature to which the wire is likely to be subjected in use. On the other hand, the upper limit of temperature of treatment is governed by the tension which is to be maintained The higher the tension the less must the temperature of the treatment exceed 200° C. The report contains data from which the relation between stress, temperature, and preliminary treatment of the wire can be determined.

A VECTOR-TROLLEY APPARATUS. — Anything that makes the principles of mechanics more obvious to the student is sure of a hearty welcome from all teachers of the subject in schools and at universities. Considerable interest, therefore, attaches to the "Vector-trolley" apparatus designed by Mr. E. J. Atkinson, of the Harrow County School, and exhibited recently at the annual meeting of the Mathematical Association, and at the Royal Institution. The method is based upon the principle of the well-known problem in mechanics, where two masses, one

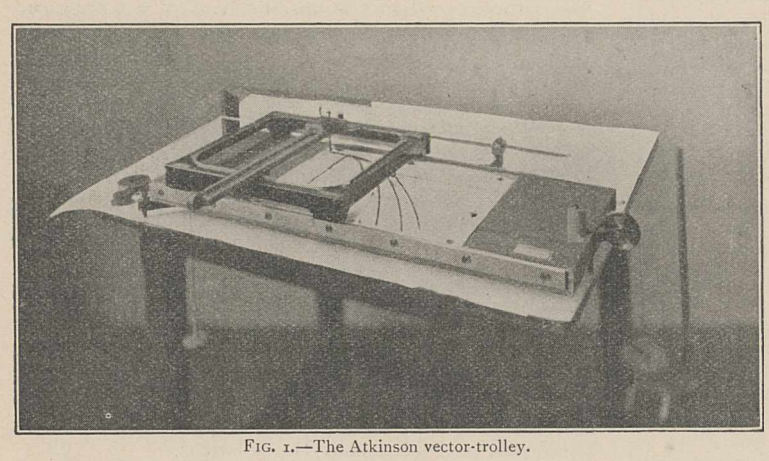

FIG. 1.—The Atkinson vector-trolley.

moving on a horizontal table and the other falling vertically, are joined by a string passing over a fixed pulley. The motion is one of uniform acceleration, even if friction and the mass of the pulley are taken into account. If in this way motion is given to the mass on the table, and the hanging mass is disconnected from it, then, assuming smooth running, the mass on the table can be taken to move with constant speed for some considerable time. The application of this principle by Mr. Atkinson is made clear by means of the accompanying illustration (Fig. 1), from which it is seen that two such accelerated or uniform motions in different directions are communicated to a registering instrument simultaneously. The angle between the two motions can be adjusted at will. Propositions like the parallelogram of velocities and of accelerations, the relationship $P = mf$, parabolic motion of the projectile, the theory of relative motion, can all be illustrated simply and convincingly. Mr. Atkinson's method is very straightforward. The mechanism is easily understood, and both the teacher and the student should find the use of such a mechanism of considerable value. The apparatus is being manufactured by Messrs. Cussons, Ltd., of Manchester.

FORGING TEMPERATURE OF STEELS.—It is well known that, in the case of steel, forging is most effective at a certain favourable temperature which is neither too high nor too low. This is called the forging temperature. As yet no method has been discovered for measuring the forgeability of a metal. Prof. Kotaro Honda has addressed himself to this problem, and in the eighty-first report from the Research Institute for Iron and Steel and other Metals, Sendai, entitled "On the Forging Temperatures of Steels," he concludes that forgeability can be adequately measured by the elongation obtained in a testing machine. He gives reasons for considering that the mechanism of the elongation due to longitudinal tension and lateral compression must be the same, and finds that, in the case of carbon steels, the elongation temperature curve has generally two maxima and two minima. The temperatures of the maxima are at 760° and 1200° C., this latter being the temperature most favourable for forging. The temperatures of the minima are at about 900° and 300°. Hence in the process of forging low carbon steels, every precaution must be taken against a fall of temperature to 900°, where the elongation is at a minimum. In the case of medium carbon steels this minimum is inconspicuous, so that the cooling of the specimen is not so critical. The investigation of a high speed tool steel containing 18 per cent. of tungsten showed that the elongation temperature curve has maxima at 800° and 1100° and a minimum at 950°. The maximum at 1100° is very sharp, and hence in high speed tool steels the temperature range favourable to forging is very limited.

ACTIVITY NUMBERS OF HYDROCHLORIC ACID. — The activity coefficients and transport numbers of hydrochloric acid solutions in ethyl alcohol are described in two papers by H. S. Harned and M. E. Fleysher, published in the Journal of the American Chemical Society for January 1925. The activity coefficient and activity of the acid are about one hundred times greater in alcoholic than in aqueous solutions. The cation transport number, determined by measuring the E.M.F. of the concentration cell $Ag/AgCl/HCl(c_1)/HCl(c_2)/AgCl/Ag$, was found to be 0·654 for 0·1N, and 0·610 for N solutions. These figures are in agreement with the results of Lapworth and Partington (1911). Measurements were also carried out in aqueous alcoholic solutions of the acid.

MICROSCOPE LAMPS. — Several novel and useful types of microscope lamps and illuminating apparatus, suitable for routine work, for micro-projection, and for dark ground and critical illumination, are described in a catalogue recently issued by Messrs. Ogilvy and Co. from their new address at 20 Mortimer Street, London, W.1. Included amongst these is the Hartridge-Williams axial illuminator. This consists of an electric lamp of suitable design enclosed in a ventilated chamber, which can be fitted to any pattern of microscope. The illuminator when fitted forms an integral part of the microscope, occupying the usual place of the mirror. By its use, errors due to polarisation or double reflection from a mirror are avoided and a light source, invariable in position, shape and character, is obtained. No external lamp or bull's eye is required, and adjustments once made are not affected by inclining the microscope or moving it about. The illuminator is fitted with an iris diaphragm which limits the area of light on the specimen to the field of the eyepiece.

Chemistry in India.

DR. M. O. FORSTER, in his address to the twelfth Indian Science Congress, has preached a sermon which is not likely to be forgotten by those who were privileged to hear it or by those who have had an opportunity of reading it. Phrased in the happy manner which came to many as a revelation on the occasion of his address to Section B of the British Association at Edinburgh, it deals with numerous fundamental and intimate questions which are exercising the minds of many thoughtful men and women at the present time. Probably no one can do this kind of thing quite so well as Dr. Forster, for he enhances his constitutional optimism by a flow of language which overwhelms the pessimist and carries the reader from the start to the finish along a smooth stream of pleasing rhetoric, past a countryside replete with all that is beautiful and satisfying, only dallying here and there to point out to the traveller some piece of Nature's handiwork more entrancing than the rest, or pausing to express a feeling of admiration for the manner in which scientific man has acquitted himself. It is only afterwards that the reader, whose mind, after his journey, will be in a pleasant condition of altruistic confusion, will wonder what it is all about. If he is an incorrigible pessimist, and wishes to retain his sanity, he will be well advised to let the first impression stand and not to examine more closely into the nature of the raw material from which Dr. Forster has woven his fascinating fabric. If, like most of us, he is a man of the world without any unhealthy bias towards extreme optimism or extreme pessimism, but, taking things much as he finds them, bestows neither premature praise nor expresses hasty condemnation, he will find much with which he can agree and a great deal to inspire thought and contemplation.

