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Petroleum in Britain

CONSENSUS of geological opinion has long been opposed to the prospect of finding commercial oil-pools in England. Ever since the failure of war-time effort to locate petroleum resources (Hardstoft excepted as a modest memorial preserved from decay, by almost uncanny, albeit slender persistence), there has been nothing stirring in relevant geological knowledge of England to change such opinion. The last two decades have been productive of outstanding geological and oil-engineering achievements elsewhere, of progressive increase of knowledge of conditions governing the natural history and favourable loci of subterranean oil-pools; but they cannot by any stretch of proved fact or reasoned hypothesis be claimed as having sponsored hitherto unsuspected data to upset deep-rooted conviction in enlightened technical circles of Britain's unfortunate inability to reveal indigenous oil in industrial quantity.

Recurrent enterprise, of a highly speculative character as 'wild-catting' mostly is, from time to time has focused public attention on activities in Kent, Sussex and elsewhere. Fanned by the breeze of a good, though often ill-informed press, the flame of prophecy of discovery of petroleum in quantities sufficient to make Britain independent of foreign supplies spread rapidly, especially in 1933. Confirmation of predictions from extra-British sources was not lacking, any more than it was when the war-time oil-drive commenced; whatever success their efforts unquestionably merited in foreign lands, the impression was widespread that there was a certain ineptitude on the part of British oil geologists to understand their own territory, and to this extent carefully weighed opinions and published statements were ignored. The position developed, as inevitable, into one of first-class public importance. Geological discussion yielded gladly to political controversy on the situation, which culminated in the passing of the Petroleum Act in 1934.

Insofar as the Act goes, it is unquestionably a sound measure, providing as it does for organised and licensed development by the State, and a direct national interest in whatever may ultimately be found as petroleum. Its implications, however, were from the layman's point of view possibly not so sound, since the publicity given to the matter in Parliament and outside naturally suggested by inference, if not as inspired official opinion, that there did indeed exist possibilities of commercial oil deposits in England. This was certainly not the intention of the Act.

None the less, it did place a moral obligation on oil technologists in general and British oil companies in particular, to re-examine the whole question of possibilities and to consider a reasonable scheme whereby, so far as humanly possible, the doubt could be settled. What more natural than that one of our leading British oil companies should take the initiative and, in the same spirit of cautious enterprise characteristic of its operations elsewhere, formulate and put into practice a scheme of widespread testing of potentially favourable areas in southern and south-western England?

On March 30, the Anglo Iranian Oil Company, through its subsidiary, the D'Arcy Exploration Company, commenced drilling operations on the first test-well to be sunk under the provisions of the

1934 Act, at Paulsgrove, on the slopes of Portsdown Hill overlooking Portsmouth. The rig is of a modern rotary type, 135 feet high, with a loading capacity of 400 tons, and stated to be capable of drilling to a depth of nearly three miles.

In his opening speech at the ceremony of setting in motion these works, Sir John Cadman referred to the enterprise, which all hoped would be eventually of great national importance, as "first and foremost a business venture, based on scientific observation, and organized with all the elaboration of detail that engineering skill and experience can suggest". He referred to the exploration company "as adventurers into the unknown, where, in the language of the oilfield, 'only the drill can tell' ".

From the strictly geological point of view, we may anticipate the drill telling of the bold structure of the Portsdown anticline which forms the conspicuous chalk background to the historic city. It may tell, also, of a sequence of rocks of which British geologists familiar with southern England stratigraphy could make a fairly shrewd guess both as to character and disposition. It may do much to strengthen conceptions of the sub-Wealden structure. It will focus attention on Upper Jurassic possibilities, in particular the sorely tried and much over-rated Kimmeridge Clay. It will perhaps offer some explanation of the not far-distant natural gas and petrol smell of associated strata at Heathfield. It may even, in three miles of deep drilling, pierce totally unexpected and much older rock structures, including Carboniferous.

All this is reasonable. But let us not build too optimistically on the results in terms of oil. Rather let us hope for the unexpected and applaud the efforts now being made and the patriotism behind them. Should failure be the reward, which every British geologist, whatever may be his convictions, would doubly deplore in the interests both of science and the State, then may it be that science, in particular geology, may benefit lastingly by the knowledge thus made available, and possibly, as in the case of the sub-Wealden boring, industry benefit by discovery of a new mineral deposit, other than petroleum, of economic worth.

Pre-nuptial Medical Examination

THOUGH vitamins and minerals are fashionable ingredients of well-informed and polite conversation, by most people reproduction is not mentioned : it is disturbing, even repulsive. Yet men and women do mate and reproduce, and the State which is beginning to regard the child as a liability will sooner or later be forced to exhibit a very lively interest both in the number and the quality of the children that are born to be fed, housed, educated and employed or not employed.

Pre-nuptial certificates are even now demanded in certain countries, though usually by them eugenic considerations are completely disregarded. In Turkey, for example, marriage is forbidden to persons affected with active venereal diseases, mental disease or leprosy ; whilst the marriage of persons afflicted with advanced and transmissible tuberculosis is delayed for as long as a year. In Norway there is a somewhat similar law prohibiting the marriage of a syphilitic, but in the case of other venereal diseases, epilepsy and leprosy, the other party to the marriage must be informed, and both parties warned by a physician of the possible consequences of marriage. On the schedule used in connexion with these cases there are questions relating to consanguinity, and information concerning the prohibition of marriages of close relatives. In Germany certificates of health before marriage are demanded of those persons applying for marriage loans ; and for these, fairly comprehensive details of the family and personal medical history are required.

In Great Britain, it may be remembered, Lord Kilmaine, in the House of Lords on November 14 of last year, moved a resolution favouring the compulsory exchange of health certificates before marriage. It was suggested that there should be four kinds of such certificates : (*a*) when both parties are perfectly fit to marry and to raise a family, (*b*) when the marriage should be delayed for 3–6 months, (*c*) which permitted marriage without parentage, and (*d*) which prohibited marriage altogether. Lord Kilmaine appeared to think that an actual medical examination in these cases was unnecessary, and that it would be enough if the two people concerned merely answered the questions of the physician concerning their general health and family history. As was to be expected,

the proposals met with well-merited and strenuous opposition, for, quite obviously, the responsibility that was to be placed upon the medical practitioner would have proved quite intolerable.

However, when such a proposal is aired in Parliament, it is safe to assume that it has been, in one form or another, under discussion by a considerable portion of the population for a decade or more. There is no doubt that the demand for information and advice concerning those physical and psychological abnormalities that militate against the success of marriage, and the wish to prevent the birth of hereditarily diseased or defective children, has been growing apace, and already a great deal is being done by private individuals and organisations to give such advice and to guide this wish by means of bureaux and clinics. Further, it is now the common view that the family doctor treats not only the illnesses of the present generation but also prescribes for the children yet to be conceived. But it is the case that not all family doctors are possessed of the knowledge and wisdom which constitute the only warranty for the giving of advice of this particular nature.

So the Eugenics Society is to be congratulated for having prepared a scheme of voluntary pre-nuptial health examinations which is meant to help the family doctor. It was decided that at the present time no good purpose could be served by advocating any scheme of compulsory examination for the reason that this simply would not work, since anyone who resented being thus examined could easily conceal or distort important facts; whereas if the examination were sought voluntarily and entered into in good faith by both parties, there would be no such concealment, and at the same time a great deal of help could be given and a great deal of very important information relating to human and social biology amassed. It is assumed that most conscientious and serious-minded people embarking on marriage want to feel assured that they are sound in mind and body, and that such of these who know that in their family histories there are defects and derangements which they have reason to think are hereditary, also want to make sure that the children that they propose to have shall not repeat such hereditary blunders.

The scheme is a purely voluntary one, and it is placed at the service of those who wish to take advantage of it. The parties concerned present themselves before their own doctor, who applies to the Eugenics Society for the appropriate schedule. This consists of three parts. The first two of these, which are concerned with the family history and the personal medical history of the applicant, are to be filled in by the applicant before the medical examination is undertaken. In the second part there is a special section dealing with sexual problems, and the answers given to the questions therein should permit the sympathetic physician to remove a great many barriers to a successful and happy marriage. Part 3 provides a most excellent guide for the doctor in his physical examination of the applicant. It is to be noted that the schedule is to be issued only to doctors, and it is in no sense a certificate. Nowhere in it is the doctor asked to certify that the applicant is fit or unfit either for marriage or procreation.

In order to help practitioners who are not well-informed in the field of human genetics, the Society has appointed a small board of specialists who may be consulted about problems of heredity. It is not stated to whom the doctor may turn for help in dealing with the marriage bureau kind of problem.

Without doubt the scheme is a most excellent one, not so much because, through its help, either the practitioner or the board of specialists will be able to offer compelling advice to any given individual or pair, but because it can, and probably will, encourage the development of a eugenic conscience (though probably only in the middle-class where such a conscience already exists), and furthermore because, if properly employed, it can be the means of adding greatly to our knowledge concerning the reasons for the success or otherwise of marriage in individual cases, and of the incidence and mode of inheritance of pathological characters in mankind. But two things must make the working of the scheme difficult. One is that exceedingly few medical men of the present generation know anything of sexual psycho-pathology or of the principles of genetics, and the other is that our knowledge of human genetics is exceedingly slight and most imperfect.

However, the project is a step in the right direction, right in the sense that it, a purely voluntary scheme devised by a private society, is undoubtedly an intelligent anticipation of what will be, in the not too distant future, a compulsory scheme backed by law. The State is bound, in its own interests, sooner or later to place its sentinels at the portals of birth, for it is by this route that most of our undesirables enter the realm.

Heat a Mode of Motion: A Modern Version

A Treatise on Heat
(including Kinetic Theory of Gases, Thermodynamics and Recent Advances in Statistical Thermodynamics). Being the second and revised edition of "A Text Book of Heat". By Prof. M. N. Saha and B. N. Srivastava. Second edition. Pp. xii+815+2 plates. (Allahabad and Calcutta: The Indian Press, Ltd., 1935.) 27*s*.

THE authors of this book have written a most stimulating version of the old song "Heat a Mode of Motion", and written it, too, rather in the grand manner. Their arrangement of matter follows classical lines. Formal thermodynamics is not introduced until more than half-way through the book. Before that point is reached, there are excellent descriptive chapters on thermometry, calorimetry, production of low temperature, heat engines, gases, changes of state, elementary kinetic theory and other topics. These are all treated in a most pleasing broadly descriptive manner, with a temperature based on the perfect gas scale and an occasional forward reference to the second law where unavoidable. The ideas of hot and cold and heat are here quite properly treated as familiar primary concepts which need not be further analysed—quantities which we must set to work to measure precisely—and the kinetic interpretation of heat is brought in naturally in its right place. The chapter on heat engines seems to me to be exceptionally satisfactory for the elementary treatment that is intended, being practically without reference to entropy, and using merely a perfect gas Carnot cycle as standard. An exceedingly pleasing feature is the section on the Otto cycle gas or oil engine, the Diesel engine and steam turbines. The latter, however, are not given credit for the full overall efficiency that has recently been attained.

At this point there is a complete break, and we go back to the beginning again for a more rigorous formal treatment of the subject, starting with the first law of thermodynamics. This proceeds along the usual lines, but includes an excellent chapter on the thermodynamics of radiation, after which it leaves classical thermodynamics and ends with an elementary account of statistical mechanics and the contribution that this newer method can make to the general theory of heat. There are points in this exposition to which exception can be taken and these will be referred to later on—but as a whole the high level of the earlier part of the book is maintained. The treatment is never ponderous—the style is simple and easy to read (in short, good), and the whole monumental work of more than eight hundred pages forms an excellent not too elementary introduction for any serious student to the thermal properties of matter. For this purpose it is all to the good that the book is not a monograph, but makes more than one fresh start and provides in many places a number of alternative arguments.

We turn now to points of detail on which criticism is possible. In calculating the pressure exerted by an almost perfect gas on the wall of a containing vessel, the authors mention that the effect of collisions on the arrival of the right sort of molecules has not been taken into account, but that it is without effect on the result. This is of course true, but the explanation here offered is obscure, and it can be given much more clearly by using the ideas of the free path and associating all molecules with the volume element of the gas in which they suffered their last collision. This very simple physical idea is in fact not mentioned in the book, which is to be regretted, and here would have been an excellent opportunity for its presentation. In the same chapter, in discussing the energy of rotation of a molecule, this energy is expressed in the Eulerian form $\frac{1}{2}(I_1\omega_1^2 + I_2\omega_2^2 + I_3\omega_3^2)$, and it is inferred without further comment that as the average energy is $\frac{1}{2}kT$ per square term, the average energy of rotation is $3/2kT$ per molecule with three degrees of rotational freedom. But this theorem on average energy content is in general only proved for Hamiltonian co-ordinates, while ω_1, ω_2, ω_3 are not velocities corresponding to any such co-ordinates. The proof here suggested therefore fails, though of course the result is true.

In another chapter, in discussing the equation of state of an imperfect gas, the old mistake is repeated of assuming that the excluded volume and cohesive forces can be discussed separately, and are additive corrections without effect on each other. To give van der Waals's original arguments for the sake of their historical interest is well enough, but it should then be pointed out firmly that the arguments and the results so obtained are *wrong*. One should not merely pass on to describe other lines of argument, such as the virial, as pure alternatives without critical comment.

The weakest feature of the book is the start of the chapters on formal thermodynamics. The whole subject has been magnificently introduced by the opening chapters, and when the new start

is made to pull the whole subject together into the laws of thermodynamics, something much more logical and formal seems to me to be called for. This of course is largely a matter of taste, and the authors are obviously acquainted with the sort of presentation here suggested, based on the work of Carathéodory and Born, and have no doubt deliberately discarded it. But it always seems to me to be a pity that so many presentations of thermodynamics should rush straight into the formal developments without any attempt to achieve the maximum logical simplicity in the foundations. The peculiar character and fundamental nature of the temperature as a variable in such presentations is entirely overlooked. A proper development of thermodynamics should, I am convinced, begin with the 'zeroeth' law of thermodynamics : *There exists a variable called the empirical temperature, which may be used in defining the state of any system having the property that it has the same value for all parts of a system in thermal equilibrium.* I am also convinced that, again following Carathéodory, thermodynamic functions and processes should so far as possible be defined in mechanical terms, and the number of new indefinables reduced to a minimum. No attempt is made to do this here. The tastes of the authors and the reviewer differ so widely on this point that it would be useless and indeed ungracious to elaborate these criticisms.

It will be sufficient to mention two more passages where the customary treatment adopted by the authors seems to fail. They introduce the first law in the form $\delta Q = dV + \delta W$, which is logically faulty, for the statement has to serve both as an existence theorem for V and a definition of δQ, and physically incorrect, for the first law is really the existence of V and is based on experiments such as Joule's in which δQ always vanishes. Secondly, the authors claim to give a proof that $\delta S \geqslant 0$ in any material process, but their proof seems to me to be based only on a study of particular entropy functions and to be quite incapable of establishing the general principle involved, which must surely be taken, following Clausius, as one of our fundamental generalisations from experience, and not deducible from any less drastic hypothesis.

The same tendency to follow conventional treatments has led the authors in the statistical chapters, which are otherwise excellent, simple expositions of the elements of statistical mechanics, to an uncritical acceptance of the concept of absolute entropy. Whatever one's personal taste in the matter, it seems proper in a book of this sort to insist at least that the concept serves no essential purpose, and that every conceivable theorem in statistical thermodynamics that can be applied to any physical or chemical problem can be formulated without its help. This is not to deny that some workers may find the concept convenient in practice. The authors, however, leave the reader thinking that the evaluations of chemical constants and reaction isochore constants can only be made with the help of absolute entropy. Something of the same weakness is to be found, too, in the treatment of Boltzmann's hypothesis concerning the connexion between entropy and probability. The concept of absolute entropy and the 'improved' formulation of Boltzmann's hypothesis have been responsible for some of the most illogical and slipshod thinking that has ever disgraced the pages of scientific books and journals, and it is high time that greater precision should be insisted on. The present authors have in no way added to the old confusion. The charge is only that they have failed to take an excellent opportunity of reducing it, for the lack of a few sentences of judicious criticism to direct the reader's thoughts aright.

Turning now to minor points, I have already expressed my admiration for the style of the book, and this is in no way diminished by a number of sentences incorrectly constructed. Such mistakes as I have noticed never left the meaning in doubt, and add a pleasant flavour to the style rather than detract from it. But there are one or two poorly phrased definitions, such as those of E_λ and e_λ, which might well be overhauled in the next edition. Again, in a work in this grand manner, the sudden introduction of abbreviations such as 'A.N.' jars on the reader, more particularly as it is, I think, undefined and apparently means the absolute zero of temperature, for which this Germanic abbreviation is quite inexcusable in an English text. Nor can I suffer gladly the misuse of the established phrase *partition function*, which has long been in common use as the equivalent (not a rendering) of the German *Zustandsumme*. It is always a matter of difficulty to coin good equivalents for scientific terms, but there is no need whatever to adopt the method of literal translation when it leads to awkward results, or of direct incorporation of the foreign word, so long as a simple, natural and reasonably expressive term is available, as is surely the case here. Would that it were always so, and that someone would coin a really good English equivalent for *Bremstrahlung* !

A word now on the printing. The book is well got up and an astonishing value for the price, and the formulæ in general are really well and intelligibly composed ; but in spite of this, the reader gets the feeling of a not really clear page. In looking into this more closely, it seems to be due to the rather large number of slightly smeared

or dirty letters, or actually broken letters on each page. In my copy I counted fourteen apparently broken letters on a page (p. 717) selected at random which should have been removed and replaced by perfect letters by a high-class professional reader. I only mention this because the general standard of the Indian Press Ltd. as shown in this book is already so high that one may obviously assume that they are themselves satisfied with nothing less than the best, and will probably wish to attend to this point more closely in future.

These remarks on typography lead naturally to the conclusion of this review. It is apparently mainly devoted to criticism, but only because the general standard of the treatise is so high that criticism of the points with which one disagrees seems worth while. One may confidently expect and heartily wish that it will be widely read and run rapidly through many editions. May I hope that in later versions some of what I find discords will have been removed? But I shall wish the book well in any event. R. H. F.

A Science Anthology

Readings from the Scientists: an Anthology. Selected and edited by J. Edward Mason. (The Scholar's Library.) Pp. x+309. (London: Macmillan and Co., Ltd., 1935.) 2*s*. 6*d*.

To produce, in small compass, a readable, and varied, anthology of the literature of science is a difficult matter, and the editor is to be congratulated on the success of his effort. It were easier, and safer, to stick to the descriptive sciences, but the editor has taken his courage into his hands and has laid under contribution chemistry, geology, natural history, mechanics, exploration, astronomy, physics, science and art, and fiction. If we divide the selections in time, and regard the date of Ruskin's death as marking the close of an era (as indeed it does), we find that out of the 280 pages of text, 130 pages are allocated to the post-Ruskin period. Obviously the natural sciences bulk largely in the selection, and opinions will differ concerning the value of the eleven pages devoted to a selection from Einstein's "Relativity"—probably the majority of readers will get more fun out of the excerpts from "The Time Machine". But the balance has been very well kept—it is pleasant to meet again the friendly words of Gilbert White, Miller and Darwin; equally pleasant to read the newer story of the eel, to learn something of spinning tops and boomerangs, and to wander into space (four-dimensional) under the guidance of Jeans or Eddington.

All the sciences can tell remarkable and marvellous tales, and some of the most remarkable are concerned with things that have never happened. It would be a pleasant, and not unprofitable, task to compile an anthology of these marvels; indeed, such an anthology would not 'dedecorate' the "Scholar's Library". The natural sciences have their full share of such stories—tales of the frays between the gryphons and the Arimaspians; of the Anthropophagi and men whose heads do grow beneath their shoulders; of the Antichrist who, as was reported by the spies of the brotherhood of St. John, was born in 1623 near Babylon "of which child the mother is a very aged woman, of race unknown, called Fort-Juda; of the father nothing is known. The child is dusky, has pleasant mouth and eyes, teeth pointed like those of a cat; . . . the said child, incontinent on his birth, walked and talked perfectly well. . . . Our spies . . . add, that, on the occasion of his nativity there appeared marvellous signs in the heavens, for at full moon the sun lost its brightness, and was for some time obscured"—not to mention a swarm of flying serpents and a shower of precious stones.

What, too, of Gerarde, who thinks it "not impertinent to . . . end with one of the marvells of this land", an account of "certaine trees whereon do grow certaine shells of a white colour tending to russett, wherein are contained little living things, which shells in time of maturitie do open, and out of them do grow those little living creatures, which falling in the water do become fowles, which we call Barnakles, and in Lancashire tree-geese, but the others that do fall upon the land perish and come to nothing".

Of the lesser marvels which have found their way into the works of later authorities, stories concerning the hibernating habits of the swallow are not the least captivating. "Swallows certainly sleep all the winter. A number of them conglobulate together by flying round and round, and then all in a heap throw themselves under water, and lye in the bed of a river". Thus far Johnson, and, though Boswell is here, possibly, an inaccurate reporter—for 'conglobulate *together*' is scarcely Johnsonian—the sentence sums up the common

belief. And have we not further evidence contributed by that shadowy figure Mr. Steevens, A.S.S., who emerges from nothingness to tell us, in the Annual Register for 1781, how he picked up bunches of swallows from a pond and how the birds, revived, flew about the kitchen in the presence of the Reverend Doctor Pye. Mr. Steevens and the Reverend Doctor Pye play no great part in the drama of history, but we could more easily part with some more eminent figures.

The volume under review, we hasten to add, confines itself, with one definitely imaginative exception, to more sober happenings. It is fully annotated and admirably produced, and the publishers are to be congratulated on a notable addition to an interesting (and low-priced) series.