To Dr. Forster's audience the address should be of inestimable value, for India needs scientific stimulation and inspiration far more than any other country of her importance in the world. Her immense natural resources and the mental calibre of her races ought to ensure her a foremost place, both scientifically and commercially, among the nations; yet she remains chained and fettered, and probably only one in a million of her inhabitants will be in a position to take to heart the message Dr. Forster sends them. Nevertheless, conditions are changing for the better, and the past twenty years have marked a notable advance in the scientific status of the Indian Empire.

The far-sighted vision of an exceptional man led to the founding of the Indian Institute of Science at Bangalore, but it was not until eleven years after the inception of the scheme that all difficulties were removed and the vesting order was signed. Meanwhile, the first director, Dr. M. W. Travers, had been appointed and had drawn up the necessary plans for the organisation and equipment of the new Institute. It is undoubtedly due to the devotion and, indeed, self-sacrifice of Dr. Travers that the scheme assumed definite shape, and that the buildings and laboratories were ready to receive the first students in July 1911. Slight changes in the original organisation were afterwards made, and at the present time there are three chief departments, namely, those of electrical technology, general and organic chemistry, and biochemistry; there is, moreover, a large central building in which the offices and library are housed, the excellence of the latter being due to the organising ability of Mr. C. F. H. Tacchella. After the retirement of Dr. Travers in 1914, the post of director was held by Sir Alfred Bourne until 1919 when, after Dr. Alfred Hay had acted as officiating director for two years, the present holder of the office, Dr. M. O. Forster, was appointed.

It was probably inevitable that, during its earlier years, the Institute should have devoted itself to many *ad hoc* problems arising out of the then existing conditions of Indian manufactures. The intention of the founder had been to establish a post-graduate university institution having for its particular object the promotion of advanced study and original research, with special regard to the educational and economic interests of India, but, at that time, advanced education in India was not in a condition to supply a sufficient number of properly trained post-graduate students, and, in those early days, it must have been exceedingly difficult to find the right men to carry out the fundamental research upon which to base the many important industries of the country. Still, in the efficient hands of Dr. Sudborough, Dr. Fowler, Dr. Watson, and Dr. Hay, much was done, and the early record of the Institute bears witness to the fact that, despite the obvious difficulties, the research work accomplished supplied material for the improvement of many industries which had hitherto been built on the rule-of-thumb and traditional methods so characteristic of Indian manufacturing procedure as a whole.

The appendix to the fifteenth annual report of the Council of the Institute, dated 1924, is now to hand, and it is evident, from the comprehensive list of investigations which the report shows are being carried out by the three departments already mentioned, that important research work of a fundamental character is being pursued. The lists are indeed pleasing to read and will stimulate Indian graduates to enter the Institute in order to obtain that training in research methods which not only broadens the outlook, but, without which, it is useless for any chemist to hope to achieve real success in industrial work. For knowledge derived from lectures and books cannot supply the vision, the independence of thought, and the honesty of purpose which are essential to the development of the scientific soul, and Indians would do well to learn the lesson some of their confrères in the west find difficult to assimilate, which is embodied in the address given by Dr. Forster at Benares.

JOCELYN THORPE.

Local Natural History in Great Britain.[1]

LOCAL scientific societies have their distinct and special place, with its incumbent responsibilities in the scientific life of the country, and it is well that this important fact should not be overlooked, particularly by the societies themselves. These, it is to be feared, do not always appreciate their obligations to organise and carry through schemes of scientific work which obviously come within their province. Intensive investigations, both systematic and ecological, of the fauna and flora of the country are problems pre-eminently suited to the activities of local societies. In fact, it will be only by the active co-operation and organisation of such societies that

[1] The North Staffordshire Field Club: Transactions and Annual Report, 1923–24.
The South-Eastern Naturalist, being the Proceedings and Transactions of the South-Eastern Union of Scientific Societies for 1924.
The Liverpool Geological Society: Proceedings, vol. 14. Part I., session the sixty-fifth, 1923–24.

it will ultimately be possible to complete our knowledge of these matters.

It is, therefore, with particular pleasure that we direct attention to Mr. L. A. Carr's paper on "The Ichneumonidæ of the Lichfield District, Staffordshire," in the first of the three volumes of annual reports and transactions here noticed, as an admirable example of the kind of work which can and should be attempted by all local societies.

In the course of only eight years' intensive and constant work, Mr. Carr has collected and identified no fewer than 1255 species of this difficult and much neglected group of insects. We do not overlook the work of Mr. Claude Morley and other isolated workers in this field, but obviously the few experts available in Great Britain cannot be expected to cover the whole ground unaided, even if the exigencies of time and expenses for travel could be met. Responsible local workers, like Mr. Carr, are required for all branches of zoology and botany, who, by their own enthusiasm, or aided by the organisation of their local societies, will make themselves responsible for one small part of the field of natural history in the immediate neighbourhood in which they live, and by care, patience, and steady work gradually get together the necessary data from which a true and accurate knowledge of the British flora and fauna can be obtained. Mr. Carr's paper is abundant evidence of the need for such work. No fewer than 335 species in his list are recorded from the British Isles for the first time, and sixteen of the species are new to science. Mr. Carr has had his identifications confirmed and his material examined not only by Mr. Morley but also by Profs. Habermehl and Schmiedeknecht and other leading authorities on the continent. His list is thus authoritative and forms a very valuable contribution to British zoology. Research of this kind is being done widely throughout Great Britain, but we would especially plead for more co-ordination and co-operation in such work by the local societies and urge upon them the example of Mr. Carr's work.

The smaller and less wealthy local societies have received much encouragement and stimulation by their affiliation to form larger bodies, of which the Yorkshire Naturalists' Union is so splendid an example. This and other similar bodies, like the recently formed Union of South-Western Societies, the South-Eastern Union of Scientific Societies, the Lancashire and Cheshire Fauna Committee, and the Faunal Survey of Glamorgan, are attempting to systematise research among affiliated societies and to carry it out on the broad lines suggested above. We should like to see this principle of larger unions extended to embrace the whole country, so that with the local societies affiliated to their proper union, and the unions in turn affiliated to one or other of the scientific societies in London, or, as now, to the British Association, a complete organisation would be brought into being for the thorough co-ordination of the work of local societies.

The unions perform another and perhaps equally important function in bringing the results of scientific research before the general public of the areas they represent, by holding annual congresses at which leading men of science deliver addresses on the special subjects of their own work. The annual volume issued by the South-Eastern Union of Scientific Societies for 1924 gives an account of its annual congress held at Guildford last year, at which Sir Richard Gregory presided and delivered an inspiring address on "Science in Civilisation," in which he sought to revive the belief in the power of science to promote spiritual and material progress and to plead for the fuller recognition of what it has done for the benefit of man. Among the sectional addresses delivered at this congress may be mentioned "Evolution and Eugenics," by Dr. A. F. Tredgold; "The Educational Value of Regional Survey," by Sir F. G. Ogilvie; "Some Remarks on Adaptation," by Dr. A. B. Rendle; and "Modes of Protection in the Pupal Stages of Butterflies and Moths," by Prof. E. B. Poulton.

It is impossible to estimate the value or to overemphasise the importance of the work which the larger unions are doing by this means. A direct link is established between the local societies and scientific workers of the first rank, and the stimulus which the former receive as the result of this contact must largely influence their members and encourage them in the work they are seeking to do.