A. F.

The British Coal Industry

Report on the British Coal Industry; a Survey of the Current Problems of the British Coal-Mining Industry and of the Distribution of Coal, with Proposals for Reorganisation. (P E P (Political and Economic Planning) Industries Group.) Pp. vi+214. (London: P E P, 1936.) 7*s*. 6*d*. net.

IN 1925 a Royal Commission, presided over by Sir Herbert Samuel, heard evidence and later published a report. Much has been written about the coal industry since, but the report of the industry now under review is the most comprehensive that has appeared in the last ten years. It is necessarily a long document because it contains evidence to substantiate the opinions expressed therein.

The three dominant features of the British coal mining industry outlined in the report are: (*a*) the absence of concentration of the country's output; (*b*) the improbability of a substantial increase in the demand for coal in the future; (*c*) the certainty that, even if there is any increase in the demand for coal, there will still remain a large number of miners with no prospect of re-employment in a coal mine, and a considerable number for whom under the present system only part-time employment will be available.

The report makes it clear that there is a number of redundant mines in Great Britain the lives of which are being prolonged by the policy of 'spreading the work', one of the results of the 'quota' system which came into being with the 1930 Act. The curtailment of output, in itself a necessary evil, was made applicable to every producing mine instead of concentrating all work at the more efficient mines, which to-day cannot work full time.

The plain fact is that an efficient coal mining industry in Great Britain implies an increase in permanent unemployment for the present mining community. Owing to technical improvements in coal utilisation and the growth of Continental production, the annual output of coal in Great Britain can never return to its pre-War dimensions. In addition, the increase in underground mechanisation has more than offset the increasing difficulties of mining. It will therefore be realised that the amount of work available for miners is bound to diminish.

As efficiency in mining goes hand in hand with concentration of work, 'spreading the work' is the wrong policy from the technical point of view, and concentration of the output at the more efficient mines, which will thus be able to work full time, means unemployment for a large number of men, for whose absorption into other industries adequate steps must be taken, or they must be catered for in some other way.

Such methods as the following are suggested: restriction of entry into the industry, pensions for all men of more than fifty-five years of age or the provision of alternative employment in the mining areas. *Per contra*, the miners, as a class, while admirable workmen, are not adaptable to other trades and the older men are disinclined to leave their own districts.

Except for the fact that the output of coal is being spread over too many mines the technical direction of the industry is excellent, and moreover the work is carried out more safely than in any other mining country. On the other hand, the control of the disposal of the output is definitely inadequate and the costs of distributing unnecessarily high.

The promise by the colliery proprietors to establish a central selling organisation in each district is a step in the right direction, but in order to get full value from the scheme and eliminate competition between districts in the inland markets, some central co-ordinating authority is required.

In order to control the export market, the report visualises a "British Coal Export Association", the duties of which include the prevention

of price cutting and dealing with the more powerful Continental buyers.

The report should be studied by all interested in the future of the mining industry, summarising as it does the views of men in all walks of life. If viewed from the aspect of efficiency alone, its views are sound; but mining differs from any other industry in that its workers are often segregated in isolated communities, far from alternative forms of employment. Can we contemplate with equanimity the closing down of a number of mines, the sole source of livelihood of many village communities? The promptings of the heart must influence the dictates of the head, and consequently the provision of adequate alternative employment is essential before many of the recommendations in the report can come into effect.

J. A. S. Ritson.

Illustrations of New Conifers

By H. Clinton-Baker and A. Bruce Jackson. Pp. ix+78+96 plates. (Hertford: Simson and Co., Ltd., 1935.) 84*s*.

In 1909 Mr. Clinton-Baker and Mr. A. Bruce Jackson were jointly responsible for the publication of two volumes of very good illustrations and descriptions of the older introduced conifers, and four years later they produced a third volume dealing with some of the lesser known species. The work was so well received, and has since proved so useful, that the authors were induced to undertake a fourth volume to include illustrations of the more recently introduced species and little known kinds that had previously been omitted. Unfortunately, Mr. Clinton-Baker did not live to see the new volume published, for he died in April, 1935, as the work was going through the press. Mr. Clinton-Baker inherited a pinetum that had been formed by his grandfather nearly one hundred years ago, and he planted a large number of additional species. In a memorial notice following the introduction to the new volume, Mr. Jackson pays tribute to his colleague's great love for plants and trees and to his ardour in maintaining the arboricultural traditions of Bayfordbury. The frontispiece to the new volume depicts some old cedars of Lebanon that are, apparently, the ones referred to in the first volume as having been planted to commemorate the building of the house at Bayfordbury in 1765.

The illustrations in the new volume are excellent in every way, and the descriptions are equally good. Species of Chinese *Abies* and *Picea* are well represented, but there are also species of numerous other genera including *Agathis*, *Araucaria*, *Widdringtonia*, *Callitris*, *Pinus*, *Podocarpus*, *Cupressus*, *Larix*, *Tsuga*, *Libocedrus* and *Cedrus*. Unfortunately, a plant has been wrongly figured as *Diselma Archeri*, but the authors are not altogether to blame for that. A small shoot bearing only the appressed scale-like type of leaves was sent to Kew for identification and the suggestion was made that it was the little-known Tasmanian plant, *Diselma Archeri*. However, that decision had to be altered some time later when specimens were seen showing both juvenile and mature types of leaves and fruits, which indicated that the plant in question was *Juniperus bermudiana*. Small shoots of *Diselma Archeri* and *Juniperus bermudiana*, bearing only the small appressed type of leaf, are very similar in appearance.

The four volumes of illustrations will be a lasting memorial to the authors, both of whom paid great attention to conifers over a long period.

Dictionnaire de la Chemie et de ses Applications

Par Dr. Clément Duval, Dr. Raymonde Duval, Dr. Roger Dolique. (Science, Technique, Métiers: Bibliothèque de Formation professionnelle.) Pp. xxxii+747. (Paris: Hermann et Cie, 1935.) 90 francs.

This dictionary is a glossary of French scientific and technical terms, and covers a wide field of pure and applied chemistry. Although it occupies but 747 pages of small format and the subject matter is necessarily greatly compressed, it is surprisingly complete. For example, it includes the trivial names and the composition of a very large number of pharmaceutical preparations.

The information appears to be up-to-date, but owing to extreme compression there are no references to the literature, and the reader is therefore left to his own devices if he wishes to check a given point or obtain further information.

Apart from its value as a glossary of purely technical terms, the book should be useful as a means of reference to those who have occasion to read articles of a technical nature but have no access to a reference library.

Lehrbuch der Chemie

Von A. F. Holleman. Organischer Teil. Lehrbuch der organischen Chemie. Von A. F. Holleman. Zwanzigste, umgearbeitete und vermehrte Auflage von Friedrich Richter. Pp. xii+546. (Berlin und Leipzig: Walter de Gruyter und Co., 1935.) 14 gold marks.

The large number of editions of Holleman's book is a measure of its popularity, and this appears to be well deserved. The present edition has been thoroughly revised and brought up to date; it embodies brief accounts of such developments as the synthesis of the anthocyanins, the structure of the sterols and bile-acids, chlorophyll and the vitamins. The theoretical side of the science is perhaps somewhat neglected as compared with the purely structural: for example, only a very brief mention is made of the modern theories of benzene substitution, without reference to the workers in this field after Vorländer. Similarly, acetoacetic ester and the oximes are the only examples of tautomerism quoted, and the existence of other (and simpler) types is not referred to.

The book is well printed and produced, even though the binding leaves something to be desired.

Visibility in Meteorology:
the Theory and Practice of the Measurement of the Visual Range. By W. E. Knowles Middleton. Pp. viii+104. (Toronto: University of Toronto Press; London: Oxford University Press, 1935.) 8*s*. 6*d*. net.

"How far can I see to-day?" This question "assumes in the minds of the aviator and navigator an importance greater, perhaps, than that of any other meteorological matter. For such men it takes the place of that great public question which Sir Napier Shaw has called the fundamental problem of meteorology—'Will it rain to-morrow?'" Thus far the author who, in his introductory chapter, remarks very pertinently that the term *visibility* was not well chosen, the visibility of an object being an expression of the ease with which it can be seen, whereas "visibility" is a distance, and moreover, is the distance at which an object cannot be seen.

Methods for the estimation of visual range and a knowledge of the factors on which visual range depends are subjects of the first importance for those concerned with matters of transport, and the appearance of this monograph is very timely. Beginning with a general account of the behaviour of light in the atmosphere, the author proceeds to a discussion of the appearance of objects and of light sources seen through the lower atmosphere, linking up this discussion to calculations of the visual range by day of black, white, grey and coloured objects, the visual range of objects by moonlight and starlight, and the visual range of light-sources at night.

So far the exposition is general and theoretical, and the author now proceeds to a description of experimental work, of the estimation of visual range in practice, of the dependence of visual range on the other meteorological elements and of a rational scale of visual ranges.

The literature of the subject is already wide (the author provides a bibliography of about a hundred and fifty items) and scattered, and the author has done a real service in bringing together this literature and analysing it critically in a manner clear, stimulating and concise. A. F.

Anatomy of the Rat
By Eunice Chace Greene. (Transactions of the American Philosophical Society, New Series, Vol. 27.) Pp. xi+370. (Philadelphia: American Philosophical Society; London: Oxford University Press, 1935.) 22*s*. 6*d*. net.

THIS book on the topographical anatomy of the rat is more detailed than that on any other laboratory or domestic animal. In addition to such systems as are usually treated at length in a dissecting manual, special attention has been devoted to the circulatory, nervous and endocrine systems. Thus there is a wealth of information for the biochemist and pathologist, no less than the anatomist, inasmuch as the Wistar rat has not only become the most common experimental animal, but has also attained the position of the animal presenting the highest standard of accuracy in anatomical description.

Fundamentals of Biochemistry:
in relation to Human Physiology. By T. R. Parsons. Fifth edition. Pp. xii+453. (Cambridge: W. Heffer and Sons, Ltd., 1935.) 10*s*. 6*d*. net.

MR. PARSONS' original aim was to produce a theoretical treatise on biochemistry containing much less information than is given in the larger treatises but enough to describe in a continuous story the principles of an involved and growing subject. The book is now in its fifth edition, showing that it has met a demand, and it remains chiefly to note that the fruitful progress which is being made has enabled new sections to be recorded dealing with subjects which had long been thought to be of the greatest complexity. These relate to the chemistry of muscle metabolism, of the sex hormones and of the flavines. The speed at which new discoveries are being made in these and other fields of inquiry which are fashionable for the moment is quite remarkable; it contrasts with the lack of progress in certain other sections—at least this is the impression which the reviewer has gained from his perusal of the book.

The Philosophy of a Biologist
By Prof. J. S. Haldane. Pp. xii+155. (Oxford: Clarendon Press; London: Oxford University Press, 1935.) 6*s*. net.

THIS little monograph may be considered almost as the philosophical testament of a distinguished biologist. In it he gives his ultimate conclusions based on a lifetime of eminent achievements in the biological field. After a searching, but sympathetic, criticism of some conclusions based on physics, biology and psychology, Prof. Haldane asserts that the real universe is a universe of personality and the manifestation of God; and that its scientific aspects are only partial interpretations of it, its imperfect nature being revealed by philosophical criticism. No doubt materialists and mechanicists would take exception to some of the arguments or appreciations put forward by the author; but they would recognise no less readily the sincerity of purpose and generous ideals of a great mind who is now mourned by his intellectual peers throughout the world. T. G.

Handbook of Botanical Diagrams
By Dr. Blodwen Lloyd. Pp. 112. (London: University of London Press, Ltd., 1935.) 8*s*. 6*d*.

DR. LLOYD'S book contains a collection of good and well-reproduced diagrams to illustrate the usual first-year university course in botany. It therefore covers the syllabuses for Intermediate Science, First Year Medical, and Higher School Certificate examinations.

Although the whole work is well produced and attractive, it is very difficult to realise its usefulness. Not one of the diagrams would be found lacking in a text-book of this standard, though, of course, these illustrations are naturally reproduced on a larger scale. It is difficult to prevent students copying text-book diagrams; but it is a pity to encourage it, as this book certainly does. In any event, it can serve only as a supplement to a text-book, and as such, the price is rather high.

Role of Chemistry in the Study of Atomic Transmutation

By Prof. F. A. Paneth

"THE history of Alchemy is the history of an error." Such was, about seventy years ago, Hermann Kopp's short summary of centuries of attempts to transmute chemical elements[1]. It is well known that two generations later alchemy became a reality, when it had passed from the realm of the chemists to that of the physicists, who not only possessed the right weapons for attacking the atoms but also invented methods of detecting transmutations of matter on an infinitely smaller scale than those sought by chemists. One must, however, not overlook the importance of the help which was, and is, given by chemistry in many cases where a process of transmutation has to be investigated.

A combination of physical and chemical methods, frequently manifested by the collaboration of a physicist and chemist, was a decisive factor in the early days of radioactivity. The discovery, in 1898, of the new elements polonium and radium was due to the first application, by Pierre and Marie Curie, of the methods of 'radiochemistry'; that is, the ordinary methods of analytical chemistry were employed with invisible substances, and the effect of the attempted separations controlled by electrometric apparatus for the measurement of radioactive rays. Soon afterwards the 'active deposits', first considered as a sort of 'induced activity', were recognised as chemical substances with a definite behaviour through their response to treatment with acids, co-precipitation with various metals, etc. Further, the theoretical foundation of the whole science of radioactivity, the disintegration theory of Rutherford and Soddy, could only be laid after uranium and uranium X, thorium and the rare gas thorium emanation—to quote only two of the historically most important cases—had been chemically separated and their isolated radiations investigated.

After a few years of such radio-chemical studies, chemistry, making use only of its familiar methods, was able to confirm the fact of radioactive transmutation. A natural consequence of Rutherford's recognition of the α-rays as charged helium atoms was the expectation that any radio-element which emitted α-rays would evolve in the course of time a definite amount of helium gas. When in 1903 Ramsay and Soddy[2] succeeded in separating, purifying and identifying spectroscopically the helium newly formed in a radium salt, this first chemical demonstration of the fact that a well-known element had obviously sprung from another well-defined chemical element appealed especially to all those not acquainted with the radio-chemical technique of identifying invisible substances; although, therefore, the result of this experiment had been predicted, its influence on the definite acceptance of the idea of elementary transformation was very marked. It was comparatively easy later to show in a similar fashion the evolution of radium emanation from a radium solution, and to measure its quantity[3] and photograph its spectrum[4]; but besides helium and radon there is only one more element which, as a product of radioactive disintegration in the laboratory, has ever been chemically identified: radium D, originating from radon, has been collected by electrolytic deposition on a platinum anode, where it displays the characteristic colour and electrochemical potential of the isotopic lead superoxide[5].

Neither radio-chemical nor chemical methods played any part in the discovery and early development of the artificial transmutation of elements brought about by bombardment with α-rays. The fluorescent screen, used by Rutherford and Chadwick in their pioneer work in 1919, as well as the Wilson chamber and electrometric devices which were applied later, were able to record one single atomic disruption; and so much information could be collected by the careful interpretation of the observed phenomena that in many cases it was possible to write the full equation of the transmutation, including the chemical character of the new products, without a single chemical experiment having been performed. In this way even new atomic species of known elements have been discovered, and atomic weights have been determined with an accuracy superior to all other figures previously obtained[6]. Nevertheless, if chemical, or at least radio-chemical, methods could have been applied, they would not only have offered a means of checking indirect conclusions but also in many cases even decided between different possibilities. Radio-chemical methods were, naturally, excluded so long as only stable atoms were found as the products of artificial disintegration; but chemical detection of, for example, hydrogen produced by the α-ray bombardment of nitrogen, did not seem to be entirely out of the question, since the sensitivity of the spectroscopic identification of hydrogen in helium, according to a

statement of Collie and Ramsay[7], should be just high enough. A recent investigation[8], however, showed the experimental basis of this claim to be wrong.

The whole situation has now changed since the discovery of artificial radio-elements and the appearance of neutrons and of helium atoms among the products of artificial disintegration. When, two years ago, Irene Curie and F. Joliot[9] observed that in some cases the results of artificial transmutation were not stable but that they decayed with the emission of radiation much in the same way as the natural radio-elements, all the methods developed for the study of the latter became immediately applicable. While the instantaneous process of collision can only be investigated by the apparatus mentioned above, the subsequent radioactive disintegration opens the field for characterisation of the new products by their periods of decay, the quality of their rays, and—last but not least—their radio-chemical behaviour. Curie and Joliot[10] showed, for example, that a minute percentage of boron atoms bombarded by α-rays are transformed into a substance which emits positrons, decays with a half-value period of 14 minutes, and shows the chemical reactions expected of nitrogen; on the other hand, the chemistry of a product generated in the same way from aluminium accorded with the supposition of its being phosphorus. Here, for the first time in processes of artificial transmutation, it was proved chemically that new elements had been formed, and from the positions of these elements, as compared with the old ones, the mechanism of the nuclear changes could be deduced, independently of the conclusions reached by physical observations.

This fruitful collaboration of the chemist with the physicist was continued on a much larger scale by Fermi and his co-workers[11], who showed that bombardment by neutrons was effective in creating artificial radio-elements throughout the periodic system, up to the highest elements. The impact of a neutron on the nucleus of an atom may result in its capture, with or without simultaneous ejection of an α-particle or a proton. In the case of aluminium it was found that all three reactions occur:

$$^{27}_{13}\mathrm{Al} + ^{1}_{0}n \rightarrow ^{4}_{2}\mathrm{He} + ^{24}_{11}\mathrm{Na} \quad (T = 15{\cdot}5\ \mathrm{hr.})$$

$$^{27}_{13}\mathrm{Al} + ^{1}_{0}n \rightarrow ^{1}_{1}\mathrm{H} + ^{27}_{12}\mathrm{Mg} \quad (T = 10\ \mathrm{min.})$$

$$^{27}_{13}\mathrm{Al} + ^{1}_{0}n \rightarrow ^{28}_{13}\mathrm{Al} \quad (T = 2{\cdot}3\ \mathrm{min.})$$

In order to demonstrate the isotopy of the three new radio-elements with sodium, magnesium and aluminium respectively, the same method could be applied which, especially in the hands of Soddy and Fleck[12], had proved so useful in establishing the chemical character of the shorter-lived natural radio-elements; small amounts of the supposed ordinary isotopes were added and, after thorough mixing, it was shown by analytical chemical operations that the activity of 15·5 hours half-period was inseparable from the sodium, that of 10 min. half-period was inseparable from the magnesium, and that of 2·3 min. half-period inseparable from the original element aluminium.

In cases like the last where isotopy with the bombarded element has to be tested, it is especially necessary first to ensure the completeness of the mixing, because it is well known that differences in the chemical or colloidal state between the radio-element and its isotope, which have been present from the beginning, may give a false impression of a chemical separability[13]. Now, as a consequence of the formation of the artificial radio-element by the capture of a neutron, the chemical linkage of its parent element has necessarily been broken, and the new radioactive atom may be in quite a different chemical or physical state; the fact that for this reason the new isotope can often be easily severed from the parent element, although not a 'separation of isotopes' in the technical sense, provides a valuable method for its concentration, as was first pointed out by Szilard and Chalmers[14].

Other similar instances in which the study of the chemical nature of artificial disintegration products has been useful in clearing up the mechanism of the nuclear change are already much too numerous to be mentioned here. Naturally the more complicated the transformation process, so much the more welcome becomes the help of the chemist. Bombardment of thorium seems to lead to the building up of a series of subsequent radio-elements, in its general behaviour similar to, but differing from, the three known disintegration series; chemical investigation has assisted in disentangling the mixture of the new active atoms[15]. It has been reported[16], too, that the active isotope of chlorine $^{38}_{17}\mathrm{Cl}$, resulting from bombardment of ordinary chlorine with slow neutrons, does not immediately change into a stable substance, but that first an isotope of argon $^{38}_{18}\mathrm{A}$ is formed, which, with emission of α-rays, is converted into a sulphur isotope $^{34}_{16}\mathrm{S}$; the inertness of the noble gas argon should make it a simple affair for the chemist to test this assumption of an active argon isotope.

A much more difficult but very interesting task was set to chemistry after it had been found by Fermi and his collaborators that neutron bombardment of uranium produced a '13-minute-body' and a '90-minute-body', the position of which in

the system of elements could be either below or above uranium, highest of the known elements, since the mechanism of their formation remained obscure. Peculiar features in the analytical chemical behaviour made Fermi[17] believe that unknown elements above uranium had been formed. This was challenged by v. Grosse[18], who stated that the reactions of both bodies were identical with those of element 91, protactinium; but the discoverers of protactinium, Hahn and Meitner[19], by mixing the new radio-elements with the protactinium isotope uranium Z, showed them to be separable from protactinium, thus disproving Grosse's statement and supporting Fermi's claim of having discovered elements with atomic numbers higher than 92. From a study of these two bodies, which would appear to be subsequent members of a radioactive series, and perhaps themselves complex, chemistry, in its turn, will gain information about a previously inaccessible region of the periodic system.

We have mentioned above that in the development of the science of natural radioactivity, first radio-chemical, and then purely chemical, methods could be used for the identification of the products of transmutation. To-day, in the study of artificial transmutations, the second stage has been likewise reached. It is obvious that the task is here more difficult, owing to the much lower yield of newly formed matter. If we have at our disposal a quantity of 100 m.c. radon, by its complete decay 2×10^{-4} c.c. helium is formed; if, however, we use the same quantity of radon for the classical artificial disintegration of nitrogen, the amount of hydrogen produced is only of the order of 10^{-9} c.c., as only about one in a hundred thousand α-particles liberates a proton from a nitrogen nucleus; which, together with special difficulties met with in the microchemistry of hydrogen, explains the failure of the attempt mentioned above to identify by chemical means the artificially produced hydrogen. Recently, however, more effective processes of artificial transmutation have been discovered; by their impact on beryllium, one in about ten thousand α-particles knocks out a neutron from a beryllium nucleus[20] according to the equation:

$$^{9}_{4}\mathrm{Be} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{1}_{0}n + {}^{12}_{6}\mathrm{C}.$$

The neutrons are beyond chemical detection, nor is it possible to find such small traces of carbon in beryllium; but, after being slowed down by collision with hydrogen nuclei, the neutrons can be used up almost quantitatively by the reaction[21]:

$$^{10}_{5}\mathrm{B} + {}^{1}_{0}n \rightarrow {}^{4}_{2}\mathrm{He} + {}^{7}_{3}\mathrm{Li},$$

thus producing an approximately equal number of helium atoms; and the microchemical detection and measurement of small quantities of helium is astonishingly safe. In an experiment, based on these considerations, the neutrons, produced by the decay of about 2,000 mc. of radon mixed with beryllium, were used for the bombardment of one litre of boron methylate; less than 10^{-10} gm. of boron was disintegrated according to the above equation, and the corresponding 10^{-7} c.c. of helium separated from the ester, identified spectroscopically, and measured by a special manometer[22].

This fact that the artificial generation of an element has now been chemically proved by its preparation in bulk, without making use for its identification of any sort of radioactive method, such as fluorescent screen, Wilson chamber or electrometer, is a step nearer to the old alchemistic goal, although the amount of newly formed matter is still so small that only delicate microchemical methods can deal with it. As in Ramsay and Soddy's experiment, in which the production of helium by radioactive decay was shown for the first time, the qualitative result could be predicted; but in both cases the way to exact quantitative measurements has thereby been opened. It may well be that there are processes of transmutation going on with so little energy that the radio-physical and radio-chemical methods of detection cannot be applied; there is now hope that in some such cases ordinary chemistry will be able to discover the newly formed elements.

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Contacts between Plant Classification and Experimental Botany*

By Dr. W. B. Turrill

TAXONOMY, from the Greek origins of the word, is the law of order. The theory and practice of classification is, and has been, the first function of the taxonomist. In the earlier history of botanical taxonomy the theory was based primarily on the dogmas of the creation and fixity of species, and this tended to the codification of artificial laws for classifying the taxonomic units, with the practical aim of easy and certain identification. With the acceptance of evolutionary ideas, the theory has largely changed, and with this change other applications have appeared and sometimes confuse results. The dogma of the constancy of species had at least one advantage for the taxonomist—his work was simply the classification of theoretically clear-cut units. Nowadays, the dynamic point of view is in vogue, and phylogenetic considerations are sometimes allowed to dominate the practical issue of classification. How far supposed phylogeny can be used advantageously in classifying the larger plant groupings is not a subject-matter of this paper; but there is a danger that classification for utilitarian purposes may be subordinated to classification for the sake of theoretical considerations.

Owing largely to the broad training which is now generally given to botanists in schools and colleges, the number of professional botanists who are content merely to identify, describe and classify on the basis of gross morphology is being reduced. It may, indeed, be suggested that a static system of endless descriptions would kill taxonomy. Many systematists give a phylogenetic flavour to the dishes they set before their colleagues. Phylogeny, to be real, must lead to a consideration of genetical problems, and the taxonomist immediately comes into contact with experimental work. Or, the taxonomist becomes keenly interested in the distribution of the plants with which he works, and modern phytogeography naturally links up with ecology and with many of the ecological problems which can only be solved by experiment. My object here is to discuss those contacts with genetics and experimental ecology which can lead to improved taxonomic technique and results, and perhaps to radical changes of outlook. It should, however, be expressly stated that no derogatory criticism is made of those taxonomic methods which are now in general use, except to emphasise their limitations. A working taxonomist knows only too well how much yet remains to be done by the older methods, the usefulness of which will probably never be exhausted. There are, however, many essentially taxonomic problems which cannot be solved by comparative morphology alone, and taxonomists have a duty to their science in directing the attention of their genetical and ecological colleagues to these.

Exact identification of the material used is, or should be, a first consideration in biological experiments. A geneticist or ecologist who does not ask for and use the advice of a systematist runs chances of such error as may make his work not merely useless but even misleading. There are, then, so many occasions on which the taxonomist and experimental botanist can co-operate with reciprocal advantage, that the wonder is that more attempts to understand each other's problems have not been made. A plea is here put forward, from the taxonomic point of view, that geneticists and ecologists will undertake problems the solution of which will materially assist the taxonomist. It is convenient to consider some of these problems under two broad heads—genetical contacts and ecological contacts.

Genetical Contacts

Genetics, it is interesting to remember, commenced as an experimental science, and though it is now inextricably linked with mathematical formulæ and with observational cytology, it still retains the living plant or animal as its basic material. Genetical experiments in plants have a simple fascination for the taxonomist in that a considerable number of living individuals, grown under uniform conditions, can be studied comparatively. The importance of studying living material is often forgotten by herbarium workers, just as the importance of herbarium material is often ignored by experimentalists.

There are, however, contacts more peculiar to geneticists and taxonomists. The establishment of a phylogeny on an objective basis depends fundamentally on palæobotany and, for the smaller taxonomic groups, on genetics in the broad sense. If the morphologist arranges a group of organisms in a linear sequence, he can only suggest very tentatively that the sequence is phylogenetic and which way it should be read. If he makes a radiating or branched diagram to illustrate his theories, the results cannot, in the absence of

* Paper entitled "Aspects of Experimental Classification" at the International Botanical Congress at Amsterdam, September 1935.

palæobotanical or genetical data, be considered as more than possibly true. Perhaps the work of Prof. Babcock and his colleagues on the genus *Crepis* best illustrates how genetical, and especially cytogenetical, studies can control phylogenetic speculation.

The taxonomist has one constantly recurring problem, that of evaluating characters, and on the evaluation subordinating one taxonomic group to another, or, alternatively, equating them. Put simply, this usually means, shall he consider *A* and *B* as distinct species or as subspecies or varieties of one species? Similar problems of genera and subgenera, etc., occur among the larger taxonomic groups, but are less amenable to experimental treatment than those at the species to variety levels. This problem has received very little deliberate treatment by modern methods. My own experience and the published results of geneticists with which I am acquainted, and which bear more or less directly—though usually unintentionally—on the subject, suggest that the kind and degree of morphological difference often give, by themselves, very little indication of how the units should be subordinated on a sound basis of fact. So far genetics has not, by itself, given us as much help as might be expected in determining the relative value of phenotypic expressions of related but different genotypes. Thus within *Silene Cucubalus* or *S. maritima* we find, after twelve years' work, that, with very few possible exceptions, no greater taxonomic value can be given to any one genotype than to any other on the basis of genetical behaviour alone; that is to say, no one varietal character or set of characters can be taxonomically subordinated to any other by its genetical behaviour, except, perhaps, in a few examples of clear-cut dominance. Mere accumulation of different genes gives, as I have shown elsewhere, no satisfactory basis for subordination in classification.

The importance of isolation as a taxonomic criterion can scarcely be exaggerated. Species must be morphologically distinguishable and determinable, but so must varieties. Species, however, must be isolated one from another, otherwise they inbreed to form one polymorphic multivarietal species. The kind and degree of isolation is a wide subject, involving ecological, phytogeographical and other considerations, besides genetical. The taxonomist is most often concerned with wild plants, and it is therefore of great importance to him to know what they actually do in Nature rather than what they can do when brought together artificially. Yet the most complete isolation is undoubtedly complete inability to cross. This inability to cross cannot usually be judged *a priori* on the basis of degree or kind of morphological difference. Thus Chittenden and I showed that in the genus *Nemophila* some, at least, of what a recent worker has called subspecies and varieties of *Nemophila Menziesii* were not only morphologically distinct but also would not cross even with reciprocal pollinations. On the other hand, some morphological entities, quite distinct when selfed, interbred with full fertility (*Kew Bull.* 1926, 1). In this genus, certainly, the entities completely isolated by failure to cross fit in with the best conception of species, those that inbreed agree with the best definition of varieties. *Centaurea Scabiosa* and *C. nigra* will not cross reciprocally, though they very frequently occur together in Nature; *C. Scabiosa* and *C. collina*, morphologically quite distinct, can be crossed artificially, and produce fertile offspring, though they appear to keep distinct in Nature, owing to other, probably in the main geographical, barriers to interbreeding. The behaviour on crossing of plants belonging to the same species, in that they are not morphologically differentiated, but from populations isolated by discontinuous distribution, is another subject which the taxonomist would suggest for extensive genetical experiments.

The cytological demonstration by Prof. C. L. Huskins of the hybrid origin of the true-breeding *Spartina Townsendii*, and the artificial creation of *Galeopsis Tetrahit* by Dr. Müntzing suggest that hybridisation may be more important in evolution than is yet realised. How far the reticulate connexions between species, genera and families is due to this it is impossible at present to say. The writings of the late Dr. Hayata on the dynamic system of plant classification are often difficult to understand, but that reticulations similar to those of which he gives examples are of very common occurrence in plants is certain, and the failure to account for them or even to consider them is a major fault in most systems of classification that claim to be more than artificial conveniences. We have few general data as to the taxonomic limits within which fertile hybrids can be produced. Intergeneric hybrids in orchids would surely pay for more detailed analysis. This reticulate distribution seen in character combinations at all taxonomic levels (varieties, species, genera and families) may or may not be due to hybridisation having been the major factor in evolution, as the late Dr. Lotsy urged, but it is surely a subject which should be analysed from the genetical point of view. A taxonomist would also like the regular publication of the negative results of genetical experiments. That the species cannot be made to cross may cause the geneticist to lose interest in a genus, but such genetical isolation may have very considerable taxonomic importance.

The taxonomist studying widely-distributed species frequently finds that the intraspecific variation is not only great but also varies in kind and degree in different parts of the distributional area. Such variation must, in view of the specific and varietal criteria already suggested, be of interest both to the geneticist and the taxonomist, and important in the study of both wild species and cultispecies. While the investigation of intraspecific variation and heterozygosity is well advanced for many of the latter, relatively few wild species have been intensively and extensively studied genetically. Wild species must be the only material which can give real proof of the origin of species by, for example, natural selection, and it is surely much better to obtain and use the necessary data from such, rather than to estimate selection by analogy with plants known only in cultivation or by mathematical symbolisation not directly based on experiment.

In his troubled career, the taxonomist meets, or if he be wise, tries to avoid, such genera as *Rubus* in the British flora or *Cratægus* in the North American. The taxonomy of the British genus *Rubus* is in such a state that specialists sometimes cannot agree in more than one determination in ten. It is probable that the usual taxonomic recording is really impracticable in such genera as *Rubus*, and a totally different scheme from that of species and varieties will have to be evolved before stability of expression is reached. Before such can be elaborated, the taxonomist requires data concerning genetical stability, hybridisation, heterozygosity and so on, which can only be obtained by genetical experiment.

Ecological Contacts

The ecologist studies primarily the relationship between plant-life and environmental conditions. Synecology cannot, of course, be properly studied without a good taxonomic knowledge of the local flora—a knowledge which some ecologists unfortunately do not trouble to obtain. Here, again, the help of the taxonomic specialist should be sought, and it will be the more readily and the more precisely given if the taxonomist obtains in return good sets of specimens for his collections. Synecology, however, is not essentially experimental in method. Autecology is or should be largely experimental, and is very closely related indeed to taxonomy. One can almost say that any autecological fact is of taxonomic importance.

The essential difference between stable (constant) or unstable (inconstant) characters is that, in the former, different environments cause no change when interacting with the same genotype, while in the latter the phenotypic expression of the same genotype fluctuates with the environment. The degree of plasticity in a given range of different environments is a specific character which cannot be known *a priori* in the absence of experimental evidence. The British Ecological Society's transplant experiments at Potterne have shown very clearly that reaction to soils varies greatly in different species. Thus *Centaurea nemoralis* flourishes almost equally well on the five soil types being used; *Anthyllis vulneraria* shows no change in morphological characters, but different death rates; *Fragaria vesca* and *Phleum pratense* are decidedly plastic, especially in quantitative characters; *Plantago major* is so decidedly plastic that one is forced to conclude that recent taxonomic publications on this and allied species based on herbarium material and without experimental support have little value. Transplant experiments, properly conducted, with full scoring and analysis of data, are slow and time-consuming, but until such are extended to a much wider range of species and of environmental conditions (especially changes in the wide series of climatic factors) the taxonomist has to make rough guesses from meagre observational data.

Another ecological subject of taxonomic importance is the occurrence of habitat barriers between species and also between what Dr. Turesson calls ecotypes. It has already been remarked that the kind and degree of isolation between putative taxonomic units is of the greatest importance in the establishment of an objective classification. Such isolation may be genetical, it is often geographical, and not infrequently it is ecological. Sometimes the isolation is so great (if not absolute) that morphologically distinguishable units are justifiably ranked as species, even if they can breed together to give fully fertile offspring. *Silene Cucubalus* and *S. maritima* are common British plants, each with a distinct ecological range. In the experimental ground they cross readily, and the offspring are fertile *inter se* and with each parent. The two species rarely meet in Nature; natural hybrids are therefore few, and amalgamation of the two species to one does not take place, as it might well do, but for the ecological barriers.

Seasonal dimorphism is of importance to the taxonomist in adding not only to the difficulties of identification but also to those of classification. The late Prof. Wettstein, it will be remembered, stressed its importance in his studies of the genera *Euphrasia*, *Gentiana* and *Alectorolophus*. It is much to be desired that experimental evidence should be obtained on a large scale as to the constancy of development and flowering at different seasons, and the variation in characters with age, especially with age reckoned from the commencement of annual growth, and of the correlation of these with other specific or varietal criteria.

Summary and Conclusions

Of the many subjects of common interest to taxonomists, geneticists and ecologists, those mentioned here have, for convenience only, been referred to under the two headings, genetical and ecological. This division is artificial and unsound in practice. It is only when all methods are used, so far as possible on the same material, that taxonomic judgments can have any final value. It can be justly urged that the professional taxonomist is frequently too overwhelmed with the mass of material he is expected to identify and classify to have time to carry out slow time-consuming experiments, even if he has facilities for them. On the other hand, those taxonomists who have had a recent botanical training should have a sufficient grounding in plant ecology and plant genetics to be able to appreciate those ecological and genetical methods and results which bear on their own studies, and should be keen to co-operate with their colleagues. It is also probable that a continual personal acquaintance with experiments on living plants, even if on a small scale, is advantageous to the taxonomist in keeping his outlook broader than it can be with herbarium routine not merely dominant but absolute. The judicious use of an experimental ground attached to a taxonomic institution pays over and over again in increased interest in major problems and in efficiency in solving taxonomic difficulties.

It may be an overbold thing for a taxonomist to suggest to his genetical and ecological colleagues that, if he were consulted, he could set them problems the solution of which would not only have first-class value in the special domain of genetics or ecology respectively, but would also directly assist the taxonomist. The taxonomist often regrets that relatively so much more genetical research has been concerned with cultivated than with wild plants. He realises the economic reasons for this, but hopes that more research can be undertaken which has not an economic end directly or immediately in view. If botanists with opportunities would undertake intensive studies on small groups of allied species, with a taxonomic ideal but using genetical, ecological and other experimental and observational methods, they would produce work of permanent value, and help to the unity of botanical science.

Obituary

Prof. J. S. Haldane, C.H., F.R.S.

"Il montra que si le physiologiste doit sans cesse recourir aux notions que lui fournissent l'anatomie, l'histologie, la médecine, l'histoire naturelle, la chimie, la physique, il doit en rester le maître, les subordonner à ses propres visées;" . . .

Thus a distinguished worker in Haldane's own special sphere, namely, Paul Bert, summed up the teaching of another great physiologist—Claude Bernard. The words are no less applicable to Haldane himself, for, remarkable as were his researches and writings on many aspects of pure and applied physiology, their value was founded in his deep insight and his search for a philosophical basis on which he could build up an intelligible interpretation of the phenomena of life, which he saw could only be understood as a whole.

It is a proof of the acuteness of Haldane's insight that, so early as his days as a medical student at Edinburgh, he was not content to accept without inquiry a teaching of physiology which did not satisfy his demands for a consistent description of its various aspects. His impatience with superficiality and desire to penetrate to fundamental conceptions of phenomena lasted throughout his life and found expression in a series of philosophical essays and books, which began with an "Essay in Philosophical Criticism" published in 1883 in collaboration with his brother Lord Haldane, and culminated in "The Philosophy of a Biologist", 1935. Between these times he never lost his interest in philosophy and, despite the great amount of work he did in pure and applied physiology, found time to write "Mechanism, Life and Personality", 1913, "The New Physiology", 1919, "The Sciences and Philosophy", 1928 (Gifford Lectures), "The Philosophical Basis of Biology", 1931 (Donellan Lectures) and "Materialism", 1932.

Though Haldane always maintained his insistence on the necessity for broad conceptions, he became particularly interested in the physiology of respiration at the very beginning of his scientific work. This interest in respiration led him in turn to another aspect of physiology of which he was a brilliant pioneer, namely, its applications to problems of industrial hygiene. His thoughts perhaps turned in this direction owing to the fact that he became demonstrator at University College, Dundee, under Prof. Carnelley, with whom he carried out an investigation of the various impurities present in the air in buildings and sewers, which was published in 1887.

Soon afterwards Haldane went to Oxford, where he became demonstrator in physiological chemistry under his uncle, Sir John Burdon Sanderson, and where he remained for the rest of his life. Here he soon began the work which led to the publication,

mainly in the *Journal of Physiology*, of an important series of papers on the blood and respiration, which not only did much to establish his own fame, but also made world-wide the reputation of the Oxford Schools of Physiology and Medicine and led to general recognition of the importance of the study of human physiology. The earliest of these papers was a short note in which he disproved D'Arsonval's idea that some poisonous impurity was given off in expired air. This note contains his first suggestion that carbon dioxide is the most important factor in regulating the respiration, and was amplified in 1893 in two papers in the *Journal of Pathology and Bacteriology*. Two papers on respiratory exchange followed, and then in 1894 Haldane and Lorrain Smith visited Christian Bohr's laboratory at Copenhagen, where they worked on the specific oxygen capacity of the blood, and learned much about gas analysis.

Haldane was remarkable for his skill in devising methods of investigation no less than for the broad view he took of physiological problems, and from the knowledge he acquired from Bohr he developed his technique of gas analysis, which has been generally adopted. He published his first description of his apparatus for air analysis in the *Journal of Physiology* in 1898, and afterwards gave a further account of his methods in "Methods of Air Analysis", 1912. This book obtained wide recognition, and in the preparation of subsequent editions Haldane was helped by his colleague, Dr. Ivon Graham. As was written of another—"The very air we breathe, he has taught us to analyze, to examine, to improve".

In 1895 Haldane began an inquiry into the nature and action of the suffocative gases met with in the air of coal mines, and was thus led to investigate the physiological action of carbon monoxide, the poisonous effect of which he showed to be due solely to its power of combining with hæmoglobin and so putting it out of action as an oxygen carrier. It was with astonishing insight that Haldane saw how this work opened the way to an effective attack on many important problems. He devised a simple method of detecting and estimating carbon monoxide in air by carmine titration of blood with which the air was shaken; he found that the stability of the carbon monoxide–hæmoglobin complex in the presence of oxygen was much decreased by the action of light; he devised a method of deducing the oxygen tension of human arterial blood from its saturation with carbon monoxide after breathing air containing this gas; he investigated the evidence that carbon monoxide is oxidised in the body and found it unsatisfactory; he determined the mass and oxygen capacity of the blood in man by the carbon monoxide method and he devised his modification of Gowers' hæmoglobinometer, which is still unequalled.

During these years Haldane did other important work on the blood pigment and its derivatives. He investigated the action of ferricyanide on the oxygen —and carbon monoxide—hæmoglobin complexes and showed that this reaction could be used to determine accurately, without the use of the blood-pump, the volume of oxygen capable of being absorbed by hæmoglobin. On this basis in 1902 he designed, with Barcroft, an apparatus for accurately measuring the oxygen and carbonic acid in small quantities of blood. Later this apparatus was improved by Brodie, and Barcroft developed from it his well-known 'differential' apparatus. In 1920 Haldane improved the method by substituting measurement of the gas liberated at constant pressure instead of at constant volume.

In 1903 Haldane turned again to the important, but then obscure, problem of the regulation of the respiration, the key to the solution of which he had already indicated in 1893. With the help of his own methods of gas analysis and by the simplest means, he proved that it was possible to obtain and analyse samples of 'alveolar air', and he made many observations on the composition of this alveolar air in human subjects at rest and during muscular work, as well as when they were exposed to widely differing barometric pressures or were breathing air containing excess or deficiency of oxygen or carbon dioxide. He was thus able to show the exquisite sensitiveness of the respiratory centre to changes in arterial carbon dioxide pressure, and to afford an insight into the means by which the breathing is so regulated as to satisfy the varying requirements of the body from moment to moment. It is on this fundamental basis that the whole of our knowledge of the physiological regulation of the breathing is securely founded.

This work, which was published in 1905, was undoubtedly the most important of Haldane's physiological researches, and the results formed perhaps the strongest foundations on which he based his philosophy of biology. Apart from revolutionising the ideas then prevalent about the regulation of the breathing, it indicated far more clearly than had been done before the amazing delicacy with which different physiological functions are co-ordinated, and it made intelligible the responses of the body to differing conditions. Later he extended the results of this paper, and then turned to the investigation of the effects of low atmospheric pressure and want of oxygen on the respiration, and showed the explanation of periodic breathing.