From the same report we learn of another branch of work which the South-Eastern Union is endeavouring to do, namely, the compilation of a card catalogue of all faunal records for the area, with full notes of all localities. Such bibliographical work is important and useful, and we are glad that the Union, as well as other similar bodies, is alive to the necessity of doing it.

An admirable example of the work done by a local society in one special field is provided by the first part of vol. 14 of the Proceedings of the Liverpool Geological Society here noticed. The seven papers which go to make up this volume include the results of original research by members of the Society, and four of them deal exclusively with aspects of local geology, to the elucidation of which they form a most valuable contribution.

The three publications under notice give ample evidence of the importance and real value of the work of the societies publishing them. They are representative of the work carried on by kindred societies all over Great Britain, and they provide a splendid example to others of the results which can be obtained by organised research, and the scope of the research which local societies can profitably and creditably pursue.

Artificial Incubation.

TWO articles on "The Scientific Principles of Artificial Incubation," by Mr. Llewelyn B. Atkinson, which are of interest to biologists and physicists and of considerable importance to the poultry farmer, have appeared in the Journal of the Royal Society of Arts, November 28 and December 5, 1924.

In Egypt, China and Malay, natural methods of hatching have been replaced successfully by artificial for thousands of years, but among Western peoples the problem of artificial incubation was only solved so late as 1882, when Hearson produced his incubator with a capsule temperature regulator. The Chinese plan is described in "Farmers of Forty Centuries" by Prof. King of the University of Wisconsin, and it is claimed that with this apparently crude method 95 to 98 per cent. of the fertile eggs are hatched. By the Egyptian method described by Capt. Cadman at the Harper Adams Poultry Conference, 1923, 85 to 90 per cent. of the fertile eggs are hatched. Using modern European and American incubators, there is an all-round hatching efficiency not greatly exceeding 55 per cent. of the fertile eggs, though there are plenty of hatches up to 85 to 90 per cent. It is accepted that incubator-hatched chicks compare very unfavourably with those reared by the mother hen, and that the troubles attendant on artificial incubation do not end with the hatching.

Mr. Atkinson sets himself the task of finding why it is

that with far more delicate arrangements than a hen provides, the results obtained by the use of the incubator do not always equal those given by the sitting hen. He concludes that an incubator which will do all that the best hen does and do it regularly and with certainty, is a perfectly realisable instrument. He gives very full details of the physical and biological factors involved in incubation, drawn largely from the results of his own experimentation, and the conditions underneath the sitting hen are compared in detail with those that exist within the various types of standard incubators. The outstanding conclusions at which he arrives are that practically every type of incubator has the air too dry; that the average temperature of the eggs in an incubator is much more regular than in a hen's nest; and that, whereas in modern incubators the whole of the egg is nearly of the same temperature, the temperature of the top being only slightly different from that of the bottom, in the hen's nest the difference between the temperature of the hen's body in contact with the egg and the temperature of the lower surface of the egg is between 14° and 20° F.

From these observations the author concludes that the secret of successful incubation lies in keeping the upper surface of the egg hot and the lower surface relatively cool. This object is attained by covering the upper surface of the eggs with a very thin sheet of india-rubber. The use of this in a hot water incubator, in which the heat reaches the eggs by radiation, is rendered extremely difficult by the fact that the temperature of the tank has to be raised to a most inconvenient degree. In the case of the hot air type of incubator, however, it is quite simple to get a difference of 14° F. between the top and the bottom of the egg by the use of this rubber sheet. It was found also that with this method rapid evaporation of moisture was prevented and that, in fact, the amounts of moisture and carbonic acid around the eggs were nearly those present in a hen's nest. Using this method, an incubator which previously had rarely given more than 55 per cent. hatched more than 95 per cent. of the fertile eggs. It is to be noted that the application of heat to the eggs is by direct contact and conduction instead of by radiation or convection. Every egg becomes its own regulator, controlling the passage of the heat from the upper surface of the egg to the cooler under surface. Mr. Atkinson states also that the chicks emerging from an incubator provided with this rubber sheet are far more viable.

The Blue Whale.

MR. GERRIT S. MILLER'S paper, "Some hitherto unpublished photographs and measurements of the Blue Whale" (Proc. U.S. Nat. Mus., Vol. 66, pp. 1-4, Pls. i.-ix.) is a welcome contribution to the literature of Cetacea. In spite of its predominating importance to modern whalers, the blue whale (*Balænoptera musculus*) is still imperfectly known, particularly with regard to cranial characters. Mr. Miller publishes specially good figures of the skull, the rostrum of which has not suffered from the warping which commonly occurs on drying. He informs us that the specimen (Washington Museum) was an adult male, 75 feet long, captured off Newfoundland in 1903; but it may be remarked that the free condition of the distal epiphyses of the radius and ulna figured in Pl. viii. is evidence that the animal had not completely passed the adolescent stage of Flower, and that in any case 75 feet is a small measurement for a really adult blue whale. The digits shown in the same figure appear to be too straight, and the hand is probably a reconstruction of a disarticulated flipper, as indicated by the fact that the numbers of the phalanges are low as compared with other records.

Mr. Miller makes no comparisons, and his facts must speak for themselves. With regard to the skull, the rostrum deserves special notice, its sides being parallel in its posterior half, then converging in a gentle curve to the tip;—in striking contrast with the triangular, straight-sided rostrum of the fin whale (*B. physalus*). The premaxillæ are noticeably parallel behind, instead of being arched outwards. The postero-internal processes of the maxillæ are long, the orbital plates of the frontals diminish greatly in diameter in passing outwards, and the nasals are stout and broad. The palatines have parallel sides, and in the side view the straight outer edge of the maxilla and the outline of the vertex are other features in which this skull differs from that of a fin whale. Excellent figures are given of the atlas, axis, sternum, pelvic bones and scapula, the last showing the restored cartilaginous parts. As bearing on the great variability of the bones in the larger Cetacea it may be noticed that the sternum differs conspicuously from those figured by True in 1904, as well as from that of the Longniddry whale described by Turner. The long series of measurements of bones will be valuable as material for comparison with southern blue whales, the identity or otherwise of which with the northern species it will be the special object of the *Discovery* expedition to investigate. S. F. H.

University and Educational Intelligence.

BRISTOL.—A research assistantship is open at the Merchant Venturers' Technical College to candidates with an honours degree in engineering. Applications should be made to Prof. A. Robertson at the College.

CAMBRIDGE.—Mr. Arthur Berry has been elected vice-provost of King's College. A new post of assistant director of magnetic research at the Cavendish Laboratory, without stipend from the University, has been established for Dr. P. Kapitza, Trinity College.

By a recent vote of the Senate, the University is to ask the Commissioners to remove from the statutes the paragraph under which certain holders of official positions, such as bishops, heads of house, and privy councillors, can at present be granted degrees *honoris causa* in virtue of the positions that they occupy. University and college teachers and officers are still to be eligible for the degree of Master of Arts, and the University retains its powers to grant honorary degrees to members of the Royal Family, to British subjects who are of conspicuous merit or have done good service to the State or to the University, and to foreigners of distinction.

Dr. Haddon is resigning from the readership in ethnology.

The vice-chancellor, Dr. Fitzpatrick, president of Queen's College; Dr. Giles, master of Emmanuel College; Mr. F. J. M. Stratton, Gonville and Caius College; and Mr. R. E. Priestly, Clare College, have been appointed delegates at the coming conference of the universities of Great Britain and Ireland.