In 1911 Haldane led an expedition to Pike's Peak to study the effects of low atmospheric pressures and the process of acclimatisation, and afterwards published further work on this subject. In his last years he was keenly interested in the physiological problems of very high flights.

In 1913 and 1914 Haldane investigated the absorption and dissociation of carbon dioxide by human blood and devised a method of determining the circulation rate in man which was founded on the results so obtained. In 1916 he took up the question of the nervous regulation of the respiration and showed how this was related to the chemical regulation. His later work on respiration was concerned with the respiratory response to anoxæmia and the effects of shallow breathing and resistance to the respiration.

His measurements by his carbon monoxide method of the oxygen pressure of arterial blood together with many other observations had convinced him that in

certain circumstances secretion of oxygen inwards must occur in the lungs. Krogh's aerotonometer measurements, however, indicated equally clearly that diffusion alone sufficed to account for the facts. Both methods seemed to be reliable and the discrepancy between the results they gave remained unexplained until Haldane proved from his observations on shallow breathing that they did not measure the same thing. The aerotonometer method measures the oxygen pressure of the mixed arterial blood leaving the lungs, while the carbon monoxide method measures the average of the oxygen pressures of the blood in different parts of the lungs, some of which are well, but others poorly, ventilated.

Haldane maintained that oxygen secretion by the lungs is one of the most important factors in acclimatisation to high altitudes, and that it may be aroused in other circumstances when the body is subject to deficiency of oxygen; he also believed that it may come into play during muscular work.

Haldane's physiological work was by no means confined to respiration. He studied the responses of the body to high external temperatures, and found that activity of the sweat glands evokes adjustment of other physiological functions in a particularly interesting manner. He also showed that the activities of the kidneys are closely connected with those of other organs and that their response to chemical stimuli is of the same order of delicacy as that of the respiratory centre. From his observations of coloured shadows and contrast he found further support for his interpretation of physiological phenomena.

Work with Haldane was at once an education and a delight. His wide views based on his philosophy enabled him to see essentials and disregard non-essentials so surely that the true value of his clear and simple conclusions could perhaps be fully appreciated only by those who had the privilege of working with him. Of practical experimental procedure, too, he was a master. His results could scarcely be surpassed in accuracy, though his methods were his own. His adherence, for example, to the use of a wooden match as an aid in reading a burette remained unshaken by the introduction of electric torches. He was not upset by conditions which would fill many with dismay. His analyses were just as efficiently conducted at the bottom of Dolcoath mine or in the middle of the night in the Station Hotel at Inverness as in his laboratory at Oxford. Those who worked with him had to conform to his customs. Work generally did not begin before midday, despite any arrangements which might have been made previously for a special occasion. Once begun, it was apt to continue until 2 or 3 a.m., though tea and dinner were not lightly disregarded. Though these ways were occasionally a little trying to those adapted to a different routine, they only increased an affection which was founded on admiration of his genius and his never-failing kindness, and appreciation of his humour. Though he was an acute critic, there is no record among those who worked with him of Haldane's ever being out of temper, and the bond between them is one of the most remarkable tributes to his character.

Great as Haldane was as a physiologist, he was equally great—indeed unique—as an investigator of the physiological problems of industrial hygiene. In 1896 he made a report on his investigations of the cause of death in three colliery explosions. He had already shown that the then prevalent view as to the symptoms produced by exposure to black damp and after-damp was inaccurate, and his report forms the basis of the measures which have been devised and are in force throughout the world for dealing with the dangers due to fires and explosions underground. From that time Haldane's interest in problems affecting the health of miners never slackened, and he was untiring in his investigation of such matters as the ventilation of mines and the prevention of underground explosions, ankylostomiasis among Cornish miners, the effects on underground workers of inadequate illumination and of high atmospheric temperatures, and liability to silicosis in consequence of the inhalation of different kinds of dust. His never-failing devotion to the welfare of the miners, and the value of his work, were recognised in 1912 by his appointment as Director of the Doncaster Coal Owners' Research Laboratory, and brought him the unique honour for a physiologist of being elected to the presidency of the Institution of Mining Engineers in 1924.

As one of the Gas Referees under the Board of Trade, Haldane did invaluable work on the composition and properties of illuminating gas.

The Home Office, the Army and the Navy, too, owed much to Haldane. He served on many commissions and was a member of a committee which inquired into the physiology of the soldiers' food, clothing and training, and the report of which brought about important reforms. During the Great War, he was called upon to advise about protection against poison gases, and not only did valuable work with regard to emergency provision of respirators but also pointed out that only some form of box respirator could ensure protection. He did valuable work on the pathology and treatment of gas poisoning and made clear the physiological effects of shallow breathing, which was a prominent symptom in chronic cases. Recognising the grave dangers of anoxæmia, he devised an apparatus for the economical and effective administration of oxygen.

For the Navy, Haldane investigated the ventilation of battleships and submarines, but his most important work was his inquiry into the difficulties and dangers besetting divers. His characteristic insight enabled him to grasp at once the cause of the serious limitation of the divers' capacity to do muscular work, of which complaint was made. He showed that this was due to the high pressure of carbon dioxide present in their helmets owing to the inadequacy of the pumps then in use. Having made sure that the divers' air supply was sufficient, he began a thorough investigation of compressed air illness and its prevention, and set to work to devise a method of decompression both safe and time-saving. He noticed that symptoms in animals and men only occurred after rapid decompression from a pressure at least one atmosphere in excess of normal to sea-level pressure, and proved

by an extensive experimental investigation that the method of very slow decompression was in some respects actually harmful. He also proved that a method of 'stage decompression' was both safer and quicker. He calculated tables for regulating the safe rate of decompression of divers by stages corresponding to the pressures to which they had been exposed and the duration of their exposure. He again took up this problem in 1935 and worked out tables for still greater pressures. His stage decompression is now generally used and has undoubtedly saved many lives, besides making it possible for divers and tunnellers to work at pressures otherwise unattainable.

Haldane gave a full account of his work on the physiology of respiration and of some of his investigations in applied physiology in his Silliman Lectures, which were published under the title "Respiration" in 1922. A new edition, to the rewriting of which he devoted much time and care, appeared in 1935. In this book, unrivalled since it first appeared, he has left a record worthy of his genius.

Haldane was created a Companion of Honour in 1928 in recognition of his scientific work on industrial hygiene. The many other honours which he received, and which are recorded elsewhere, included the Copley Medal of the Royal Society in 1934.

Only a few weeks before his death, which occurred after a short illness on March 14, in his seventy-sixth year, Haldane had returned, apparently in good health, from a visit to Persia and Iraq, whither he had gone to study heat-stroke.

Haldane's influence on all aspects of physiological thought has been enormous and his loss is not only a bitter blow to those who knew and loved him, but also leaves a gap in the application of physiology to industrial and medical problems which will indeed be hard to fill. J. G. P.

Mr. Maurice C. Macmillan

A MONTH ago we recorded with much regret the death of Mr. George A. Macmillan, one of the directors of Messrs. Macmillan and Co., Ltd., the publishers of NATURE. Another link connecting the journal with this publishing firm has now been broken by the death on Monday last, March 30, at eighty-two years of age, of Mr. Maurice Crawford Macmillan, brother of Sir Frederick Macmillan, the chairman of the company, and cousin of Mr. George Macmillan.

The firm was founded in 1843, when Mr. Daniel Macmillan, the father of Sir Frederick and Mr. Maurice Macmillan, was joined by his younger brother Alexander and published the first volume with the name of Macmillan on the title-page, namely, A. R. Craig's "Philosophy of Training". Seven years later the firm adopted the title Macmillan and Co., which it has retained ever since.

Mr. Maurice Macmillan entered the business in 1882, after a distinguished career at Uppingham and Cambridge, followed by five years' experience as an assistant master at St. Paul's School, under Dr. Walker. He devoted himself particularly to the educational side of the business, and to him is largely due the comprehensive list of standard books for students of all standards and subjects published by the firm. He was keenly interested in every aspect of educational work, from the primary school to the university, and he followed with close attention all developments in methods of teaching scientific and other subjects. He was chiefly responsible for the establishment of branches of the firm in India, Australia and other centres where the educational publications of the firm are largely used.

Though NATURE was founded several years before Mr. Maurice Macmillan came into the firm, he was always an encouraging supporter of it and was keenly interested in many scientific subjects dealt with in these columns. In this, as well as in the selection of books of high standard, he rendered valuable service to science, and we pay a grateful tribute to him for his great work and beneficial influence over a period of many years. He leaves three sons, two of whom, Mr. Daniel Macmillan and Mr. Harold Macmillan, M.P., are directors of the firm.

MR. GEORGE HUBBARD, a London architect of distinction, who was twice a vice-president of the Royal Institute of British Architects, died at his residence at Eltham on March 19, his seventy-seventh birthday. Mr. Hubbard was well known as an archæologist and collector of antiquities. His most noteworthy contributions to archæological studies were a paper on "Architecture on the Eastern Side of the Adriatic", and in prehistoric archæology a book written in conjunction with his brother, A. J. Hubbard, on "Neolithic Dew Ponds and Cattleways", published in 1905, which went far to settle finally the problem of the construction and uses of this primitive method of dealing with deficiencies of water supply.

WE regret to announce the death at the age of sixty-nine years on February 27 of Prof. Charles Jules Henri Nicolle, for more than thirty years director of the Pasteur Institute of Tunis, and professor at the Collège de France. He is best known for his work on typhus, which in 1909 he proved to be transmitted by the clothes louse. He was also a pioneer in the prophylaxis of this disease and of measles, in addition to much valuable work on other infectious diseases, for which he was awarded the Osiris Prize of the Institut de France in 1927, and a Nobel Prize in 1928. Prof. Nicolle was a member of the Paris Academies of Sciences and Medicine, and an honorary fellow of the Royal Society of Medicine.

WE regret to announce the following deaths :

Sir Archibald Garrod, K.C.M.G., F.R.S., formerly regius professor of medicine in the University of Oxford and consulting physician to St. Bartholomew's Hospital, on March 28, aged seventy-eight years.

Sir Joseph Petavel, K.B.E., F.R.S., director of the National Physical Laboratory, Teddington, on March 31, aged sixty-two years.

News and Views

Ancient Monuments in Northern England

In view of the services which are being rendered to archæological and historical studies by the Office of Works through its activities in protecting and preserving our ancient monuments, it is both an advantage and a necessity that the co-operation of the public should be obtained in furthering the purpose of this work. For this, among other reasons, it is desirable that a knowledge of aims and methods, as well as of what has already been achieved under existing legislation, should be as widely diffused as possible. Much depends here, as with the collections in our national museums, upon the extent to which a suitable literature is available, from which the visiting public may learn what is most significant and best worth attention. Already at many of the ancient monuments—ultimately, no doubt, at all of any importance—detailed accounts, which cover technical matters, as well as plans and general descriptive notes, are available for the visitor; but a broader view which entails comparative treatment has been attempted in a new series of official publications which has been inaugurated by the First Commissioner of Works himself ("Illustrated Regional Guides to Ancient Monuments under the Ownership or Guardianship of His Majesty's Office of Works: Vol. 1, Northern England". By the Right Hon. W. Ormsby-Gore. Pp. 52. London: H.M. Stationery Office. 1*s*.). It is interesting to note how Mr. Ormsby-Gore has attacked what is really a difficult problem. The average visitor may be expected to have a historical background adequate for appreciation of the character of Norman castle or abbey; but how will such a visitor approach, for example, the Devil's Arrows at Boroughbridge? Wisely, differential treatment has been adopted. In the historic period the monuments are classified, each according to its kind, and then briefly described *seriatim*, but for the prehistoric period, the prehistory of the region has been reviewed as a whole, the protected monuments being used to support and illustrate the argument. This has the additional advantage that it brings out the essential function of the Department far more clearly than would be possible in a mere annotated list.

Electioneering in Ceylon

The results, and still more the methods of electioneering, in the recent general election for seats on the State Council of Ceylon, afford an instructive, if somewhat alarming, example of the effects of the break in tradition, which comes with the wholesale application of the machinery of Western democracy to an Eastern society, in which the exercise of individual judgment has had neither training nor opportunity to function independently of the social or religious communal group. Everywhere religion and caste dictated the decision of the electors. Group clashes were frequent, and twelve persons lost their lives. In at least two instances, it is stated by the Colombo correspondent of *The Times* in the issue of March 24, Christian members of long standing and conspicuous public service lost their seats to opponents, unknown before the contest, whose principal qualification appears to have been that they were Buddhists. This exploitation of sectional prejudice was, perhaps, no more than might have been anticipated, even though it scarcely appeared in the elections of four years ago. The grant of adult franchise to both sexes has placed on the electoral register 2,500,000 voters, of whom, it is estimated, 2,000,000 are illiterate. In consequence, the voting had to be conducted by the allocation of a colour to each candidate, the ballot paper being deposited in the appropriately coloured box in blank. Yellow, the Buddhist colour, swept the board. Of forty-three contested seats, thirty-three went to Buddhists, an increase from twenty-eight in the previous Council. Universal suffrage was granted to Ceylon on the report of the Donoughmore Commission, which visited the island in 1927; but the results of the present election have raised in an acute form the question whether it is likely to prove as beneficial as was anticipated. A strong body of influential opinion is pressing for an inquiry.

The Race Problem

In his Friday Evening Discourse at the Royal Institution on March 27, Prof. Julian Huxley discussed "The Race Problem". It is obvious that different geographical groups of the human species differ inherently from each other; the term *race* is commonly employed to denote such a distinguishable group. Various difficulties crop up, however, as regards its usage in practice. First, characteristics which have no genetic basis, but are national, cultural, linguistic, etc., have been erroneously ascribed to races. For example, there cannot exist such a thing as an 'Aryan race', since the term Aryan concerns language; again, the main obvious differences between, say, the English, the French and the Germans, are not genetic but of national and cultural origin. Secondly, modern genetics has shown that after a cross, all possible combinations of the genes concerned will be produced, and will then continue to recur. In the absence of selection, no even approximately uniform blend will be formed. Thirdly, man is such a mobile organism that migration and intercrossing between different groups has been occurring on a large scale since before the dawn of history. Accordingly, nothing approximating to a pure race now exists, with the possible exception of a few remote and primitive tribes. *Race* is normally used of man in the same sense as race or subspecies of animals—that is, with an evolutionary implication.

At best, it may be legitimately used of the hypothetical major groups (for example, black, white and yellow) into which we deduce that our species early became differentiated, and which may be called *primary races*; and of the equally hypothetical subgroups apparently produced by later differentiation (for example, Nordic, Alpine or Mediterranean), which may be called *secondary races*.

AT the present day, there exists no important human group which can properly be called a race, and the use of the term not only has no useful application, but actually leads to confusion, both scientific and political. For groups of people genetically distinguishable from other groups, some noncommittal term like *ethnic group* or *ethnos* is indicated. Ethnic groups of various degrees of difference will be distinguished; the only scientific method of so doing is to take the mean, the frequency curves, and the conditions of several measurable physical characters. For the common adjectival use of *racial* as opposed to national, cultural, etc., the terms *ethnic* or *genetic* should be used, according to circumstances. To define *race* in man scientifically is impossible, since the implications of the term do not conform with reality. Meanwhile, since the word race has been widely used in a pseudo-scientific way to justify and rationalise various political and nationalist activities, it is highly desirable that an international inquiry should be made which would result in an impartial scientific pronouncement on the subject.

Defence Against Air Raids

IT is announced that the committee set up in February 1935, under the chairmanship of Mr. H. T. Tizard, Rector of the Imperial College of Science and Technology, has been considering proposals from various sources for countering raids by enemy aircraft. The vast bulk of these suggestions are impracticable simply because of a lack of appreciation of the conditions. A certain number are workable up to a point, but depend upon the enemy being visible from the ground, or upon the defending aircraft being able to make contact with the attackers. Two factors in modern aeronautical development tend to militate these chances. Advances in navigation and blind flying enable raiders to remain continuously in clouds, with a reasonable chance of reaching their objective. If observed, owing to an unexpected breaking of the cloud curtain, the high speed of modern aircraft helps them to avoid any measures directed against them from the ground, and also to keep away from defending aircraft, unless the latter are already at the same height and of considerably greater speed. There are, however, schemes in hand which promise workable results. Wireless-controlled aircraft either carrying explosives or depending upon direct collision, aerial bombs moored by balloons or carried by parachutes forming a screen, mechanical damaging devices such as rams, hooks or wires carried in the same way, big calibre anti-aircraft guns firing shells sufficiently explosive to damage machines even without actually hitting them, are among the many suggestions put forward.

The 200-inch Reflector

IT is stated by the New York correspondent of *The Times* that the 200-inch disk began its 3,300-mile railway journey from Corning, New York, to Pasadena on March 26. It is encased in a steel crate weighing 10 tons, with the face of the disk protected by a 4-inch blanket of cork, and its rim by five layers of heavy felt, and is being carried on edge in a specially designed truck. The weight of the crated disk is supported by steel beams covered with cushions of compressed cork. The accompanying illustration (Fig. 1), reproduced from the article by Dr. George E. Hale on the 200-inch telescope which was

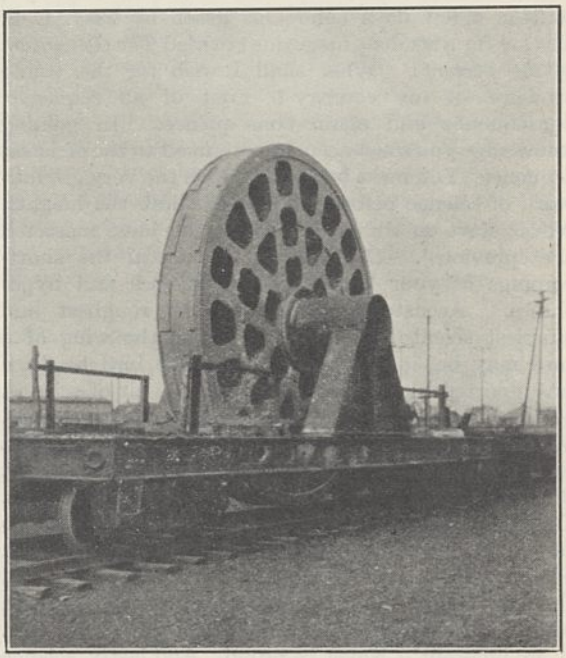

FIG. 1. Base of tube for 200-inch telescope.

published as a Supplement to NATURE of February 8, will bring home better than words the transport difficulties involved. The train will not travel faster than 25 miles an hour; the greatest care will have to be exercised, because the bottom edge of the crate is only six inches above the level of the rails, and at certain tunnels and bridges the top will have a clearance of only three inches. The news of the safe arrival of the disk at Palomar Mountain will be awaited with anxiety.

Sir Patrick Laidlaw, F.R.S.

SIR PATRICK LAIDLAW has been appointed by the Medical Research Council to be deputy director of the National Institute for Medical Research, and head of the Department of Pathology and Bacteriology, in succession to the late Capt. S. R. Douglas. Sir Patrick has been a member of the Council's scientific staff at the National Institute since 1922, before which he was lecturer in pathology at Guy's Hospital. He received the Royal Medal of the Royal Society in 1933, and was knighted in 1935. He has latterly been engaged chiefly in the investigation of diseases

of man and animals due to infection with ultra-microscopic viruses. His successful work on the cause and prevention of dog distemper, supported by the *Field* Distemper Fund, is well known. More recently he and his colleagues have demonstrated the presence of a virus in human influenza, and have opened up an experimental line of attack upon this disease by which it is hoped to obtain important results.

Pavlov and the Spirit of Science

A CORRESPONDENT has sent us the following translation of a note under the title "Bequest of Pavlov to the Academic Youth of his Country", written a few days before his death by Prof. I. P. Pavlov for a student magazine entitled *The Generation of the Victors*: "What shall I wish for the young students of my country? First of all sequence, consequence and again consequence. In gaining knowledge you must accustom yourself to the strictest sequence. You must be familiar with the very groundwork of science before you try to climb the heights. Never start on the 'next' before you have mastered the 'previous'. Do not try to conceal the shortcomings of your knowledge by guesses and hypotheses. Accustom yourself to the roughest and simplest scientific tools. Perfect as the wing of a bird may be, it will never enable the bird to fly if unsupported by the air. Facts are the air of science. Without them the man of science can never rise. Without them your theories are vain surmises. But while you are studying, observing, experimenting, do not remain content with the surface of things. Do not become a mere recorder of facts, but try to penetrate to the mystery of their origin. Seek obstinately for the laws that govern them. And then—modesty. Never think you know all. Though others may flatter you, retain the courage to say, 'I am ignorant'. Never be proud. And lastly, science must be your passion. Remember that science claims a man's whole life. Had he two lives they would not suffice. Science demands an undivided allegiance from its followers. In your work and in your research there must always be passion."