Sir R. H. Biffen, St. Catharine's College; Mr. R. Adie, Trinity College; Mr. F. L. Engledow and Mr. C. W. B. Wright, St. John's College, have been appointed to represent the scientific workers on the Station Committee of the Horticultural Research Station, while Messrs. W. P. Seabrook, A. G. Daniels, and A. T. Paskett represent the fruit and vegetable growers.

Notice has been given that an election will be made next July to the Charles Abercrombie Smith Studentship of 150*l.* a year at Peterhouse. Every candidate must be or must become a research student, proceeding to the degree of Ph.D. The studentship is normally for two years and may be renewed in exceptional circumstances for a third year.

DURHAM.—The seventh Earl Grey memorial lecture will be delivered at Armstrong College on Thursday, March 5, at 7.30, by Dr. F. W. Aston, on "The Structural Units of the Material Universe."

Applications are invited for the professorship in botany at Armstrong College. The latest date for the receipt of applications (in each case ten copies) is May 15. They should be sent to the Registrar of the College, Newcastle-upon-Tyne.

LONDON.—The two following courses of free public lectures at the Royal School of Mines are announced: "Chemical Combination in Metallic Alloys and its Nature," by Prof. C. A. Edwards, at 5.30, on March 3, 4, 10, and 11; and "Tubbing Deep Shafts" and "Subsidence," by Prof. L. Denoël, at 5.15, on March 16, 17, 18, and 19. Free public lectures will be delivered at University College as follows: on March 4, 11, and 18, "Nutrition of the Young Animal," by Prof. T. B. Wood, and on March 9 and 11, "Vital Statistics," by Prof. H. Westergaard. The lecture hour in each case will be 5.30.

MANCHESTER.—Messrs. Brunner, Mond and Co., Ltd., have continued their grants in aid of research in the Departments of Physics and Chemistry.

The Council has adopted regulations for the award of the Philip Buckle Research Scholarship in agricultural zoology. This scholarship has been endowed in memory of the late Philip Buckle by his brothers and sisters.

Mr. J. C. Oakden has been appointed assistant lecturer in mechanical engineering in the Faculty of Technology.

THE City of Cardiff Education Committee will shortly appoint a head of the department of physics of the Cardiff Technical College. Applicants for the post should send 20 copies of their applications and testimonials on or before Saturday, February 28, to the Principal of the College.

APPLICATIONS are invited by the Manchester Municipal College of Technology for the position in the college of lecturer in the chemistry of fermentation processes. Particulars of the appointment and a form of application may be obtained from the Registrar. The latest date for the return of the completed form is March 14.

THE Commonwealth Fund, 1 East 57th Street, New York, was founded in 1918 by Mrs. Stephen V. Harkness "to do something for the welfare of mankind" and is a philanthropic institution which has already made some noteworthy gifts. It is now announced that twenty fellowships a year in American universities, each of the value of about 600*l.*, have been established for British graduates by the Fund. The fellowships will be tenable for two years, and election will be by a committee of award consisting of Sir Walter Robert Buchanan-Riddell, Bt., Principal of Hertford College, Oxford (chairman); Sir Hugh Kerr Anderson, Master of Gonville and Caius College, Cambridge; Sir James Colquhoun Irvine, Principal of the University of St. Andrews; Sir Theodore Morison, Vice-Chancellor of the University of Durham; and Prof. T. Percy Nunn, Principal of the London Day Training College. The Prince of Wales has consented to become honorary chairman of the committee. The general object of the fellowships is to promote international goodwill and generally to foster unity of thought and purpose in the United States and Great Britain. The awards will therefore be made on the basis of character, ability for leadership, health and general fitness, and on the nomination of recognised universities of Great Britain and Ireland.

MR. H. SIMPSON GEE, of Knighton Frith, Leicester, who died last July, bequeathed to University College, Leicester, of which he was honorary treasurer, 20,000*l.* free of all duties, to found "The Simpson Gee Endowment Fund." Under the provisions of the will the executors could have deferred payment of the legacy for three years, but they generously offered to discharge the legacy forthwith and give the College the option of taking over certain specified securities of a full trustee character at the "market price" of the day. This offer the College Council gratefully accepted, and as a consequence trustee stocks of this value have been transferred, by which the endowment income of the College has been augmented by 980*l.* per annum. Other gifts recently received are:—2000*l.* from Sir Jonathan North, chairman of the College Council (by which his donation to the General Endowment Fund has been brought up to 5000*l.*), and 3000*l.* from Messrs. Stead and Simpson, Ltd., to the fund for endowing lectureships in chemistry and physics. Leicester University College, although brought into existence in 1921 during the post-War economic depression, has, nevertheless, in addition to the finest site in Leicester, on the top of the city, and large and beautiful buildings and college gardens, valued at 150,000*l.*, obtained an invested endowment fund which has just completed its first 100,000*l.* In addition, it receives an annual grant from the city of Leicester. By the beginning of next academic year, it will have teachers in all the main subjects of university study, unusually adequate equipment in laboratories, and a library of 9000 volumes.

THE annual distribution of prizes was held at the Sir John Cass Technical Institute, Aldgate, London, E.C.3, on Tuesday, February 10, when the prizes and certificates were distributed by Mr. S. O. Nevile, past-president of the Institute of Brewing. The chairman of the governing body, the Rev. J. F. Marr, in giving a summary of the work of the Institute, stated that although the courses of study at the Institute are principally conducted in the evenings, no fewer than 36 students were successful at the examinations of the University of London during the past session, two of whom obtained the degree of Ph.D., and three the degree of M.Sc., by research. In addressing the students, Mr. Nevile stated that institutes such as the Sir John Cass Technical Institute supply two urgent needs of modern industrialism: they offer opportunities for advanced scientific education and training in research, and they enable those engaged in the minor ranks of industry to obtain a knowledge of the principles which underlie their daily work and a broader conception of their industry as a whole. The technology of brewing comprises—first, the production of the raw materials; secondly, the treatment of those raw materials to provide a satisfactory extract; and thirdly, the process of fermentation itself. Pasteur must be regarded as the father of the modern conception of fermentation as applied to the brewing and wine industries. Our knowledge of hops and barley is still very incomplete, and the research scheme of the Institute of Brewing is largely concentrated on these two main fundamental issues.

Early Science at Oxford.

February 22, 1683–4.—A letter from Mr. Aston dated Feb. 14 was read, which gave an account of an experiment lately shewn before ye Royal Society by Mr. Paget, viz. ye south pole of ye inclinatory needle followed ye flame of a quarter of a sheet of paper, 5 degrees, ye side of ye box being very little hot; ye inclinatory needle was hung in ye plane of ye meridian; ye North pole shunned ye flame.—With regard to a fountain in Poland, that is said to follow ye motion of ye Moon, is cold to ye touch, and yet easily inflammable, Dr. Plot informs us, that there is a spring in Lancashire, which, though cold, takes fire, and will harden eggs.

Concerning ye Lough-neagh stone, it was ordered, that ye Gentlemen of ye Society of Dublin should be desired, that they would be pleased to impart their thoughts concerning it, ye manner of its being made such, and of what materials it may be made.