Paint Research Station, Teddington

ON Tuesday, May 19, the Right Hon. James Ramsay MacDonald, M.P., Lord President of the Council, will open the new buildings of the Paint Research Station, Teddington. The Research Association of British Paint, Colour and Varnish Manufacturers, incorporated in 1926, under the presidency of Mr. S. K. Thornley, really began its investigation work in a private laboratory, but soon, in May 1927, occupied a small converted factory at Teddington. Many alterations and additions were necessary, and in 1930 a substantial new block was added to the old building. In the autumn of 1935 a further extension, which Mr. MacDonald will open, was completed; altogether there is now extensive and admirable laboratory accommodation for chemical, physical and technical work, as well as a large library offering excellent reference facilities on all matters bearing upon the related industries. The Association is co-operatively financed with the assistance of the Department of Scientific and Industrial Research, and in common with other and similar research associations has for its aim the application of scientific knowledge and methods to the problems of the industries concerned, which range from paint to printing ink, pigments, varnishes, linoleum and the like. The work up to recent times has been mainly concerned with problems arising out of development and control of manufacture; but a special division has now been formed for the study of paint application problems, with a corresponding extension of interest to architects, builders and decorators. The original research work carried out at the Paint Research Station is, from time to time, set out in the form of technical papers and bulletins, of which some ninety have been issued to date. In addition, a comprehensive "Abstract Review of Current Literature in the Paint, Varnish and Allied Industries" is published and is available to interested people; as a reference journal on paint matters this "Abstract Review" is unique.

Technique of Low Temperature Investigation

THE first lecture of the series arranged in connexion with the Very Low Temperatures Exhibition, at the Science Museum, South Kensington, was delivered in the Lecture Theatre of the Museum on Wednesday, April 1, by Prof. M. W. Travers, of the University of Bristol, the title being "The Technique of Low Temperature Investigation". Prof. Travers spoke with the authority of a pioneer, having been associated with Sir William Ramsay in the discovery of neon and other rare gases in experiments carried out at University College, London. These discoveries were the outcome of investigations at low temperatures and have resulted in the familiar neon signs and other forms of modern illumination. In tracing the work of various investigators from the time of Michael Faraday, Prof. Travers explained in a popular way with numerous experimental demonstrations the methods by which very low temperatures are attained. Admission to these lectures is by ticket obtainable free of charge from the Museum.

Recent Acquisitions at the Natural History Museum

AMONGST recent acquisitions to the Zoological Department are the skin and skull of a forest hog (*Hylochoerus meinertzhageni*) from the Aberdare Mountains, Kenya Colony, presented by Mr. W. B. Cotton. Other additions include four wild cats from Argyllshire, presented by Mr. Ernest Baker, a lion skin from British Somaliland, presented by Mr. F. J. E. Manners Smith, the skin of a genet from Mpika, Northern Rhodesia, presented by Capt. C. R. P. Henderson, and the skin and skull of a tahr (*Hemitragus hylocrius*) from the Nilgiri Hills, presented by Major E. G. Phythian-Adams. Among the purchases are two hundred mammals and birds from Jugoslavia, a country from which the Museum possesses very little material. The Mineral Department

has received by gift from Mr. S. R. Mitchell crystals and platy aggregates of the hydrous magnesium phosphate, newberyite, from the guano deposits of the Skipton Caves, near Ballarat, Victoria, and from Capt. R. S. Pain a fine collection of doubly terminated quartz crystals, variously coloured, from a gypsum hill in the Salt Range, Punjab. Asbestos has been presented by Mr. L. G. Brandon-Fleming from India, and by the Griqualand Exploration and Finance Co. from its mines in Griqualand West. Lady Kleinwort has given a fine stalactite from the Mammoth Caves in Kentucky. The purchases include a magnificent group of crystals of tarnowitzite, the variety of aragonite containing lead carbonate, from Tsumeb in South-West Africa, and a large group and a large twin plate of selenite, the crystallised form of gypsum.

Imperial Forestry Institute, Oxford

THE Imperial Forestry Institute was established in 1924 at Oxford and placed under the direction of the professor of forestry—the School of Forestry and the Institute being kept separate. In the eleventh annual report (Hollywell Press, Oxford, 1935) it is announced that, owing to the work of the Institute having greatly increased, a new appointment of director of the Institute alone has been made, the Oxford professor of forestry remaining as general head of the Department and to remain in general administrative charge of the School and the Institute. Mr. J. N. Oliphant, deputy director of forestry, Malaya, has been appointed to the new post. It is stated in the report that "With a revival of recruitment for the forest services the number [of students at the Institute] may be expected to approach the normal once more". Among the research work undertaken is the investigation into the cricket-bat willow. It is to be hoped that something definite and practical may come out of this work to assist landowners in Great Britain possessing areas eminently suited to the growth of the willow. The report mentions an estate where five hundred specimens of a well-known hybrid were supplied fifteen years ago; it being discovered years afterwards that they were not the true *Salix cærulea*. The present writer knows of a case, now twenty-five years old, where a much larger number of a so-called cricket-bat willow were planted with a considerable financial loss to the estate. The owner wants a practical remedy. Another investigation is with the elm. The report says: "The elm studies begun by Dr. Bancroft in 1933 have been continued in the Cotentin region of Lower Normandy, the south of England, the east of Scotland, and in S.W. Ireland; the later investigations have been concerned more particularly with the origin of the English elm, *Ulmus campestris*, and of the Guernsey elm, *Ulmus stricta* var. *sarniensis*. Interesting observations were made in the Cotentin in July 1935, concerning the connexion between habit-type and climatic conditions, the effect of growth-conditions on the quality of the timber, and the effect of the introduction of *Ulmus montana* Stokes in the neighbourhood of Bricquebec."

Inexhaustibility of Oil Resources in America

SCIENCE SERVICE of Washington, D.C., reports that Mr. A. J. Byles, president of the American Petroleum Institute, assured members at their sixteenth annual meeting that exhaustion of American petroleum and products was beyond the limits of man's powers of prediction. During the last decade, a number of facts pointing to their inexhaustibility have come to light. Proved reserves are now estimated at twice the amount they were in 1925, in spite of the volume of oil withdrawn. Oil has been found at greater depths, and in some cases even below old pools; moreover, there still remain unexplored more than a billion acres of geological formations which may prove to be oil-bearing. Deposits of bituminous coal are to all intents and purposes unlimited, and these can be drawn upon if necessary to meet the demand for motor fuel. Further, more than a hundred billion barrels of oil are said to be obtainable from shale oil deposits. Improved scientific methods of discovery and production have facilitated greater recovery of oil per well and more economical usage of oil. Mr. Byles expressed the view that rumours of oil scarcity were spread merely in order to frighten people into advocation of federal control of the industry.

Pollen Grains

MISS ANNIE D. BETTS, editor of *The Bee World*, writing with reference to the reviewer's comment on the "lack of comprehensive works" in discussing Wodehouse's "Pollen Grains" (NATURE, Feb. 22, p. 294), has directed our attention to two recent works dealing with pollen, which, though primarily designed for the purpose of identifying pollen grains in honey, may be of use in other spheres of pollen study. These works are: Armbruster, "Pollenformen und Honigherkunftsbestimmung" (1929, and a supplement 1935); Zander, "Pollengestaltung und Herkunftsbestimmung bei Blütenhonig". The first-mentioned publication contains drawings of the pollen of more than 1,200 species of plants; the second has photographs of more than 700 species.

Dovedale

THE Pilgrim Trust has just presented important areas on both banks of the Dove to the National Trust. The Bostern Estate of 415 acres has been acquired from Lord Daresbury, and of this about 165 acres of the Derbyshire slopes of Dovedale will become the property of the Trust. The estate is in the heart of Dovedale and includes Bayley Hill and Bostern Nab—both over 1,000 ft., with views extending to Kinder Scout, Axe Edge moors and Chelmorton Low to the north, and the hills of Staffordshire and south Derbyshire to the south. The other area acquired through the generosity of the Pilgrim Trust lies on the Staffordshire bank farther north and comprises the Alstonefield Glebe land of 70 acres with a long frontage to the Dove and the more austere beauties of upper Dovedale. It is opposite Biggin Dale and the Iron Tors presented by Mr. R. McDougall and Mr. Kerfoot. The new property adjoins Wolfscote Dale and includes Peasland Rocks

and Gipsy Bank, and was bought from the Rev. S. Beresford with the consent of the Ecclesiastical Commissioners.

Announcements

Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, has been awarded the Grande Médaille à l'effigie d'Isidore Geoffroy St. Hilaire, by the Société Nationale d'Acclimatation de France, which is the highest honour the Society accords. Dr. V. Van Straelen, director of the Royal Museum of Natural History, Brussels, also received the medal.

The President of the French Republic has been pleased to confer upon Sir Henry Wellcome la Croix d'Officier de la Légion d'Honneur. This decoration is a further tribute to British medical and chemical research, to which Sir Henry has made notable contributions.

The Council of the Iron and Steel Institute has awarded the Andrew Carnegie Gold Medal for 1935 to Dr. D. F. Marshall, of Sheffield, for his paper on "Further Determinations of the External Heat Loss of Blast-Furnaces". The Andrew Carnegie Gold Medal is awarded to the author of that report of work carried out with the aid of a grant from the Andrew Carnegie Research Fund which, in the Council's opinion, is the best of those published during the year. It is interesting to note that in 1933 the Williams Prize was awarded jointly to Dr. Marshall for his paper on "The External Heat Loss of a Blast-Furnace", in which the author presented the results of a research of which his Carnegie report recorded the continuation.

The Council of the Royal Society of Edinburgh has nominated Prof. J. Graham Kerr, M.P., and Prof. James Ritchie to represent the Society on the International Committee for Bird Preservation, British Section.

Mr. E. J. Roberts, lecturer in agriculture at the University College of North Wales, Bangor, has, by the courtesy of the College, been seconded for a period of a year for service with the Agricultural Research Council as crop drying investigator. During the forthcoming grass drying season, Mr. Roberts will be engaged in collecting data regarding grass drying plants in operation in England and Wales and in Scotland, and it is hoped that on the completion of his investigation it may be possible to publish comprehensive information for the use of farmers who are contemplating the purchase of a crop drier.

It is announced that the Academic Assistance Council has received a donation of £1,000 from the executors of Miss Ida Benecke, for the general purpose of assisting displaced scholars and scientific workers.

Two earthquakes of moderate intensity were recorded at Kew Observatory on March 25. The first impulses of the earlier shock arrived at 8 hr. 46 min. 5 sec. G.M.T. and those of the latter shock at 9 hr. 3 min. 15 sec. G.M.T. The records show that both the earthquakes occurred under the North Atlantic, south-west of Iceland and about 1,250 miles north-west of Kew.

The German Hay Fever Association has organised a scientific centre at Cologne for the study of allergic diseases.

The fiftieth anniversary of the English Goethe Society, which was founded on February 25, 1886, under the presidency of Prof. Max Müller for the purpose of promoting the study of Goethe's works and thought, was celebrated on February 26 by a conversazione at University College, London. After a reception by the president, Prof. G. P. Gooch, an address was delivered by Prof. H. G. Fiedler, of Oxford, entitled "Memories of Fifty Years of the Goethe Society". A volume of the Society's proceedings is published annually under the editorship of the honorary secretary, Prof. L. A. Willoughby. Further information can be obtained from the assistant secretary, Miss Ella Oswald, 3 Steele's Road, N.W.3.

Applications are invited for the following appointments, on or before the dates mentioned :

A research chemist in the Department of Clinical Investigations and Research, Royal Infirmary, Manchester—The Director (April 17).

A principal of the Constantine Technical College—Director of Education, Education Offices, Middlesbrough (April 18).

A lecturer in electrical technology in Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (April 18).

A University lecturer in mathematics in the University of Cambridge—Dr. S. Goldstein, St. John's College (April 20).

Demonstrators in inorganic and physical chemistry, physics and physiology in Bedford College for Women, Regent's Park, N.W.1—The Secretary (April 25).

A Government meteorologist and an Assistant meteorologist to the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (April 30).

A professor of psychology and a professor of sociology in the University of the Witwatersrand—The High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (April 30).

A professor of anatomy in the University of Leeds—The Registrar (April 30).

An assistant civil engineer for the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quote M/4051).

A librarian and information officer to the Research Association of British Flour-Millers—The Director of Research, Old London Road, St. Albans.

A botanist and a chemist at the Board of Greenkeeping Research, St. Ives Research Station, Bingley, Yorks—The Director.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 583.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Carbon Dioxide Content of Atmospheric Air

DURING the last nine months of his life my father, Prof. J. S. Haldane, was engaged, in collaboration with Dr. R. H. Makgill, in the systematic analysis of atmospheric air. Owing to his death and the absence of Dr. Makgill in New Zealand, some time may elapse before the full results of their work are published. But certain of them are of enough general interest to warrant a preliminary note.

The apparatus used was an improved form of the well-known Haldane volumetric gas analysis apparatus, adapted for the estimation of carbon dioxide only. The measuring burette, control burette, and carbon dioxide absorption bulb are all immersed in the same water bath, and their connexions are greatly shortened. 20 c.c. of air is used for each analysis. If the proper precautions are taken, duplicate estimations of carbon dioxide always agree within 2 volumes per 100,000, and generally within 1 volume. A single analysis can be completed in ten minutes. The apparatus is made by Messrs. Siebe Gorman and Co., Ltd., 187 Westminster Bridge Road, S.E.1. About 1,500 analyses of atmospheric air have been made with it. It has also been used for experiments on photosynthesis and plant respiration, and on the gases in equilibrium with river, spring and sea water. In what follows the carbon dioxide content is given throughout in volumes per 100,000.

The amount of carbon dioxide in country air at heights from 4 ft. to 70 ft. above ground-level varied between 21 and 44 volumes. The diurnal variation due to photosynthesis was very marked from July, when systematic observations began, until October. But in December no definite diurnal periodicity was observed. Thus the average of 153 analyses made at Cloan (Perthshire) during August 1935 was 32·4 volumes, that of 15 made at night was 38·6. The maximum fall due to the photosynthesis was observed when bright sunshine followed rain. In dry weather, sunshine had but little effect. It seems likely that during drought the stomata of leaves are nearly closed so as to conserve water, and carbon dioxide is thus excluded.

The exhalation of carbon dioxide from the soil was very obvious. 23 pairs of samples were taken simultaneously at ground-level on bare tilled soil and at a height of 4½ ft. The carbon dioxide at ground-level was higher on 19 occasions, equal on one, and lower on three. The mean excess was 5·4 volumes per 100,000. Samples taken from holes about 3 cm. below the surface contained as much as 100 volumes. The carbon dioxide excess persisted even among grass during sunshine, though low values were found in a mass of creeper on a wall. The influence of combustion was equally clear. Eighteen samples taken during still weather in London, and analysed by Mr. W. J. A. Butterfield, ranged from 42·5 to 90 volumes of carbon dioxide per 100,000, averaging 65.

A possibly more important influence, at least in Britain, is that of the sea. Samples of air blowing inland off the sea on to the coast of Ayrshire in August and September averaged 37 volumes of carbon dioxide. On the other hand, samples taken by Commander G. C. C. Damant on the southern shore of the Isle of Wight in November during southerly breezes averaged 27 volumes. It is generally thought that the sea round the British Isles acts as a sink for carbon dioxide. The Ayrshire observations suggest that this is not always the case.

The carbon dioxide content of the air also varied for causes which are at present uncertain. Thus during October, the night air at Oxford generally contained 32–34 volumes. From October 31 until November 8 it ranged from 35 to 42, averaging 38. This was a period of successive cyclonic depressions.

It appears that this method, which is much more rapid than the gravimetric or alkalimetric methods, and at least equally reliable, while it only requires a simple portable apparatus, may prove of considerable value for three purposes. It may furnish new data for plant ecology. Thus grass appears to carry out photosynthesis in an atmosphere distinctly richer in carbon dioxide than tree leaves in the same area; and my father conjectured that, at least in the temperate zone in summer, the carbon dioxide concentration of the air might be considerably lower in the interior of continents than near the coast. It could probably be used for the investigation of stratospheric air. A similar apparatus could estimate oxygen with less absolute accuracy, but almost equal sensitivity to small differences. Finally, it might be of value to meteorologists in distinguishing between bodies of air of different origins.

J. B. S. HALDANE.

Cherwell, Oxford.
March 15.

Surface Layers of Crystals

THE explanation of pyro-electric excitation in crystals, obviously extending to piezo-electric, as strain of a natural internal polarisation after the manner of Poisson and Kelvin, is one of the beautiful basic ideas in polarised electrics.

A crystal consists of a series of layers of ions, parallel to a face, alternately positive and negative, whether they are free ions or the directed poles of atoms. Fifteen years ago, I set out the relevant analysis which had long been running in my mind, the main result emerging that if the layers are equidistant the resulting electric field for a plate is that due to half the first layer and half the final layer. According to the Kelvin idea, this field would become abolished by accumulation along the surface of foreign cancelling ions, of whatever kind, if of opposing sign; an equilibrium which thermal expansion would disturb, with pyro-electric results. The result as here stated is

established by replacing each ionic stratum by a thicker one, swollen out so that they overlap with the superposed parts equal and opposite. This is after the manner of the Young-Fresnel argument for optical diffraction by a slit, which makes the result due to initial and final fractions of the Huygenian zones. But this result cannot be all, for these terminal half strata are not affected by change of temperature, or rather are affected only in definite manner by the superficial expansion of the layer thereby caused. There is in addition the internal Poisson-Kelvin polarisation, and change of its intensity-moment by thermal expansion alters the electric field by known laws: there may be such local change of polarisation also in the replacing of the strata as above by thicker internally cancelling strata.

A question may open out here as to how the pyro-electric effect is divided between these two causes. But the feature now in front of us is the very great number of compensating ions in this surface layer and the great aggregate of their charges: so much so that I only half believed in the result which I found to be inevitable[1], and nobody else took any notice of it at all. But now, in the fundamental domain of atomic diffraction detected by Davisson and developed rapidly in technique and results in the school of G. P. Thomson, the case stands differently. For a diffraction by just such a single surface layer, usually the halved sheet of the simple case of equidistant internal strata here considered, has been established: and though the rapid progress of the subject naturally detects also more complex compensating ionic sheets of equidistant internal strata, I do not discover that any reason has been offered for their structure.

I refrain from further speculation on this very important and progressive experimental subject. The gradualness of transition between consistent phases of fluid[2] is another case where simple theory may assist.

May I be permitted, however, now to sketch a somewhat wild speculation; though scarcely wilder than the relevant accepted facts, most recently gained along the line of the present rapid radioactive advance, by the initiatives of the Curie-Joliots, of Fermi, and of Chadwick. A main new feature is that if crystalline dust of light elements such as boron or lithium is mixed with a gaseous radioactive product there is emitted a stream of particles proved to be of the same mass as the proton, but absolutely without electrodynamic origin for that mass. A new possibility here introduced is that the active gas may condense as a surface film, as above, on the small crystals, forming a close layer, so that a casual atomic explosion or encounter may there involve more than two interacting particles; but this merely points out a difference of type in the new technique, it does not suggest how it can be effective in the direction required. The conclusion that very rapid particles of about the same (protonic) mass may be of different kinds, of electric type or not, tends to subvert the historic simple mode of theory of the electrodynamic field and the interlocking singularities from which the field of strain obtains its terminal support. It is in this revolutionary regard to be classed with the recently discovered diffraction of uncharged atom-streams.

Joseph Larmor.

Holywood,
Northern Ireland.
Feb. 26.

[1] *Proc. Roy. Soc.*, A (1921); reprinted in "Math. and Phys. Papers", 2, 620 (1928).
[2] *loc. cit.*, 511, xxiv.

Heat Denaturation of Proteins as a Chain Reaction

Blood coagulation, which is a special case of protein denaturation, has been found to be a chain reaction by which a new reacting substance is formed[1]. By the action of heat on a mono-disperse system of highly purified serum-globulin in a salt solution, a similar reaction was found to take place. The denaturation process was followed by means of nephelometric measurements with a Pulfrich photometer. The denaturation was limited to a time of exposure to heat (waterbath at 70° C.) by which the coagulated denatured particles of proteins are assumed to remain practically of the same size[2]. It could therefore be assumed that the nephelometric values expressed the real amounts of proteins denaturated.

The curve indicating the first part of the denaturation process is exponential. At a constant temperature of 70° C. the time was estimated as that which was required for a genuine globulin solution to reach an arbitrary opalescence (nephelometric value x). A certain small amount of a globulin solution (A), which had already been partly denaturated at 70° C., was added to a tube with a solution of genuine globulin (B). The solution B was then placed in the waterbath at 70° C. It was found that the denaturation curve was different from A. The velocity of the denaturation was faster from the very beginning. The chosen opalescence x for B was reached in a much shorter time than A. The initial nephelometric value of B was naturally a little higher than A but insufficient to explain the course of the process. Further, it was found that the course of the denaturation process is determined by the properties of the denaturated proteins transferred to the solutions of genuine globulin. When samples of A were taken out from a denaturating globulin solution at different times during the process and added to new solutions of genuine globulin (B), the curves indicating the denaturation process of the B systems are found to be similar to the reaction going on in A at the very moment of the transfer. When transferred from A at the beginning of the process, the curve of B will be rather flat; taken out from A at the time when the speed of the process is very fast, the curve of B will rise immediately very steeply; and if transferred at the end of the denaturation, the B curve will again begin very flat.

From earlier work[3] on the binding of heparin to proteins, we know that basic groups appear during the denaturation of the proteins, groups which were not available before. By elimination of some of the NH_2 groups by the addition to the genuine protein solutions of very small amounts of formaldehyde, or reducing the effect of the NH_2 groups by addition of small amounts of alkali, the denaturation process may be either retarded or perfectly inhibited. These facts give further support for the assumption that certain amino-groups play an essential role in denaturation. Therefore there seems to be no real indication of being able to explain the mechanism of denaturation by a hitherto unverified process of hydration or hydrolysis, as suggested by Chick and Martin[4].