1686–7.—Mr. Halley sent accounts (1) of Mr. Hooke's hypothesis concerning ye changes which seem to have happened in ye surface of ye Earth, from ye shells in beds found petrified in ye Alps, and other hills far from, and above ye sea; and again sea sand and shells, found at great depths underground. (2) Of an experiment of flint and steel in vacuo; which was that there were no sparks visible from ye collision, though they were very vivid in ye same receiver when ye air was admitted. (3) Of a very strange effect of lightning from France, viz. that something in it pierced through a piece of glass, making some holes about ye bignesse of pistol bullets, and melting ye edges of ye glass making it smooth like ye edges of a cup. (4) That ye French in Canada have found a whole mountain of lead ore, which lies bare; so that there is no need of mining.

Whereas Mr. Hooke thinks that there are not extant any authentic records of ye latitudes of places sufficiently to evince ye fixation of ye Poles, Dr. Bernard observes that ye latitude of Marseilles, taken by Pythias, in ye time of Alexander ye Great, appears to be ye same as 'tis now, and that in ye latter end of Julius Ffirmicus, is an observation of ye latitude of Oxford, taken about a hundred years since.

Mr. Lhwyd communicated ye following curiosities, sent out of ye Isle of Anglesey together with a collection of sea plants and shells:—Eggs of Skate and Dog-fish, *Favus marinus Sibbaldi*, and a broad leaved *Fucus* which had a facing of fine silk in appearance, and was all over garnished with small filaments standing upright, about an eighth of an inch long; much resembling ye stamina of flowers. This surface was easily scraped off, and was supposed to adhere to this plant after ye same nature that mosses, lichens, fungi, and such other vegetables adhere to stones, trees, bones, horns, etc.

February 23, 1685–6.—A discourse concerning sounds and echoes, drawn up by Mr. Walker, was by him communicated and read.—Dr. Plot communicated some shells, *Buccina*, in which ye spirals turn to ye left.

February 24, 1684–5.—A Horn was communicated by Dr. Plot, said to be a horn, which grew behind ye head of a woman, who was shewn in London about fourteen years since, and is reported to have shed her horn once in three years. This was sent by Mr. Ashmole to be laid up in his Repository.

A letter from Dr. Howman, dated Norwich Jan. 27, gave an account of a hydrophobia in an alderman of Norwich, caused by ye bite of a mad fox. Mr. Walker affirmed, that about fifteen years since a person died mad in Cheshire, having been bitten by a mad cat, which received its madness from ye bite of a mad dog.

Societies and Academies.

LONDON.

Royal Society, February 12.—H. Muir **Evans**: A contribution to the anatomy and physiology of the air-bladder and Weberian ossicles in Cyprinidæ. In Cyprinidæ the air-bladder is constricted, so as to form an anterior and posterior chamber connected by a short duct. The Weberian mechanism is designed to conduct vibrations and not to register variations of pressure. The nerve-ganglion regulates tension of anterior sac and thus allows it to receive vibrations: it controls the sphincters and prevents undue lowering of tension when the pneumatic duct is open, and excess of tension due to pressure of gas in the posterior sac.—J. S. **Huxley**: Studies on amphibian metamorphosis. II. It is not always possible to induce metamorphosis of the axolotl by enforced air-breathing in a considerable number of specimens. This may be due to genetic differences between strains. When axolotls are so treated the dorsal fin falls over and fuses completely with the skin of the back. By using urethane it was found possible to keep frog tadpoles in narcosis for 8-12 days. If previously treated with thyroid, they metamorphosed as rapidly as controls. An atmosphere of oxygen is deleterious to tadpoles, and retards metamorphosis. A mixture of air and oxygen containing 40 per cent. oxygen allows metamorphosis to proceed at the same rate as in air. The dorsal fin of male newts which is developed in the breeding season is not caused to regress by administration of thyroid, unlike the larval fin-crest occupying the same position.—A. S. **Parkes** and J. C. **Drummond**: Effects of vitamin-B deficiency on reproduction. In a buck rat on a diet totally deficient in vitamin-B degeneration of testes and sterility ensue. The amount of degeneration can be generally correlated both with degree of deficiency and time on the diet. The fecundating power of the buck can be definitely correlated with degree of deficiency. Size of litter, however, shows little variation. The proportion of males among the young decreases.—A. **Dendy**: On an orthogenetic series of growth forms in certain tetraxonid sponge-spicules. The so-called strept-asters or siliceous spicules of the Theneidæ and Pachastrellidæ are not asters, and the spirally twisted axis which they exhibit is not an elongated centrum. They are really derivatives of the primitive triact, which have arisen in accordance with a remarkable law of growth. These spicules, for which the name "dichotriacts" is proposed, appear to form an orthogenetic series of growth-forms, probably representing both a phylogenetic and an ontogenetic series. As in true asters, the increase in the number of rays is accompanied by diminution in size.—C. E. **Walker**: The meiotic phase in Triton (*Molge vulgaris*). As is the case in the ordinary somatic mitoses, the univalent filament splits in the telophase of the somatic division immediately preceding the 1st meiotic (heterotype) division. These semivalent threads rejoin in the early prophase; the univalent filaments thus formed join longitudinally, and at the anaphase whole somatic chromosomes are distributed to the daughter cells. The splitting of the univalent filament in the telophase of the last somatic division is not consummated until the 2nd meiotic division, when the chromosomes split into longitudinal halves. The 1st meiotic division is a unique phenomenon interpolated between two mitoses providing for the equal distribution of whole chromosomes.—W. E. **Alkins**: *Clausilia bidentata* (Ström) and *Cl. cravenensis* (Taylor): a statistical inquiry into the relationship of two similar species. *Clausilia bidentata* is widely spread in Britain and elsewhere; *Cl. cravenensis*

occurs only in a restricted area in the north of England, and its specific status has generally been questioned. The altitude, diameter, and diameter/altitude ratio in series of each species collected from limited loci in which both species live together in the same habitat, have been studied. While both species, and especially *bidentata*, are highly variable, and though local races may be distinguished within *cravenensis*, the two forms are clearly separated by biometric criteria, and there is no evidence of intermediate forms.

Royal Microscopical Society, December 17.—F. W. Rogers **Brambell**: The part played by the Golgi apparatus in secretion and its subsequent reformation in the cells of the oviducal glands of the fowl. The Golgi apparatus in the *cells of the alveolar glands* undergoes hypertrophy during periods of activity and reduction during periods of rest. It is not extruded with the secretion. The *ciliated epithelium* lining the entire oviduct is also secretory. During secretion the nucleus moves down the cell towards the lumen and the Golgi apparatus fragments, and is extruded from the cell. The nucleus then moves to the back of the cell and the Golgi apparatus reforms *de novo*. The albumen of the egg of the bird is homologous with the envelope of mucus formed around the egg of the mammal in the Fallopian tube. In this respect the egg of Ornithorhynchus and the marsupials is intermediate. The changes in the oviduct of the fowl between the laying of two successive eggs are comparable to the changes in the non-pregnant uterus of the mammal during the œstrous cycle.—R. J. **Ludford**: Some modifications of the osmic acid methods in cytological technique. By treating suitably fixed tissues, after osmication, for 14-21 days with water at 35°-40° C., a good general impregnation of the Golgi apparatus can be obtained. Sections can then be stained to demonstrate the mitochondria and nuclear structures. Before staining it is desirable to treat sections with 0·1 per cent. potassium permanganate, followed by sulphurous acid, in order to bleach the cytoplasm.