The protein molecule may tentatively be regarded as an approximately spherical body (Svedberg[5], Astbury[6]), of which the surface layer of atoms and radicals plays an essential role in the reactions of the molecule. The structure of this surface layer may be affected by forces exerted by the interior parts of

the molecule, by the surrounding medium and by neighbouring molecules approaching a state of equilibrium depending also on temperature. According to this picture, the denaturation process may be explained in the following way. The appearance on the surface of the molecule of basic groups from its interior may be the essential reaction in the denaturation. By such means, the molecules react with each other and form an irreversible reaction product whereby even new peptide chains may arise. The same explanation would apply to the appearance of the —SH groups in denaturation. Further, it may be possible that the high temperature coefficient in the heat denaturation of proteins is due rather to steric changes of the molecule than to the more improbable explanation of a very large critical increment given as 130,000 calories[2].

ALBERT FISCHER.

Biological Institute,
Carlsberg Foundation,
Copenhagen.
Feb. 6.

[1] Fischer, A., NATURE, **135**, 1075 (1935).
[2] Clark, J. H., *J. Gen. physiol.*, **19**, 199 (1935).
[3] Fischer, A., *Biochem. Z.*, **278**, 133 (1935).
[4] Chick, H., and Martin, C. J., *J. Physiol.*, **45**, 61 (1913).
[5] Svedberg, T., *Kolloid Z.*, **51**, 10 (1930).
[6] Astbury, W., Dickinson, S., and Bailey, K., *Biochem. Z.*, **29**, 2351 (1935).

Structures and Formulæ of the Prussian Blues and Related Compounds

ALTHOUGH prussian blue has been known since 1704, and has long been an important pigment, its chemistry has never been satisfactorily explained. The whole subject is surprisingly confused in spite of the large volume of work which has been published. The structures of prussian blue and of some associated compounds have recently been determined at this Company's Ardeer Factory by X-ray analysis. The powder method was used.

In the case of the blue, a class of definite compounds is shown to exist, the formula being $Fe''' R Fe''(CN)_6$, where R represents an alkali metal or ammonia. Commercial pigments all tend to be of this type. The structure is cubic, $a = 10{\cdot}2$ A., and is illustrated in Fig. 2. The iron atoms are arranged, ferrous and ferric alternately, at the corners of a cubic lattice of 5·1 A. edge, and the CN groups lie in the edges of these small cubes. The alkali atoms occur at the centres of alternate small cubes. In this class are compounds of all the alkali metals and ammonium, with the exceptions of lithium and cæsium, the atoms of which appear to be too small and too large respectively to enter this lattice easily. It is possible that the small cubes not containing alkali may contain water molecules.

In 'ruthenium purple'[1] the ferrous atom is replaced by divalent ruthenium. Here a similar class of compounds has also been shown to exist. The unit cube edge is 10·4 A. The formula is $Fe''' R Ru''(CN)_6$.

The white ferrous-alkali ferrocyanides, which are intermediate compounds in the preparation of commercial blues, have been shown to be yet another class of compounds. The formula here is $Fe'' R_2 Fe''(CN)_6$, where R represents Na, K, NH_4, Rb or Cs. The structure of this series is again cubic, $a = 5{\cdot}1$ A., and is closely related to that of the prussian blues. The general outline is the same, but now all the iron atoms are ferrous, and all cubes now contain an alkali atom (Fig. 1).

The structure of Berlin green, the oxidation product of prussian blue, has also been determined. The formula is $Fe''' Fe'''(CN)_6$, namely, that of ferric ferricyanide. This structure also is very similar to that of prussian blue; but here all the iron atoms are ferric, and there are no alkali atoms present (Fig. 3). The unit cell is again 5·1 A., and it is possible that water occurs in the small cubes.

The cupriferricyanides, $Cu'' R Fe'''(CN)_6$, are found to exist, and have the same structure as the prussian blues, with cupric copper replacing ferrous iron. The edge of the unit cube is here slightly less than 10·2 A.

These results have all been checked by chemical analysis.

These three types of structure form an extremely interesting series, as, starting with ferrous-alkali ferrocyanide, this compound oxidises very easily to prussian blue, which in turn may be oxidised to Berlin green. Thus, from a lattice of ferrous atoms linked by CN groups, with an alkali atom at the centre of each small cube (Fig. 1), alternate alkali atoms are removed and alternate iron atoms become ferric on oxidation to prussian blue (Fig. 2), whilst on further oxidation to Berlin green the remaining alkali atoms are removed and all the iron atoms become ferric (Fig. 3). Throughout all this, the same iron-cyanogen skeleton structure remains, except for very slight changes in the Fe–Fe distances, which alter

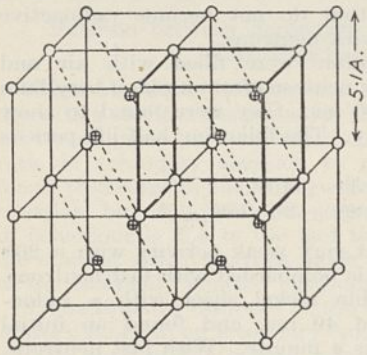

FIG. 1. Ferrous alkali ferrocyanide, $Fe'' R_2 Fe''(CN)_6$.
○ = ferrous.
⊕ = alkali.

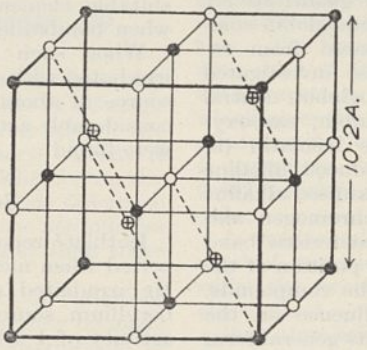

FIG. 2. Prussian Blue, $Fe''' R Fe''(CN)_6$.
● = ferric.
○ = ferrous.
⊕ = alkali.

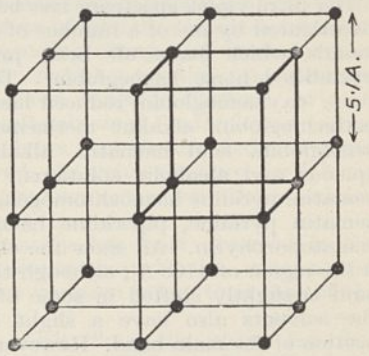

FIG. 3. Berlin Green, $Fe''' Fe'''(CN)_6$.
● = ferric.

the lattice spacing slightly, whilst the blue colour is formed and then destroyed again. A detailed account cannot be given here, but it may be stated that there is also a slight variation in lattice spacing between members of each class, owing to the differences in size of the alkali atoms.

In addition, blues containing no alkali have been prepared, and X-ray photographs show that the Fe–CN skeleton structure is cubic and similar to that already described. (a = 10·2 A. approx.) Here it seems that additional iron, or iron in combination with a negative ion, can replace the alkali metal. The water content of these blues is unusually high.

The unoxidised analogues of these alkali-free blues have a structure different from any yet described, and are at present under examination. The exact measurement of lattice spacings, water contents, etc., is now proceeding. It is hoped to publish this work elsewhere in more detail.

Most of the analyses were made in the Company's Dyestuffs Laboratory at Blackley.

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[1] Howe, *J. Amer. Chem. Soc.*, **18**, 983 (1896).

The Ultra-Violet Spectrum of Hæmoglobin Derivatives and Bile Pigment

As a result of numerous investigations of the ultra-violet spectrum of hæmoglobin and its derivatives, the location of an absorption band in the region of 4100 A. has been established for these compounds. It appears to be due to the hæm radical, and is independent of the nature of the globin fraction.

The ultra-violet spectrum has been quantitatively investigated by me of a number of hæmoglobin compounds which have all been prepared from recrystallised horse hæmoglobin. Those investigated were: oxyhæmoglobin, reduced hæmoglobin, neutral methæmoglobin, alkaline methæmoglobin, carboxyhæmoglobin, acid hæmatin, alkaline hæmatin (in aqueous and alcoholic solutions), reduced alkaline hæmatin, pyridine hæmochromogen, oxidised alkaline hæmatin pyridine, piperidine hæmochromogen and hæmatoporphyrin. All show the characteristic band in the region of 4100 A., although the position of the band is slightly shifted in some of the compounds. The solvents also have a slight influence on the position of the main band. However, its general form and position appears centred at 4100 A. This band is obviously not influenced by the presence of the globin fraction as the hæmoglobin and hæmatin spectrum are quite similar. Nor does the iron in the molecule in any state of oxidation exert any effect since hæmatoporphyrin, the iron-free derivative, has essentially the same absorption spectrum as hæmoglobin.

On the other hand, the ultra-violet absorption of pure bilirubin reveals a very different spectrum. There is no characteristic band at 4100 A. but a rather indefinite absorption extending from 5000 A. to around 4300 A.

Attempts to correlate the structure of the hæm radical and its ultra-violet spectrum are not numerous. Holden and Hicks[1] postulate that the main absorption band is present only when the pigment molecules are widely separated or when the valencies of the iron atom are fully utilised. Certainly, solution of the pigments in different solvents with the resultant change in dispersion influences the spectrum of the hæm pigments, but only to a slight degree, and does not explain the presence of the band as a characteristic of the hæm radical. It is impossible to cause the absorption band to disappear by changing the dispersion of the pigment. The only condition under which it will disappear is to convert the hæm nucleus into a bile pigment which involves molecular rearrangement.

A study of our results leads to the hypothesis that the absorption band at 4100 A. in hæm compounds is due to the porphyrin ring system made up of four substituted pyrrol nuclei. In the bilirubin, which is formed by the breakdown of the hæm molecule, the porphyrin ring system is opened into a straight chain of substituted pyrrol nuclei and the absorption which is characteristic of the ring system disappears.

Investigation of the ultra-violet spectrum of other bile pigments is being undertaken in order to confirm this hypothesis.

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[1] Holden, H. F., and Hicks, C. S., *Aust. J. Exp. Biol. and Med. Sci.*, **10**, 219 (1932).

Induced Radioactivity of Nickel and Tin

IN the course of an investigation, it was found desirable to build Geiger-Müller counters with substances that are not activated by neutron bombardment. From the list given by Fermi[1] and his collaborators, nickel and tin were selected as the most suitable elements that do not become radioactive when bombarded with neutrons.

When such counters were filled with air and irradiated with slow neutrons from a radon-beryllium source of about 100 mc., they were found to show considerable activity. The following half-life periods were found:

Ni : $3^h \pm 10^m$.
Sn : $8^m \pm 2$; $18^m \pm 2$.

Rotblat[2] reported very weak activity with a 20^m period when nickel is bombarded with fast neutrons. He irradiated a thin nickel sheet with a radon-beryllium source of 40 mc. and found an initial activity of 1·5 kicks a minute. With fast neutrons, we could, however, detect no activity either of nickel or of tin, even though sources up to 250 mc. were employed.

The initial activity of a nickel counter of 2 cm. diameter, 15 cm. long and with walls 0·5 mm. thick was about 60 kicks a minute above the zero count, of 40 a minute, when the irradiating source was about 100 mc. strong. With a similar source the initial activity of a tin counter of nearly the same dimensions was about 50 kicks a minute.

To compare these activities with that of a known active element, a tube of copper-nickel alloy, the copper content of which was chemically analysed and found to be 55 per cent, was made into a counter and irradiated with slow neutrons. The intensities

measured proved that the activities of nickel and tin were only of the order of one hundredth of the very highly water sensitive ($\alpha = 15$) 5^m period of copper. It became thus evident that the purity of the metals employed was of great importance.

To check whether the 180^m period of nickel was really different from 150^m periods of the neighbouring elements, cobalt and iron, a steel counter was activated and its decay period measured. The half-life thus determined was 154^m, agreeing within the limits of precision with the value given by Fermi and others. From a number of determinations made with three different counters, it seems fairly certain that the 180^m period of active nickel is really different from the periods of its neighbours.

In the case of tin, the isotopes capable of being activated are probably 112, 122 and 124, and their combined relative abundance is only 12·3 per cent. Therefore the real activity of tin appears to be fairly strong. A rough estimation of the relative intensities of the two kinds of active nuclei showed that the activity with 18^m period is twice as strong as that with 8^m period.

The efficiency of this method of building counters with the substances to be studied as compared with that usually employed was roughly estimated in the following way. A thin-walled (0·042 gm./cm.^{2}) steel counter was itself activated and its activity measured. Then a tightly fitting cylindrical steel foil of the same thickness as the counter wall was activated separately and its activity measured by putting it around the counter in the usual way. It was found that the efficiency was enhanced by a factor of about 4 when the counter itself was activated.

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[1] Fermi *et al.*, *Proc. Roy. Soc.*, A, **149**, 522 (1935).
[2] J. Rotblat, NATURE, **136**, 515 (1935).

Relation between Secondary Emission and Work Function

WHEN the work function of a metal is varied by depositing on its surface various amounts of a foreign substance (up to a complete monatomic layer), the ratio of secondary emission to primary current is found to change in the same sense as the thermionic emission, but to a much less degree. This difference of behaviour is due to the fact that the secondaries are emitted with velocities much greater than those of the thermally emitted electrons.

A quantitative estimate of the effect of variations of work function on secondary emission may be made on the basis of the known velocity distribution of secondary electrons. Using Haworth's data[1] for molybdenum, I have calculated the distribution of the normal components of energy, assuming the secondary emission at an angle θ to the normal[2] to be proportional to $\cos\theta$. The calculation shows that for secondaries having normal energies less than 5 electron-volts (a value which includes 52 per cent of the total number), the number N having normal energy greater than U may be represented approximately by the Maxwellian formula

$$\log_{10} N = A - bU,$$

where A and b are constants, the latter having the value 0·070 if U is measured in electron-volts.

This equation gives the number of secondaries having sufficient normal energy to pass through a potential barrier, of magnitude U, parallel to the surface. Since any change in the work function of a given emitter is equal to the corresponding change in the potential barrier at its surface, the equation should describe equally well the variation of secondary emission with work function.

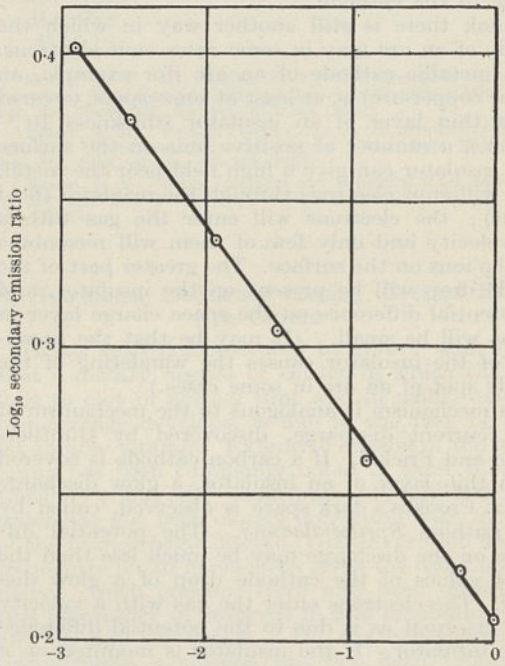

FIG. 1. Relation between secondary emission and work function for molybdenum contaminated with barium.

I have measured the secondary emission (at a primary voltage of 300) from a molybdenum filament with different degrees of barium surface contamination. The corresponding changes of work function were derived from contact potential measurements with respect to a clean tungsten filament. Fig. 1, which gives the results obtained for the lower degrees of contamination, shows that the law deduced above is accurately obeyed, the value obtained for b being 0·067, which is in good agreement with the calculated value.

A similar relationship has been observed in the case of tungsten contaminated with oxygen, for which the secondary emission is less than that of the clean metal.

For atomically thick films, the above law was found to be inapplicable. This result might have been expected, since in this case a proportion of the secondaries arise in the film itself, whereas in the calculation it was assumed that the effect of the film was simply to modify the velocities of secondaries originating in the underlying metal.

It is hoped that a detailed account of these experiments will be published in due course.

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[1] L. J. Haworth. *Phys. Rev.*, **48**, 88 (1935).
[2] H. E. Farnsworth, *Phys. Rev.*, **31**, 414 (1928).

Electron Emission of the Cathode of an Arc

In the carbon- and tungsten-arc the electrons are in most cases emitted thermionically by the cathode, while in the mercury-arc (with mercury cathode) the cathode current is assumed to be due to the emission of electrons from a cold cathode by the high field before the cathode (field current). This high field is generated by the space charge of the positive ions flowing to the cathode.

I think there is still another way in which the cathode of an arc may in some cases emit electrons. If the metallic cathode of an arc (for example, an iron- or copper-arc) is, at least at some spots, covered with a thin layer of an insulator (thickness 10^{-4}–10^{-5} cm.), a number of positive ions on the surface of the insulator can give a high field near the metal, which will emit electrons through the insulator (field current); the electrons will enter the gas with a high velocity and only few of them will recombine with the ions on the surface. The greater part of the cathode drop will be present on the insulator, and the potential difference on the space charge layer in the gas will be small. (It may be that the breakdown of the insulator causes the wandering of the cathode spot of an arc in some cases.)

This mechanism is analogous to the mechanism of a low current discharge, discovered by Günther-schulze and Fricke[1]. If a carbon cathode is covered with a thin layer of an insulator, a glow discharge without Crookes's dark space is observed, called by these authors *Spritzentladung*. The potential difference on the discharge may be much less than the normal values of the cathode drop of a glow discharge. The electrons enter the gas with a velocity almost as great as is due to the potential difference on the insulator. If the insulator is mounted on a metal instead of on carbon, little sparks are seen on the cathode. This difference may be due to the lower electron concentration and the lower field current density in carbon, as compared with a metal.

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[1] *Z. Phys.*, **86**, 451 and 821 (1933); **92**, 728 (1934).

Dissociation of Strong Electrolytes in Concentrated Solutions

In the previous work of one of the authors, it was shown, by a study of the Raman effect, that while nitric acid[1] and sulphuric acid[2] progressively dissociate with dilution, the nitrates[3] are completely dissociated at all concentrations. The study has now been extended to a large number of strong electrolytes, and the results obtained indicate the following general characteristics:

(1) All the oxy-acids dissociate progressively with increasing dilution.

(2) The halogen acids, however, are completely dissociated even in concentrated solutions.

(3) The acid salts of the alkalis are completely dissociated into the alkali ion and the acid radical, the further dissociation of the latter being progressive.

(4) All other salts of the alkalis and alkaline earths are completely dissociated even in saturated solutions.

The explanation of the above results seems to be simple on the basis of the electronic theory of valency. The alkali and the alkaline earth elements, being strongly electrovalent, have their octet outer electronic structures easily completed, so that the stability of both the anions and the cations is great enough to prevent recombination of them into undissociated molecules. Thus, they are able to exist independently in the completely dissociated condition even in the crystalline state. In the state of solution, the dielectric constant of the solvent facilitates the further separation of these ions, which are, therefore, completely dissociated.

The hydrogen atom, however, is different from the alkalis in that it is capable of forming both the electrovalent and covalent bonds. This dual property of hydrogen enables it to form both types of molecules with the anions, those with the electrovalent link which are completely dissociated and others with the covalent link which are in the undissociated condition. At every concentration of the electrolyte, there is equilibrium between these two types of molecules. With decreasing concentration, this equilibrium changes, the molecules with the covalent link changing to those with the electrovalent link.

The exceptional behaviour of the halogen acids remains to be explained. It appears probable that the monovalent halogen ions, being more strongly electrovalent than the anions of the oxy-acids, can form only electrovalent or a very weak covalent bond with the hydrogen and hence are completely dissociated. The presence of Raman lines due to the undissociated molecules in the gaseous and liquefied state of these substances may be due to the weak covalent bond between the hydrogen and the halogens, which easily breaks up in the presence of a solvent of high dielectric constant.

Thus, though for dilute solutions, Debye was able to assume complete dissociation of all strong electrolytes, such a single generalisation does not seem to be possible for concentrated solutions. While all electrovalent bonds in strong electrolytes are completely broken down even in concentrated solutions, covalent bonds, possible only between the anions and the hydrogen ion, change progressively into the electrovalent type with dilution, which then leads to complete dissociation.

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[1] *Proc. Roy. Soc.*, A, **127**, 279 (1930).
[2] *Ind. J. Phys.*, **8**, 123 (1933).
[3] *Proc. Roy. Soc.*, A, **144**, 159 (1934).

Exhibition of 'Autogenous' and 'Stenogamous' Characteristics by *Theobaldia subochrea*, Edwards (Diptera, Culicidæ)

Of the various idiosyncrasies of mosquitoes, laying fertile eggs without a previous meal of blood (autogeny) and mating within very small cages (stenogamy) are among the most unusual. Exhibitions of the former peculiarity have hitherto been provided exclusively by different 'strains' of the mosquito which Roubaud has named *Culex pipiens* var. *autogenicus*[1] but for which (as previously stated) we advocate the adoption of a different specific name[2]. The latter

peculiarity—stenogamy—is known to be a characteristic of the above-mentioned species and also of two others, namely, *Aedes aegypti* and *Anopheles maculipennis* var. *atroparvus*.

The following observations recently recorded in our laboratory in regard to the mosquito *Theobaldia subochrea*, Edwards, appear to be worthy of note. It may be mentioned that, in Great Britain, *T. subochrea* is one of the rarer species, having so far been recorded from eight localities only. These are Earl's Court (London), Hayling Island (Hants), Hull (Yorks), Isle of Sheppey (Kent), Letchworth (Herts), Rustington (Sussex), Southampton (Hants) and Studland (Dorset).

On February 1 and 15 last, we collected third-instar larvæ of *T. subochrea* in a brackish pond at Hayling Island. These larvæ (together with some of the water from the pond) were placed in the lower cylinder of a Moscon incubator; the upper cylinder of which (wherein the hatched-out adults forgather) has a volume of about 500 c.c. By the end of February there were six adults (five males and one female) in the upper cylinder. No meal of blood was given to the female.