Geological Society, January 7.—A. K. **Wells**: The geology of the Rhobell Fawr district (Merionethshire). The area described covers some 30 square miles centred about the mountain-mass of Rhobell Fawr. The succession ranges from low down in the Lingula flags to the Bala mudstones. A feature of special interest is the development of an igneous cycle at a lower level than anywhere else in North Wales. The centre of eruption of which Rhobell is the denuded basal wreck, was a subaërial volcano which became active during the pre-Arenig interval. Basic intrusions are common at several horizons between the Dolgelly beds and the Upper Acid group, and are without exception sills. The area provides good illustrations of the action of an intrusive magma in persistently flooding certain horizons and invading selected rocks while leaving others unaffected. As a consequence of its position at the south-eastern "corner" of the Harlech dome, the strike changes almost through a right-angle in passing from south to north. Folding along north-and-south axes is dominant, but the folds have been buckled against the Rhobell mass, which acted as a resistant knot lying in advance of the hard core of the dome. The area is much faulted, the most important dislocations being parallel to those recently described from the Bala district.

PARIS.

Academy of Sciences, January 12.—A. **Lacroix**: The meteorite of Roda. A detailed mineralogical and chemical analysis of this meteorite is given, which only differs from the terrestrial harzburgites by containing a higher proportion of iron.—Charles **Richet**, Eudoxie **Bachrach**, and Henry **Cardot**: The heredity of acquired characters proved by the displacement of the thermal optimum. A normal strain of lactic bacillus has a maximum development at a temperature of 36° C. A strain of this bacillus, grown for three years in the presence of potassium chloride, has the optimum temperature raised by 6° C. to 42° C.; and this change persists and is characteristic of this strain of bacillus.—C. **Camichel**, L. **Escande**, and M. **Ricaud**: Overflow weirs.—Paul **Vuillemin**: A normal classification, auxiliary classification, and practical grouping of the fungi.—Bertrand **Gambier**: The invariants of Gauss, Beltrami, and Minding.—A. **Kolmogoroff**: The axiomatic definition of the integral.—M. **Lavrentieff**: The sub-classes of the classification of M. Baire.—V. **Weniaminoff**: The limit-derivative of an analytical function.—Maurice **Roy**: The adherence of a perfect liquid to a solid which it wets and Lagrange's theorem.—Georges **Patart**: The influence of the cooling of a gaseous fluid previous to its compression. A demonstration of the advantages of a preliminary cooling of gases before compression.—Emile **Belot**: The movement of a vortex in a resisting medium: application to planetary vortices.—Rafael de **Buen**: The influence of the surface temperature on deep thermal changes in the western Mediterranean. A discussion of the experimental data given by Richard, Oxner, and Sirvent.—H. **Eyraud**: The projective Riemann character of the electromagnetic gravific field.—A. **Perot**: A photographic recorder and oscillograph.—Léon and Eugene **Bloch**: The spark spectrum of tungsten in the Schumann region. A catalogue of wave-lengths and intensities of tungsten lines between $\lambda = 1826$ and $\lambda = 1453$.—Charles **Chéneveau**: The formation of optically disturbed media by the penetration of a transparent liquid into a transparent resin.—Jean **Thibaud**: Research on characteristic gamma spectra by crystalline diffraction. The method employed was that of the rotating crystal (velocity less than 1° in 24 hours) and Broglie photographic recorder. The γ spectra were obtained as fine lines without signs of any continuous bands. The crystal diffraction method furnishes a good confirmation of the values attributed to the γ frequencies by the method of excited β spectra.—Fred **Vlès** and Mlle. Madeleine **Gex**: The ultra-violet absorption of petrols. A study of the changes produced in the absorption bands by fractional distillation.—H. **Pélabon**: The direct formation of the mercury oxychlorides. The three oxychlorides, $HgO \cdot 2HgCl_2$, $2HgO \cdot HgCl_2$, $4HgO \cdot HgCl_2$, can be formed directly from HgO and $HgCl_2$ in the presence of water and of alcohol if the temperature is low. The first of these is white and is not formed if the temperature rises above 30° C., but once formed, can be heated to 100° C. without decomposition.—Emile **Luce**: Researches on the migratory aptitudes of the α-naphthyl radicle.— — **Royer**: The rotatory power of cholesterol bodies.—E. **Fournier**: A mode of capture by subterranean erosion, special to certain closed basins of the chain of the Jura.—Ch. **Gorceix**: The metric proof of the ovoid form of the earth. The ovoid proposed as the best representation of all the available geodesic measurements is intermediate between the ellipsoids of Clarke (1880) and Bessel (1841).—Jean **Piveteau**: The existence of a reptile with lacertilian affinities in the permian formations of Madagascar. The name *Broomia Madagascariensis* is given to this reptile, which is represented by a large number of well-preserved examples, only the head presenting difficulties.—G. **Mangenot**: The

mode of formation of starch grains in the latex of the Euphorbiaceæ.—Maurice **Lenoir**: The telophase of the first division in the embryonic sac of *Fritillaria imperialis*.—Vittorio **Pettinori**: The toxic action of *Amanita phalloides*. This poison acts not only on vertebrates, but also on infusoria, small crustaceans, the larvæ of insects and fishes. It has no action on the isolated heart of the frog, and probably is without action on lizards and frogs.—Gilbert **Ranson**: The cause of the green coloration appearing on oysters. The pigment of *Navicula ostrearia*, which is unaffected by the digestive juices of the oyster, is shown to be the cause of the green coloration.—Harry **Plotz**: Some observations on the mechanism of serum anaphylaxy. In anaphylaxy produced by serum injection two factors intervene: the physico-chemical state of the serum used for the sensitising injection, and the physico-chemical state of the second injection.—Georges **Bourguignon** and Mlle. Renée **Déjean**: Double chronaxy of the optical system in man.—Jean **Camus** and J. J. **Gournay**: Researches on diabetes and diuresis.

MELBOURNE.

Royal Society of Victoria, November 20.—J. **Ewart**: Stock poisoning in the Northern Territory. Along the main stock route in the Northern Territory very heavy losses of stock have been experienced in recent years and their cause has been in doubt. The cause was determined, by actual experiments carried out in Central Australia on a herd of cattle, to be poisoning due to *Indigofera boviperda*, the indigo cattle bane, and to *Isotropis atropurpurea*, the poison sage. The former is well known as a cattle-killer in Western Australia, but was not previously recorded as killing stock in the Northern Territory. It loses its poisonous properties when dried in a hot sun, owing to the ready decomposition of its alkaloid "cygnin." The Isotropis was not previously recorded as a poisonous plant. It is less poisonous than *Indigofera boviperda*, but the poison is more stable. An extract obtained by Dr. Young is poisonous to guinea-pigs, but the nature of the poison is as yet unknown.—C. **Fenner**: The Bacchus Marsh basin, Victoria. At a period somewhat earlier than middle Tertiary, the whole of Eastern Australia, including Victoria, consisted of low undulating highlands and vast level plains, well wooded and well watered. Under these conditions great brown coal deposits of Victoria, etc., were built up. Later there came some differential uplift of the land, and associated with this there was an outpouring of basaltic lava (the "older basalts"), and about this time the subsidence of Bass Strait possibly commenced. Later, there was another volcanic period (the "newer basalts"); these flows dammed up many of the streams, and filled up some of the old valleys, forming lakes and twin streams and causing a complete change in the drainage system. The faulting which followed or accompanied this volcanic period gave rise to the great mountain system of Eastern Australia. Locally it caused additional alteration in the stream activities. Thenceforward the natural downward cutting, side-swinging, and headward erosion of the Bacchus Marsh streams brought about the formation of the basin as it exists to-day.—A. H. **Coulsen**: Geology of the Coimadai area, Victoria, with special reference to the Limestone series. Lower Ordovician and Permo-Carboniferous glacial rocks form the basement of the area, but the paper is concerned with the Kainozoic rocks. These comprise gravels, sands, etc., monchiquite dykes and basalt. The limestone, or more properly dolomite, contains fossils and a very finely laminated mudstone with small grains which bear a strong resemblance to the pollen grains of Pinus. The grains sometimes have a quadrate centre and at others there is a suggestion of spines and wings. The fossils are all referable to the Pleistocene. The extreme uniform fineness of grain and the absence, with one or two possible exceptions, of calcareous organisms, suggest that the dolomitic limestone is the result of deposition of a chemical precipitate of magnesian limestone and differential leaching, in places, giving a more magnesian limestone. Basaltic lava flows followed the sedimentation in the lake, but were preceded by the outburst of a fine ash which has only been found in the limestone lake. The outpouring of basalt completely altered the drainage system of the area. Pyrete and Goodman's Creeks came into existence and deposited, in their initial stages, high level gravels as a capping over the older rocks. In deepening their channels they carried away much of the softer gravels of the old "Bullengarook River," destroyed the limestone lake, and removed most of the limestone, the remnant of which is now covered by the higher gravels of these streams.