On the morning of March 7 we found an egg-raft on the surface of the water in the lower cylinder. This raft was composed of 153 eggs, all but four of which hatched into larvæ during the afternoon of March 10.

These observations indicate that *Theobaldia subochrea* is both autogenous and stenogamous.

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[1] E. Roubaud, *Ann. Sci. nat.*, (10), **16**, 5 (1933).
[2] J. F. Marshall and J. Staley, NATURE, **136**, 641 (1935).

Transference of a Mite from Cyclamen to Strawberry

ON November 21, 1935, a number of cyclamen flowers were received from a nursery near Exeter, and were found to be heavily infested with *Tarsonemus pallidus*, Banks, which was causing injury typical of that normally associated with infestation by this mite. A few of these flowers were placed on the crown of a strawberry plant, which was kept in the laboratory. By the beginning of January 1936, the young leaves of this plant were showing symptoms typical of *Tarsonemus* damage. The plant was examined on January 7, and mites were seen to be plentiful between the folds of the young leaves. A more critical examination on January 9 resulted in the discovery of adult mites inside the crown as well as on the young leaves.

Ewing and Smith[1] have recently found that *Tarsonemus pallidus*, Banks, and *T. fragariæ*, Zimm., are synonymous. Under the former name, the mite is a pest of cyclamen, begonia, etc., both on the Continent, in America and in England. Under the latter name it has been regarded as a pest of strawberry only[2]. This is one of the few outbreaks of *T. pallidus* on cyclamen that has been reported in Great Britain for some years, though the mites apparently used to be very common on cyclamen and begonias grown commercially under glass.

The transference of *T. pallidus* from strawberry to cyclamen, begonia and raspberry has been attempted by Massee[3] without success. Ewing and Smith[1] recently established mites from strawberry on plants of *Cyclamen*, *Delphinium*, *Saintpaulia* and *Achyranthes*.

The present small experiment is believed to be the first successful demonstration of the ability of the mite to transfer from cyclamen to strawberry.

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[1] Ewing, H. E., and Smith, F. F., "The European Tarsonemid Strawberry Mite identical with the American Cyclamen Mite", *Proc. Ent. Soc. Wash.*, **36**, No. 8–9, 267–268 (1935).
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[3] Massee, A. M., "Some Injurious and Beneficial Mites and Insects on Top and Soft Fruits", *J. Pomol. and Hort. Sci.*, **10**, No. 2, 106–129 (1932).

A Nutritional Deficiency causing Gizzard Erosions in Chicks

IT has been demonstrated by Dam[1,2] and by us[3,4] that a dietary disease of chicks, in which the blood fails to clot in normal time and in which extensive hæmorrhage develops, is due to the lack of a new fat-soluble vitamin. Extensive erosion of the gizzard lining has been commonly noted in these investigations[1,2,3,4], but the occurrence of this latter disorder has not been closely correlated with incidence of the hæmorrhagic disease. Gizzard erosion has been frequently found in chickens given the usual practical diets[5]. Such erosions have also been observed at this laboratory in embryos in late incubation stages and in day-old chicks. On the other hand, the hæmorrhagic syndrome has not been reported in chickens reared under practical conditions. In view of these facts, we have investigated gizzard erosion with the object of determining whether it is a true portion of the hæmorrhagic syndrome or a separate disease not caused by deficiency of the anti-hæmorrhagic vitamin.

It was found that high levels of a hexane extract of dried kale or dried alfalfa caused an alleviation of gizzard erosion. Quantities of these extracts equivalent to one fourth per cent of dried substance were adequate in preventing deficiency of the anti-hæmorrhagic vitamin, and were shown by assay to be of nearly equal potency in this respect. However, the quantity of alfalfa extract required to prevent or cure gizzard erosion was about a hundred times the adequate anti-hæmorrhagic dosage, while the quantity of kale extract required was about twenty times the adequate anti-hæmorrhagic dosage. It was thus shown that the anti-gizzard-erosion activity of these extracts was not proportional to their anti-hæmorrhagic activity.

Afterwards, it was found that the non-saponifiable fraction of these extracts exerted no appreciable effect on gizzard erosion when fed at levels up to the equivalent of 40 per cent of dried substance, although these levels provided massive dosages of the anti-hæmorrhagic vitamin. Tests were then conducted with both the saponifiable and the non-saponifiable fractions of kale lipids and it was found that the anti-gizzard erosion activity was localised in the saponifiable fraction.

Other dietary supplements tested for potency in prevention of gizzard erosion and found negative were cod liver oil 5 per cent, wheat germ oil 5 per cent,

orange oil 0·5 per cent, fresh yellow carrots *ad. lib.*, fresh lemon juice 2 c.c. orally per bird per day, liver extract equivalent to 170 per cent, egg yolk and egg white, alfalfa ash equivalent to 25 per cent, glycerine 4 per cent, cotton pulp 5 per cent and sand 10 per cent. Thus it was shown that copious amounts of the known vitamins, including the anti-hæmorrhagic vitamin, were without influence on gizzard erosion.

Gizzard erosion is not a portion of the hæmorrhagic syndrome, but is a separate deficiency disease which may be corrected by a new fat-soluble factor found in the saponifiable fraction and probably vitamin in Nature. Studies on this anti-gizzard-erosion factor are being continued.

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[1] Dam, H., NATURE, **135**, 652 (1935).
[2] Dam, H., *Biochem. J.*, **29**, 1273 (1935).
[3] Almquist, H. J., and Stokstad, E. L. R., NATURE, **136**, 31 (1935).
[4] Almquist, H. J., and Stokstad, E. L. R., *J. Biol. Chem.*, **111**, 105 (1935).
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Humic Composts and Inorganic Fertilisers

SIR ALBERT HOWARD'S lecture before the Royal Society of Arts on November 14 last on "The Manufacture of Humus by the Indore Process" has been followed by several inquiries as to the attitude of the Indore Institute of Plant Industry towards the question of the comparative value to crops of inorganic fertilisers and composts. It therefore seems desirable to define that attitude by a definite and public statement.

Regarding the maintenance of soil organic matter at its optimum level as one of the aims of soil management, we consider this can generally be best achieved by the use of humic composts. These are easily and cheaply made from organic wastes on farms and plantations by a judicious application of the fundamental principles underlying their aerobic decomposition. Such humic composts will naturally contain some plant nutrients, which should be conserved so far as is compatible with a high yield of humified material, which it is the prime function of composts to supply.

Table 1. Yield of green fodder (total of three cuttings). Lucerne.

Yield	Well-rotted dung manure (N = 0·371 per cent; P_2O_5 = 0·69 per cent).			Municipal compost (N = 0·44 per cent; P_2O_5 = 1·27 per cent).			Well-rotted dung manure (10 carts/acre) Super (762 lb./acre).
	Carts per acre			Carts per acre			
	10	20	30	10	20	30	
Mds. per acre	387	411	429	351	405	476	429

$P < 0·05$; significant difference 73.

Under certain conditions crops may respond to nutrients contained in composts equally well or better than to those in inorganic fertilisers (Table 1). Under other conditions it may be otherwise, but it seems that for the most efficient utilisation of added inorganic nutrients a certain level of soil organic matter content—which may or may not be found in a given soil—is necessary for each crop. This is illustrated by the following pot-culture results on cotton. Such pot-culture results have been confirmed by field trials on several crops.

Table 2. Yield of seed cotton (gm. per plant). Pot culture experiment 1934–35.

Nutrients	Cambodia (Indore 1)		Malvi 9	
	No treatment	Compost	No treatment	Compost
Nil	3·5	4·9	2·8	6·3
N	4·8	14·0	3·2	13·9
P	10·7	6·8	2·7	6·3
K	7·7	19·2	2·3	9·9
N, P	15·6	18·7	15·2	12·7
N, K	8·6	13·7	3·9	13·4

$P < 0·01$; significant difference = 2·4.
Rates of manures used per kilogram of soil.
Compost: to supply 200 mgm. of N.
N, K, P: „ „ of each.

Hence, in our view, humic composts do not necessarily compete with inorganic fertilisers; rather they are complementary to each other.

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The Nature of Light

SIR J. J. THOMSON[1] has suggested that a photon is a finite, harmonic train of circular lines of electric force originating when an electron in a radiating atom falls from one energy-level to another. Such circular lines of force would move at right angles to their planes, and their centres would travel along a straight line with the velocity of light. If a set of electromagnetic waves of the kind suggested could exist, the energy in any wave-front could be concentrated around the axis of propagation, so that the radiation could be confined within a cylindrical pencil and would not be dissipated through space. The 'photon' would therefore travel unchanged without loss of energy.

It seems to be quite impossible, however, that the solutions of Maxwell's equations propounded by Thomson can exist in any reasonable medium.

The electric intensity of the circular lines of force obeys an expression of the form $Q = A\rho + B/\rho$, where A and B are constants and ρ is the usual radius vector of cylindrical co-ordinates. To satisfy conditions of finiteness, there must exist an unpleasantly arbitrary value of ρ $(= a)$, such that $B = 0$ when $\rho < a$ and $A = 0$ when $\rho > a$. Outside this 'core' of radius a, the magnetic vector, γ, parallel to the axis of propagation, vanishes, and there is no radial flow of energy. Inside the 'core', however, γ is finite and constant, and there *is* a radial flow of energy, which, presumably, would have to be dissipated at the mathematical surface, $\rho = a$. This difficulty, of course, is to be traced back to the fact that, although Thomson has made the tangential electric vector continuous in crossing the arbitrary interface, he has not satisfied the continuity condition for the tangential magnetic vector at the same boundary. This last condition can be complied with only if $A = 0$. As a consequence, Q can be finite everywhere only if it vanishes everywhere.

Such cylindrical wave-trains can exist therefore only if, imbedded in the propagating medium, there is a perfectly conducting surface at $\rho = a$.

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NATURE, **137**, 232 (Feb. 8, 1936).

Effect of Lunar Eclipse on the Ionosphere

FOR some time we have been studying the variation of height of the different layers of the ionosphere at different hours of the day and night by the well-known group-retardation method. The technique of Breit and Tuve[1], with the later improvements suggested by Appleton and Builder[2], has been adopted for emitting short radio pulses from an aerial system of half-wave Hertzian horizontal dipole type, fed by a Lecher system. The receiver with the recording system of cathode ray oscillograph is located at a distance of about 1·5 km. from the transmitter. It may be mentioned that the average equivalent height of the Kennelly-Heaviside, or E layer, is found to be 100 km., and that of the Appleton, or F layer, about 270 km. The observations have been taken with waves having frequency of 3·8 megacycles per second.

During the lunar eclipse of January 8, 1936, a whole-night observation showed that the echoes from the F layer, which were prominent before the eclipse, became substantially feeble during the totality between the hours 2330 and 2354 I.S.T. The reflected waves regained their former strength after the eclipse. This observation indicates that the moon has also some contributory effect in changing the ionisation of the upper atmosphere. The ion-content becomes appreciably minimised during the absence of the moon. This presumably may be due to the presence of ultra-violet waves which appear in the lunar spectrum[3].

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[1] Breit and Tuve, *Phys. Rev.*, **28**, 554 (1926).
[2] Appleton and Builder, NATURE, **127**, 970 (June 27, 1931).
[3] Hanson and Hulburt, *Phys. Rev.*, **37**, 477 (1931).

Points from Foregoing Letters

THE results of research on the carbon dioxide content of air under various conditions, carried out immediately prior to his death by Prof. J. S. Haldane, together with Dr. R. H. Makgill, are outlined by Prof. J. B. S. Haldane. The influence of height above ground, vegetation, seasons, soil, sea, city surroundings, etc., is indicated. The simplicity and rapidity of the method devised may render it useful in other fields, for example, for distinguishing, in meteorological observations, between bodies of air of different origin.

Dr. Albert Fischer finds that by transferring a few drops of a solution (A) of serum globulin (at 70° C.), in process of coagulation, to a fresh solution (B) of the same substance, the rate of induced coagulation in (B) depends upon the rate in (A) at the moment of transfer. From the retarding effect of alkali, he infers that such chain reactions, leading to the denaturation of proteins, may be explained by the appearance of radicals ($-NH_2$, $-SH$) on the surface of the spherical protein molecules.

Diagrams showing the atomic arrangements in crystalline powders of prussian blue and related pigments, as deduced from X-ray investigations, are submitted by J. F. Keggin and F. D. Miles.

Absorption of light by several of the compounds of hæmoglobin (red pigment of the blood) has been investigated by G. A. Adams. These substances show a common absorption point in the region of 4100 A., which is apparently due to the porphyrin ring system in 'hæm' (a basic compound the hydrochloride of which is hæmin, a bluish-black decomposition product of hæmoglobin).

By using Geiger-Müller counters (for counting ionising particles) with walls made of nickel and of tin, and irradiating them with slow neutrons, R. Naidu finds that induced radioactive substances are produced. In the case of nickel, the half-life is three hours, while in the case of tin two half-periods of 8 and 18 minutes respectively are observed.

The secondary emission of molybdenum with various amounts of barium surface contamination has been studied by L. R. G. Treloar. A definite relation has been established between secondary emission and work function, provided that the contamination is not more than one atom thick.

A new possible way in which electrons can escape from the cathode of an arc is indicated by Dr. M. J. Druyvesteyn; if the cathode is covered with a very thin layer of an insulating substance, the number of positive ions on its surface can produce a high field which will enable electrons to escape from the metal, and penetrate through this insulator into the gas with a high velocity, without recombining with the ions on the surface.

According to Drs. I. Ramakrishna Rao and C. Sambasiva Rao, a study of the Raman effect in strong electrolytes suggests that, while all molecules with electrovalent bonds are completely dissociated even in highly concentrated solutions, those with covalent bonds (possible only between the anion and the hydrogen ion) change progressively with dilution into the electrovalent type and thus towards complete dissociation.

John F. Marshall and J. Staley report observations on the mosquito *Theobaldia subochrea* which indicate that this species possesses the rare characteristics of mating within small cages and laying fertile eggs without a previous meal of blood.

A case of transference of the mite, *Tarsonemus pallidus*, from cyclamen to a strawberry plant is reported by D. O. Boyd and W. E. H. Hodson.

The existence in the fat-soluble extract of kale or alfalfa of a new vitamin the absence of which leads to gizzard erosion in chicks, is indicated by experiments reported by H. J. Almquist and E. L. R. Stokstad. The authors show that the needed dietary factor is distinct from that responsible for the prevention of hæmorrhage in chicks.

Y. D. Wad and F. K. Jackson of the Institute of Plant Industry, Indore, show that humic composts and inorganic fertilisers should be regarded as complementary to each other and not necessarily competing. For the most efficient use of inorganic nutrients, soil organic matter must be in proper condition and must reach a certain level. If the necessary amount, which varies with the crop, is not present, humic composts may be employed to adjust the level.

Research Items

Origin of Iron in Antiquity

In *Antiquity* for March under the title "The Coming of Iron", Mr. G. A. Wainwright reviews in some detail the recorded finds of early examples of iron, and on this evidence offers suggestions as to the source of this metal in antiquity. The most ancient pieces of iron known are the beads from Gerzah, some fifty miles south of Cairo, which were found by himself. These are dated at about 3500 B.C. Sir Leonard Woolley found some fragments of iron in the Royal Tombs at Ur, which are dated at 3000 B.C. but may possibly be so early as 3500 B.C. These two specimens of early iron contain 7·5 per cent and 10·9 per cent of nickel respectively and are, therefore, meteoric. All early iron was formerly held to be meteoric; but Desch's analysis of the fragment with a bronze dagger handle found by Frankfort at Tel Asmar in Mesopotamia showed that smelted iron was in use in 2800 B.C. The celestial origin of the rarely occurring iron in early Egypt is recognised by the addition of the epithet "from the sky" added after the fourteenth century B.C., when smelted iron had been introduced. Egypt actually was the last of the countries of the East to receive iron, and then only under the intensification of influences from the north. In Mesopotamia iron was as rare as in Egypt until 1100 B.C. In Asia Minor from the twentieth century onward iron was used regularly, and from the fifteenth century Asia Minor, northern Syria and north-west Mesopotamia exported iron objects; while it was clearly the wanderings of the Asianic tribes which brought iron to Palestine in the fourteenth and thirteenth centuries. By 1100 B.C. Assyria, Carchemish, Cyprus, Greece and the Ægean were entering the iron age; while in the eighth century Sargon had in store one hundred and fifty tons of iron, of which the ingots resemble in their curious shape those which two hundred years later were entering Germany and France with the La Tène culture.

Development of the Kidney in the Frog

Although much work has been carried out on the development of the urino-genital system of *Rana*, the story was incomplete in certain respects and in particular in regard to the post-metamorphic changes in the male. Those of the female are clearer since there is not the same close anatomical connexion between the urinary and genital ducts. P. Gray (*Quart. J. Micro. Sci.*, 78, Pt. III; 1936) has filled in this gap and helped to disperse some of the previous misconceptions. Part of the confusion that exists in earlier accounts is due to the failure to recognise that in the adult three different regions are represented in the kidney. At metamorphosis, only the anterior and middle regions are present, and these are characterised *inter alia* by the possession of straight tubes running transversely. The first one or two of these are concerned with the passage of sperms, the next three or four carry both sperms and excretory products. Behind these are about six tubes, originally straight but afterwards becoming bent, which only serve to carry urine. In the posterior region, which begins to differentiate at the beginning of the second year, there are no straight tubes and it has no genital function. Kidney and genital ridge are connected by a sheet of blastema. This sheet breaks up into a number of strands, the rudiments of the vasa efferentia. In the second year the vasa run from the kidney, within which they are connected with a strand of blastema representing Bidder's canal, to the testis. The seminal vesicles are developed from a group of from four to six clumps of kidney blastema cells near the posterior end of the archinephric duct. It is not until the third year that these develop into the coiled tubes characteristic of the adult. The author suggests that they may represent the remains of an ancestral kidney specialised for sperm storage.

The European Corn Borer in North America

This insect is the larva of the moth *Pyrausta nubilialis* which was first discovered in the United States in 1917. It most probably was accidentally imported with broom-corn from Hungary or Italy, and had already been in the United States for some years before being detected. The results of sixteen years' investigation have shown that it is one of the most injurious plant pests that have invaded that country. According to the account given by Mr. D. J. Caffrey in the U.S. Farmers' Bulletin, No. 1548 (revised August 1935), a total area of about 265,000 square miles were infested by this pest at the end of 1934, while it has also invaded a large area in eastern Canada. So far, it does not appear to have extended farther west than the great lakes, while its eastward range reaches to New England and Long Island, N.Y. While corn (maize) is its chief host, it also attacks various wild and cultivated plants. Control by biological means is a scheme the possibilities of which are being fully explored: some millions of parasites from Europe and the Orient have been liberated and certain of these are now established over limited areas. Whether biological control will prove effective to an economic degree is uncertain, and several years, at least, must elapse before any judgment can be formed. Control by cultural methods is, however, effective and can be achieved by utilising or destroying all parts of infested plants each year before the insects develop from the borer stage into the moths.

Anomura of the Dutch East Indies

Dr. I. Gordon has described the Anomura (excluding Paguridea) from the Dutch East Indies (Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises de LL.AA.RR. le Prince et la Princesse Léopold de Belgique. *Mémoires du Musée Royal d'Histoire Naturelle de Belgique*. Hors Séries. 3, fascicule 17, 1935). There are only a few of these, and all belong to known species of *Galathea*, *Petrolisthes*, *Pachycheles*, *Porcellana*, *Polyonyx* and *Remipes*. It is, however, a satisfaction to have further records of little-known forms which usually differ slightly from the original descriptions, notably *Galathea affinis consobrina*, de Man, which has peculiar feathered setæ on the dorsal surface of rostrum and eye-stalks, not present in the type specimens. The paper is illustrated with clear text figures.

Apple Rootstock Studies

A FURTHER stage has been reached in the intensive survey of apple rootstocks initiated by R. G. Hatton at the East Malling Research Station sixteen years ago. The apples then planted showed early indications of differential influence of stocks on the vigour of the scions, and subsequent reports showed the possibility of grouping the stocks according as their influence was relatively dwarfing or invigorating. The latest report (*J. Pom. and Hort. Sci.*, 13, 4, 293; 1935) shows that whilst certain rearrangements in the order of stock influence have occurred since the 1928 records were published, the main result is an accentuation of the original differences. The several criteria of vigour adopted, namely, total wood growth, thickness of trunk, height and spread of branches, and total weight of tree, give substantially similar results. Stocks *M*IX and *M*XII are consistently the most dwarfing and most vigorous respectively, and certain stocks of intermediate vigour give the same relative order with different scions. Data obtained by other workers at East Malling have shown that the ratio by weight of tops to roots remains constant for a scion on different stocks, though the actual weights vary. A review of the work of other investigators indicates that storage qualities and chemical composition of fruits may be influenced by rootstock, but resistance to certain diseases does not seem to be transmitted from stock to scion. Hatton attaches but little significance to the influence of scion on stock, but this aspect of the problem is not without importance, and much work remains to be done before the obscure relationship between these two parts of an apple tree is thoroughly understood.