Official Publications Received.

Carnegie Institution of Washington. Year Book No. 23, November 1, 1923, to June 30, 1924; with Administrative Reports through December 12, 1924. Pp. xx+43+325. (Washington, D.C.)

Medical Schools of the World. Pp. 26. (New York: The Rockefeller Foundation.)

Commonwealth of Australia: Institute of Science and Industry. Bulletin No. 28: Problems of the Viticultural Industry. By A. V. Lyon. Pp. 84. (Melbourne: H. J. Green.)

University of Oregon Publication. Vol. 2, No. 7, November: A Proposed Classification of Igneous Rocks. By Edwin T. Hodge. Pp. 72. (Eugene: University of Oregon Press.) 1 dollar.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 47: Cotton Growing in Relation to Climate in Egypt and the Sudan. By C. B. Williams. Pp. ii+31+9 plates. (Cairo: Government Publications Office.) 5 P.T.

The South African Journal of Science. Vol. 21, November: Comprising the Report of the South African Association for the Advancement of Science, 1924, Cape Town. Pp. xl+698+xx. (Johannesburg.) 30s. net.

Hampstead Scientific Society. Report of the Council and Proceedings, with a List of the Members, for the period October 1922 to September 1924. Pp. 70. (London: 32 Willoughby Road, N.W.3.)

Nyasaland Protectorate: Department of Agriculture. Bulletin No. 1 of 1924: The Destruction of Vegetation and its Relation to Climate, Water Supply and Soil Fertility. Part 1: General Effects of the Destruction of Vegetation, by Dr. F. Dixey; Part 2: The Relation of Forest Vegetation to Climate, Water Supply and Soil Erosion, by J. B. Clements; Part 3: The Erosion of Arable Soil in Nyasaland and Methods of Prevention, by A. J. W. Hornby. Pp. 16. (Zomba.)

Smithsonian Institution: The Smithsonian Institution's Study of Natural Resources. Niagara Falls: its Power Possibilities and Preservation. By Samuel S. Wyer. (Publication 2820.) Pp. vi+28+2 plates. (Washington, D.C.)

Carnegie Institution of Washington. Annual Report of the Director of the Laboratory for Plant Physiology. (Extracted from Year-Book No. 23, for the Year 1924.) Pp. 125-143. (Washington, D.C.)

New South Wales. Department of Mines: Geological Survey. Bulletin No. 7: Gold. By E. J. Kenny. Pp. 60+10 plates. 2s. Bulletin No. 8: Aluminium (Alunite and Bauxite). By L. F. Harper. Pp. 21. 1s. Bulletin No. 11: Cadmium and Mercury, or "Quicksilver." By E. J. Kenny. Pp. 12. 1s. (Sydney: Alfred James Kent.)

Diary of Societies.

SATURDAY, FEBRUARY 21.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—Miss Isabel Burnett: Motives in the Acquisition of Skill.—Prof. T. H. Pear: On Forgetting the Unpleasant: An Examination into Recent Criticisms of Psycho-analysis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Rothenstein: The Artist's Relation to Social and Religious Life (II.).

PHYSIOLOGICAL SOCIETY (at London School of Medicine for Women), at 4.—G. Briscoe: Pressure of Phrenic Effects on Conduction of Respiratory Impulses.—E. E. Hewer and M. F. Lucas-Keene: Histological Preparations of certain Fœtal Tissues (Human).—J. W. Pickering: The Supposed Deficiency of Pro-Thrombin in Hæmophilic Blood.—W. Cramer: The Process of Secretion in the Thyroid Gland.—J. F. Fulton: Plurisegmental Innervation of Single Muscle Fibres (Frog).—A. St. G. Huggett and Prof. J. Mellanby: Preparation and Properties of Secretin.—R. E. Havard and G. A. Ray: The Effect of Exercise on Blood Phosphate.—J. B. S. Haldane: Some Effects of ingesting $MgCl_2$ and $SrCl_2$.—A. D. Ritchie: Chloroform Rigor in Frog's Muscle.—J. H. Burn and H. P. Marks: The Relation of the Thyroid Gland to the Action of Insulin.—F. C. Kelly: The Effect of Iodine on the Metabolism

of Nitrogen and Phosphorus in the Growing Pig.—A. D. Kay and W. Smith: The Effect of Insulin on Blood Volume.—H. Florey: Microscopical Observations on the Cerebral Circulation.—D. Woodman: Effects of Parathyroid Feeding.—E. C. Pillman-Williams: Blood Nitrogen Values during Labour.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District) (at Municipal Buildings, Blyth), at 5.—L. Leeper: Five Years' Progress at Blyth.—J. L. Turner: The Law relating to the Collection of House Refuse and Trade Refuse.

MONDAY, FEBRUARY 23.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr. B. N. Peach and Dr. J. Horne: The Scientific Career of Sir Archibald Geikie.

VICTORIA INSTITUTE (at Central Buildings, S.W.), at 4.30.—Prof. A. T. Clay: The Amaru.

INSTITUTE OF ACTUARIES, at 5.—F. L. Collins: Winding up a Life Assurance Company under the Provisions of Section 17 of the Assurance Companies Act, 1909.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. W. De P. Nicholson: The Nature of Tumour Formation (I.).

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. E. Warrilow and others: Discussion on the Electrical Journals, Past, Present, and Future.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—H. W. Clothier: The Design of Electrical Plant, Control Gear, and Connexions for Protection against Shock, Fire, and Faults.

ROYAL SOCIETY OF ARTS, at 8.—Dr. W. Rosenhain: The Inner Structure of Alloys (II.) (Cantor Lectures).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—F. N. Doubleday: Report upon Some Drugs and Solutions used in Local Anæsthesia.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Gerald Lenox-Conyngham: The Great Barrier Reef.

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir G. Lenthal Cheatle: The Early Stages of Pathological Hyperplasia in the Breast, with special reference to Cysts and their Danger.

TUESDAY, FEBRUARY 24.

ROYAL DUBLIN SOCIETY (at Royal College of Surgeons, Dublin), at 4.15.—Prof. F. E. Hackett and others: Discussion on Modern Theories of Atomic Structure.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—R. H. Brackenbury: Transport in Tropical Africa.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Colour of the Animal Creation (III.): The Colour of the Chameleon.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 6.—L. H. Savile: The Demolition of the Harbour and Defence Works of Heligoland.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Discussion on Curious Breakdowns.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—T. D. Trees: Selection of Ball and Roller Bearings for Electrical Machines.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—K. C. D. Hickman: Colour and the Psychology of the Kinema.—O. Bloch: A Daylight Viewing and Projecting Filter for Autochrome Plates.—Miss Catharine O. Stevens: A Plea for the Kinematography of Wind Waves.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—R. N. Aveline: The Testing of the Automobile.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—H. H. Blache: The Latest Type of the Burmeister and Wain Diesel Engine.

ROYAL ANTHROPOLOGICAL INSTITUTE (at London School of Economics), at 8.15.—L. H. Dudley Buxton: The Stoney Indians of the Bow River, Alberta.

WEDNESDAY, FEBRUARY 25.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. W. De P. Nicholson: The Nature of Tumour Formation (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. A. H. Cox: (*a*) The Geology of Cader Idris (Merionethshire); (*b*) The Dissection of Pitching Folds.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Mining Institute, Newcastle-on-Tyne), at 7.15.—Prof. T. H. Havelock: The Principle of Interference in Ship-waves and Ship Resistance.

INSTITUTION OF ENGINEERS-IN-CHARGE (at St. Bride Institute, Bride Lane, E.C.), at 7.30.—Discussion on Responsibilities and Difficulties of the Engineer-in-Charge.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—Dr. J. A. Murray: The Making of Microscopical Preparations (I.): Wet Preparations.—F. Summers: Applications of the Microscope in Textile Research.—T. B. Bright: Methods of Examination of Mildewed Cotton Material.

ROYAL SOCIETY OF ARTS, at 8.—Sir Dugald Clerk: The Power of Internal Combustion Engines for Motor Cars.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. N. H. M. Burke: Some Aspects of the Interrelation between Bodily and Mental Disease.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at Liverpool).

THURSDAY, FEBRUARY 26.

ROYAL SOCIETY, at 4.30.—Prof. E. H. Starling and Dr. E. B. Verney: The Secretion of Urine, as studied on the Isolated Kidney.—F. Eichholst and Prof. E. H. Starling: The Action of Inorganic Salts on the Secretion of the Isolated Kidney.—Dr. G. V. Anrep: A New Method of Crossed Circulation.—Dr. G. V. Anrep and I. de B. Daly: The Output of Adrenaline in Cerebral Anæmia, as studied by means of Crossed Circulation.—Dr. G. V. Anrep and Prof. E. H. Starling: Central and Reflex Regulation of the Circulation.—K. Furusawa: Muscular Exercise, Lactic Acid and the Supply and Utilisation of Oxygen. Part IX. Muscular Activity and Carbohydrate Metabolism in the Normal Individual.—*To be read in title only*:—A. Hunter and J. A. Dauphinee: (*a*) Quantitative Studies concerning the Distribution of Arginase in Fishes and other Animals; (*b*) An Approximative Colorimetric Method for the Determination of Urea with an Application to the Detection and Quantitative Estimation of Arginase.—Dr. J. J. R. Macleod and N. A. McCormick: The Effect on the Blood Sugar of Fish of various Conditions, including Removal of the Principal Islets (Isletectomy).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir Arthur Smith Woodward: Dinosaurs (I.).

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates' Meeting) (at Luton), at 7.30.—W. B. Draper: The Balancing of Automobile Engine Crank Shafts.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Sir William B. Hardy: Problems presented by Films on Solid Surfaces.

INSTITUTION OF STRUCTURAL ENGINEERS (at 296 Vauxhall Bridge Road), at 8.—E. Godfrey: Reinforced Concrete Columns.

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Section).

FRIDAY, FEBRUARY 27.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—J. J. Manley: Notes concerning the Sprengel Pump.—J. Young: The Thomson Effect in Copper, Iron, and Carbon Steels.—D. W. Dye: Improved Cathode Ray Tube Method for the Harmonic Comparison of Frequencies and for the Delineation of their Wave Form.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Dr. G. W. De P. Nicholson: The Nature of Tumour Formation (III.).

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—J. Mitchell: Research in Industry.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Discussion on Practical Problems of Lubrication.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Pickwell: The Monuments and Fountains of London.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—R. Marks: Why Pneumatic Tires?

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—E. Stroud: A Treatise on Modern Lighting Practice.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Literary and Philosophical Society, Newcastle-on-Tyne), at 7.30.—Prof. A. L. Mellanby and Dr. W. Kerr: Limiting Possibilities of Steam Plant.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (in Cleveland Scientific and Technical Institution), at 7.30.—G. M. Harroway: The Problem of the Workshop.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Dr. B. Malinowski: Mate Selection in Primitive Society.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James C. Irvine: Sugars from the Standpoint of the Organic Chemist.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: The Counting of the Atoms (I.).

PUBLIC LECTURES.

SATURDAY, FEBRUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. Balfour Browne: My Journey to Brazil.

MONDAY, FEBRUARY 23.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. E. B. Behrens: International Problems of Industry: Problems of the Future.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (Royal School of Mines), at 5.15.—Prof. L. Denoël: Tubbing Deep Shafts and Subsidence. (Succeeding Lectures on February 24, 25, 26.)

BIRKBECK COLLEGE, at 5.30.—Dr. G. G. Coulton: Medieval Education (IV.): The Medieval University.

KING'S COLLEGE, at 5.30.—Prof. W. T. Gordon: The Geological History of Plants (Swiney Lectures). (Succeeding Lectures on February 25, March 2, 4, 9, 11, 16, 18, 23, 25, 30, April 1.)

TUESDAY, FEBRUARY 24.

KING'S COLLEGE, at 5.30.—Prof. W. J. De Burgh: Neo-Platonism and Christianity.

GRESHAM COLLEGE, at 6.—Prof. W. H. Wagstaff: Geometry (Gresham Lectures). (Succeeding Lectures on February 25, 26, 27.)

LEEDS UNIVERSITY, at 8.—Prof. W. Garstang: Animal Life on the Yorkshire Coast.

WEDNESDAY, FEBRUARY 25.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—C. H. C. Baker: The Principles of Design as applied to our Homes.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. R. Cruchet: The Relation of Paralysis Agitans to the Parkinsonian Syndrome of Epidemic Encephalitis.

KING'S COLLEGE, at 5.30.—Dr. Eileen E. Power: Travel and Travellers of the Middle Ages (VII.): The Opening of the Land Routes to Cathay, A.D. 1200–1350.

THURSDAY, FEBRUARY 26.

UNIVERSITY COLLEGE, at 5.—G. A. Sutherland: Auditorium Acoustics. (Succeeding Lectures on March 5, 12.)—At 5.15.—Sir Henry Hadow: The Place of Music in University Education.

KING'S COLLEGE, at 5.30.—Prof. E. W. Scripture: German Poets and their Verse.

SATURDAY, FEBRUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—W. J. Perry: The Ancient Mariners of the Pacific.