Trachyte and Olivine-Basalt Associations

A CONTRIBUTION to petrogenesis of considerable interest is made by A. B. Edwards in the course of an investigation of the association of trachyte with olivine-basalt in the Tertiary igneous provinces of Victoria, Kerguelen Island, and Otago, New Zealand (*Proc. Roy. Soc. Victoria*, 48, 13; 1935). It is concluded that the association in these three areas supports the hypothesis that alkaline rocks are the normal product of differentiation of an olivine-basaltic magma, so long as there is no undue contamination by contemporary syntexis. The factors controlling differentiation are summarised as (*a*) chemical composition of the primary magma, acting through the type of pyroxene that crystallises; (*b*) the growth of cupola-like extensions above the main reservoir, permitting the accumulation of alkaline magma in localised bodies; and (*c*) the oxidising conditions ushered in by gas-streaming during extrusion, and the transport of sodic material accomplished by such streaming. In the absence of an immediately antecedent orogeny, such alkaline rocks can develop in a continental sialic region as readily as in an oceanic region; but conditions attending orogenesis favour large-scale assimilation of argillaceous and siliceous sediments, with accompanying production of andesitic types.

Canadian Earthquake of November 1, 1935

WE have received from Mr. E. A. Hodgson of the Ottawa Observatory a copy of his preliminary report on this important earthquake. From the records obtained at seven neighbouring stations, the epicentre is temporarily placed in lat. 46° 47′ N., long. 79° 4′ W., or about four miles north-north-east of Timiskaming, Que., and the focus is believed to be at a depth of about 125 miles. One result of this great depth is the large area of more than 500,000 square miles over which the shock was felt. Soon after the earthquake, Mr. Hodgson spent a month in the district around the epicentre. No fissures in bed rock were detected at any point; but it was found that the rails on the line from Kipawa to Dozois had shifted between points a few miles to the east and north of the epicentre.

Vision

THE review of recent progress in our knowledge of the underlying processes of vision which Dr. R. Granit of the University of Helsingfors contributed to vol. 76 of the *Finska Läkaresällskapets Handlingar* has now been made available to a wider circle by appearing in German in vol. 14 of *Acta Ophtalmologica* (Copenhagen: Levin und Munksgaard, 1936). In his review he insists on the importance of considering visual processes as a part of the physiology of the central nervous system. At points of the optical system where two or more paths for the impulse converge, interaction is possible, which may lead to summation or inhibition. He believes that future progress will be based on the duplication theory, according to which for small intensities of light the rods of the retina are the receivers and at high intensities the cones. He points out the fertility of the flicker method of illumination for investigating the properties of the retina and gives the results of observations, many of which he has carried out himself, on the frequency of the intermittent illumination at which the sensation becomes one of continuous light. He finds that this frequency increases with the logarithm of the intensity of the light, and with the logarithm of the area of the retina over which it is spread.

Theory of the Geometric Object

THIS was the title of a lecture given by Prof. J. A. Schouten, of Delft, at King's College, London, on March 17. The idea of a 'geometric object' was first introduced by Klein in 1909. Since the discovery of pseudo-parallelism in 1917, several definitions have been given by Veblen, Whitehead, Schouten and others, but none of these definitions was quite satisfactory. Since the Moscow Congress on Vector and Tensor Analysis in 1934, Wundheiler, together with Schouten and Van Dantzig, have carried on a further investigation of this problem. They have discovered that the lack of rigour in the old definitions was due to the fact that no account had been taken of the two aspects of a geometric object, the functional and the componental. Corresponding to these two points of view they have introduced the following definitions: (1) A *macrogeometric* object is one whose transformed 'determining functions' are functionals of the old determining functions and of the transformation functions. (2) A *microgeometric* object is one whose transformed components are functionals of the old components *at the same point*, and the transformation functions. Every microgeometric object is macrogeometric, but the converse does not hold. By taking a one-dimensional space and the affine group of transformations, an example has been constructed of a macrogeometric object which is not microgeometric. Such objects, however, scarcely ever occur, since objects occurring in geometry are nearly always of a distinct finite class, as defined by Veblen and Whitehead, and when this is the case, the objects can be easily 'completed' into microgeometric objects.

Phase Variation in Grasshoppers

THE family Acridiidæ includes the so-called 'short-horned' grasshoppers and locusts. Locusts are, in fact, grasshoppers showing special behaviour: they differ from other members of their family on account of their habit, under suitable ecological conditions, of becoming predominantly gregarious, and migrating considerable distances in large swarms.

In 1921, B. P. Uvarov formulated the theory that locusts occur in two forms or phases, hitherto regarded as separate species. In one phase, namely, solitaria, these insects do not differ in behaviour from other short-horned grasshoppers. In the other phase—gregaria—they become gregarious and swarm. In this phase their nymphal coloration is very different from that of the solitary phase and when they become adult, difference in form and the proportional growth of parts reveal themselves. Uvarov's theory was confirmed experimentally by Faure in 1932 and later by others. It has been generally believed that the existence of such phases is a peculiarity of locusts alone. Quite recently, however, I. A. Rubtzov* has shown that an essentially similar phenomenon also occurs in non-swarming short-horned grasshoppers, but that the amplitude of such phase differences is less pronounced than in locusts. Rubtzov's observations were carried out in Siberia and embodied in a paper written in the Russian language. Biologists are indebted to Uvarov for translating this paper and assisting in its publication.

Rubtzov was impressed by the colour variations found in a number of species of grasshoppers. They were found to differ in coloration more or less in accordance with the population density per unit area of territory. Individuals collected from relatively dense associations, with up to 300 grasshoppers per square metre, were notably dark-coloured, larger and had longer wings than those distributed in the proportion of one, or fewer, over the same unit area. These differences are especially marked in *Aeropus sibiricus* and *Chorthippus albomarginatus*, while a number of other species can be arranged in descending order of their tendency to show marked colour differences. The most pronounced differences are found in *A. sibiricus*, which is an active species tending to form dense aggregations of individuals. These differences are almost equally well shown in *C. albomarginatus*. In all cases, the dark-coloured forms occurring collectively are interpreted as representing the phase gregaria, while the pale examples found singly and sparsely are regarded as representing the solitaria phase. This conclusion is supported by such experimental evidence as is available.

Thus, individuals of *C. albomarginatus*, reared in isolation, showed a tendency to develop into the pale-coloured solitaria form, while those reared gregariously, in crowded conditions, produced a very definite gregaria type. Apart from the colour differences alluded to, the supposed phase differences are also betrayed in: (1) solitaria individuals being smaller, with femur and tegmen shorter; (2) shortening of the tegmen in solitaria being more pronounced than that of the femora, the ratio being greater in solitaria than gregaria; and (3) variability in solitaria being always greater than in gregaria—as can be seen by comparing the maximum and minimum figures. Rubtzov's data are accompanied by coloured figures portraying supposed phase differences and they unmistakably suggest that we have, among non-swarming grasshoppers, clear evidence of the existence of those same phases that feature so markedly in the economy of locusts.

A further phenomenon, discussed by Rubtzov, can only be very briefly alluded to here. He shows that a homologous series of colour variations reveal themselves through many species of Acridiidæ. These are inheritable variations and, according to him, each such race possesses the potentiality, to a greater or lesser degree, to exhibit phase characteristics. The latter, as it were, are super-added to the former in response to the extreme conditions of individual life. In practice, it resolves into the necessity, fully recognised by this author, of clearly determining which race of a given species is being utilised in all studies designed to explore the phase idea.

A. D. Imms.

* Rubtzov, "Phase Variation in Non-Swarming Grasshoppers", *Bull. Entomol. Res.*, **26**, Pt. 4, 499-520 (Dec. 1935).

Underground Water Supplies

THE Cantor Lectures of the Royal Society of Arts, delivered last winter by Dr. Bernard Smith, director of the Geological Survey of Great Britain, dealt with the "Geological Aspects of Underground Water Supplies". The lectures, which give a comprehensive review of the geological conditions affecting water supplies from underground sources, are now available. In his first lecture, Dr. Smith alluded to the universality of underground water, though, in some cases, it might lie at depths too great to be of practical value, and stated that most of it, in Great Britain, is rain water, which has made its way down from the surface, though a residual quantity of 'fossil' or 'connate' water may have been held in the rocks for great periods of time. Rainfall disappears from the surface of the ground chiefly by run-off, and secondarily by percolation, evaporation and absorption by vegetation, the relative proportions at any given locality depending upon the topography, the degree of rainfall, the porosity of the soil or rock, the amount of water in the soil at the time, the amount of vegetation and the humidity of the atmosphere.

While run-off constitutes surface waters (rivers, lakes, etc.), it should be recognised that much of what is measured as run-off is actually a steady

contribution to the streams and rivers by means of springs and seepages from the underground stores built up by percolation, and it was emphasised that in cases during the past drought where reservoirs or lakes utilised for public supply were maintained at a fair level, this was owing entirely to underground water which issued steadily as feeders for the impounded supply. The relative proportions of evaporation, run-off and percolation vary greatly in different localities and seasons, so that general formulæ applicable to any district cannot be used with safety. Evaporation may be 50 per cent of the rainfall; run-off up to 92 per cent and percolation 80 per cent or even 90–95 per cent.

The properties of rocks in regard to absorption and transmission of water were discussed by Dr. Smith, who pointed out the distinction between porosity and perviousness, stating in regard to the former that 30–40 per cent of the volume of a mass of loose sand and gravel is represented by pore-space, whilst that of naturally cemented sands and gravels is only half that amount. On the average, igneous rocks have a pore space of 1 per cent, shale has 4 per cent and limestones have an average of about 5 per cent. On the other hand, the porosity of chalk attains a maximum of about 50 per cent. Pore spaces vary in size from the microscopic (micropores) to those visible to the naked eye (macropores), and the relative proportions of these to the total porosity of a rock determine to a large extent its perviousness (apart from fissures).

The perviousness of a rock is its capacity to allow water to pass through it, and depends not entirely upon the porosity (total volume of pore space), but rather on the size of the pore spaces and their continuity or interconnexion one with another. In most districts, the rocks are saturated below a depth dependent upon several factors—porosity, amount of rainfall and surface profile. In permeable rock, the surface of the saturated zone is termed the 'water table' and the water below it 'ground water'. Above the water table, in the sometimes-called 'zone of aeration', is 'wandering' or 'vadose' water. Water tables are fairly easy to determine in the comparatively unaltered stratified rocks, but not so easy in the impervious, or relatively impervious rocks, exemplified by the more ancient strata and by igneous rocks.

While in granitic areas large supplies are best sought from streams, yet many smaller supplies are to be found underground, due to the water held in the joints. This is particularly the case in Cornwall and Devon. As a class, however, granitic and kindred rocks are not good aquifers, and, in his second lecture, Dr. Smith discussed the Upper Palæozoic, Mesozoic and Tertiary strata, in which underground water occurs in large quantities. The fluctuation of the water table and the breaking out of bournes were described, with instances in the chalk uplands and elsewhere, and reference was made to the researches of Baldwin Latham and others.

Artesian wells and basins received explanatory notice, and it was pointed out that some artesian wells are very deep, having been bored to 4,000 ft. in Berlin and in St. Louis and Pittsburgh. These are deeper than any in Great Britain, most of which range at various depths up to 1,000 ft., with specially deep cases at Ottershaw (1,585 ft.), Virginia Water (1,430 ft.) and Boultham, Lincoln (1,562 ft.). The exhaustion of artesian wells may be brought about by over-pumping of the natural reservoir, clogging of the rock pores, unsatisfactory casing and heavy pumping from neighbouring wells. Of the pervious, or partly pervious, formations of Great Britain, the Carboniferous, Millstone Grit and Coal Measures; the Triassic sandstones, the Inferior and Great Oolites, the Lower and Upper Greensands and the Chalk may be regarded as the chief water-bearing strata.

In the final lecture, the geological complications (faults, flexures, cover) affecting the circulation of underground water were considered, the variation in thickness of strata and missing formations. The best way of studying the question of thickness is to draw 'isopachytes' or 'lines of equal thickness'. This information, together with surface contours related to Ordnance datum, should prove of great utility. Another point of interest to hydro-geologists and water engineers is the change in the quality of water beneath cover, from that of water at the outcrop. Most waters, where traced down an artesian slope, or into an artesian basin, are found to change in mineral character, sometimes quite rapidly.

Dr. Smith concluded his review by remarking that the question of locating supplies is often a complex matter, demanding considerable knowledge from the hydro-geologist and skill from the water engineer.

Recent Developments in Luminous Discharge Tubes

IN the *Electrician* of January 31, Mr. C. C. Paterson gives an interesting account of recent developments in luminous discharge tubes. There are two directions in which developments are making rapid progress. The first is the use of 'super pressure' lamps, and the second is the use of luminescent powders.

The high-pressure mercury vapour lamp which runs at a pressure of 150 atmospheres is a very courageous step in advance, but it is not yet known whether it will prove suitable for practical use. In the ordinary mercury vapour lamp, the vapour is under a pressure of two atmospheres; the luminous column does not fill the tube, but contracts into a 'rope' stretched along its axis, and most of the power is being expended inside this. As the vapour pressure increases, the total volume of the luminous vapour diminishes, and as the power is concentrated in this, the ionisation becomes extremely intense and the intrinsic brilliancy greatly increases.

The possibility of the usefulness of luminescent powders has now been demonstrated in the case of cold cathode (high voltage) tubes, and doubtless they will soon be applied to hot cathode tubes. Luminescent powders have been used for some years, but research has now shown methods of greatly enhancing their brilliancy. Mercury vapour has marked radiation in the ultra-violet, and when it falls on a suitable luminescent material its wave-length becomes longer and the radiation becomes visible. Zinc and cadmium sulphides are well known to be luminescent, but there

are many other substances, and so research in this direction is most promising.

Mr. Paterson has experimented with a 'sign type' tube which without luminescent powder gave 20 candles (250 lumens) with an efficiency of about four tenths of a candle per watt. With the inside surface coated with one of the new powders and using the same electric power, it gave 240 candles, the efficiency being increased twelve times.

One of the attractive features of luminescent powders is the 'band' nature of their spectra. As a rule, ordinary luminous discharge tubes emit line spectra at a definite number of single and isolated wave-lengths; the powders under suitable stimulation emit over a group of wave-lengths. They are thus very suitable for filling in gaps in the spectra of the light given out by vapours and gases.

Another type of lamp developed last year uses a tungsten filament in series with, and in the same transparent envelope as, a high-pressure mercury discharge tube. This serves the double purpose of eliminating part of the regulating device and introducing much needed red radiation into the light coming from the mercury vapour. The efficiency is of the order of two candles per watt, and the combination will be a competitor to the tungsten lamp for the interior lighting of factories.

Electrically Produced Music

THE paper read before the Royal Society of Arts on March 4 by Mr. G. G. Blake on electrically produced music considered only those instruments which depend on the method known in radio as the 'heterodyne'. Mr. Blake showed first the production of beat notes by two musical instruments. When they were both vibrating at the same frequency they emitted the same note. By gradually altering the frequency of one of the instruments, a third—the heterodyne—note could be heard. As the instruments went more out of tune, the frequency of the beat note became higher. This showed the heterodyning of sound waves.

When radio waves produce a heterodyne note at very high frequencies, each of the individual notes is inaudible, but the beat note takes place just as with low-frequency sound waves and is clearly audible. Mr. Blake, using a special instrument which he calls the ethonium, showed the following phenomena. The instrument consisted merely of two electrical transmitters suitably coupled to a wireless set. With the two transmitters and the wireless set in tune, nothing could be heard. When one of the transmitters was slightly detuned, beat notes were emitted from the loud speaker of the set. Movement of the hand towards or away from the aerial attached to one of the transmitters varied the frequency of that transmitter and the musical notes produced varied from deep bass to the shrillest treble. The alteration of note is due to very minute changes in the electrostatic capacity of the aerial. The slightest movement of the hand at a distance of a yard from the aerial alters the pitch of the note.

The circuits of the ethonium were then readjusted and the existence of a zone about two feet from the aerial was demonstrated where the presence of the hand produced no effect. Moving the hand from this zone to or from the aerial produced a deep bass note, increasing in pitch the farther the hand was moved away from the zero zone. Moving the hand away from the aerial diminishes its capacitance. Mr. Blake showed how the zero zone could be moved farther away from or nearer to the aerial.

In working the instrument, the control of this zero zone is of importance. It gives the player the ability to extend or contract the length of the musical scale over which he intends to play. It can be compared to a piano with an elastic keyboard which can be extended so as to make it suitable for a man with long arms, or contracted to suit a player with a short reach.

A demonstration was given of the superposing of music played by the ethonium upon radio-gramophone music. By connecting the electro-magnetic pick-up from a gramophone to the grid circuit of the first amplifying valve of the wireless set, the amplifier also being connected to the detector circuits, a musician can play any music he desires on the ethonium, to a suitable radio-gramophone accompaniment, his music and that of the gramophone being produced simultaneously from the loud speaker of the wireless set.

It has been shown previously by Theremin and others that unwanted harmonics can be easily suppressed by suitable filter circuits and needful overtones can be introduced. Thus the quality of electrically produced music can be altered so that it gives a faithful imitation of a flute, a violin, a cornet, a banjo and other musical instruments.

An important fact demonstrated by Mr. Blake was that the production of musical notes by heterodyne is independent of the fundamental frequency of the transmitters employed. Provided the two transmitters are exactly in phase initially, they can be operated at any desired frequency. One of the ethoniums shown operated at 1·25 million cycles. When one of its transmitters is detuned it is only oscillating at 1·2499 million cycles, the difference of frequency between the transmitters being 100 cycles, which is within the audible range. Another of the ethoniums shown operated at a frequency of 0·67 million cycles; if one of the transmitters be detuned to a frequency of 0·669,900 the difference between them will be again 100 cycles, and the second ethonium emits exactly the same note as the first. When both the ethoniums sound simultaneously, no wireless interference takes place between them. This opens up the possibility of electrically produced orchestral music from a number of these or similar electrical instruments when played simultaneously.

Many instructive lecture experiments were shown. With the ethonium tuned to silence, it was demonstrated that almost any object placed on the top of the aerial increased its capacitance so that it produced a note. The notes produced by a pin, a coin, a lump of sugar, an onion, etc., were easily heard and distinguished. Placing a piece of cardboard, a sheet of glass, a large suitcase, a wooden drawing-board or a metal tea-tray between the hand of the player and the aerial did not interfere with the use of the instrument; but when the object was metallic, it was essential that it be insulated from the earth.

Clocks in the Paris Observatory

THE *Bulletin Horaire du Bureau International de l'heure* of February gives an account of the running of the clocks at the Paris Observatory during 1935.

It is interesting to note that a British clock, the Shortt free pendulum No. 44, has given the best performance of the year, and indeed this particular clock has put up a year's performance which is probably unequalled by other clocks of the same make. During 1935, the monthly mean values of the daily rate varied only from $-0{\cdot}367^s$ per day to $-0{\cdot}377^s$ per day, and the accidental variation of the daily rate from the mean value for the month was only $0{\cdot}0017^s$. In computing the last figure, the Paris astronomers took account of the variation in apparent clock-rate due to long period nutation, the principal term as regards clock-rate in which has an amplitude of $\pm 0{\cdot}003^s$ per day and a period of six months. It has hitherto been considered in Paris unnecessary to take this term into account in discussing clock-rates.

The best Shortt clock at Greenwich is No. 3, which has twice given a straight run, so far as could be determined, over a period of three months, that is to say, that during the three months the clock error was not observed to depart from the value corresponding to the mean rate. A clock error greater than $0{\cdot}01^s$ should be detected. It has been habitual to take account of both long and short period nutation at Greenwich in discussing clock performances.

To clear up misunderstandings about this subject, it is as well to state here that wireless time signals are sent out on mean time, which is unaffected by either long- or short-period nutation. The sidereal time contains nutation, so that the error and rate of a mechanically perfect clock show the nutation when compared with true sidereal time. In discussing the mechanical performance of the clock, it is ideally necessary to remove nutation from the sidereal time, which is what one determines by transit observations. The corrections for nutation have always been made in computing mean time for wireless signals from transit observations, but in discussing sidereal clock rates, determined from transit observations, long-period nutation has sometimes been ignored, as its effect on the rate (but not on the error) is small.

Educational Topics and Events

CAMBRIDGE.—The following grants towards the expenses of expeditions have been made from the Worts Fund: £50 to F. E. Kemp, an expedition to the Great Barrier Reef; £50 to N. E. Odell, to study glacier movements in the Eastern Himalayas; £30 to T. T. Steiger, to study the effects of European civilisation upon the life of a native tribe in Uganda; £40 to G. E. Daniel, for archæological purposes in the Western Mediterranean; £37 to J. S. Turner, for an ecological survey of the oak woods of the Killarney region; £40 to Miss C. K. Rickardo, to study the ecology of a small lake in Rhodesia; £50 to M. G. M. Pryor, to study the ecology and distribution of the Trichoptera (caddis flies) of the mountains of northern Jugoslavia.

The General Board recommends that the following additional University teaching offices be established from October 1, 1936: a readership in the Department of Geology, a University demonstratorship in soil science in the Department of Agriculture, a University demonstratorship in the Department of Botany (subject to the requirement that the person appointed shall act as curator of the Herbarium and the Botanical Museum), a University lectureship in the Department of Zoology, a University demonstratorship in the Department of Zoology (subject to the requirement that the person appointed shall act as senior curator of the Museum of Zoology), a University lectureship in the Department of Physiology (temporarily replacing a demonstratorship).

At Downing College, Dr. J. Hammond has been elected to a non-stipendiary fellowship.

LONDON.—Prof. J. G. Semple has been appointed as from October 1, 1936, to the University chair of mathematics tenable at King's College. Since 1930 he has been professor of mathematics in the Queen's University, Belfast.

The title of reader in electrical engineering in the University has been conferred on Mr. W. J. John, in respect of the post held by him at Queen Mary College.

It has been resolved that, on the occasion of the centenary celebrations of the University this year, degrees should be conferred *honoris causa* on thirteen British and six foreign distinguished men, including Sir William Bragg, Mr. S. A. Courtauld, Sir Joseph Larmor, Dr. J. W. Mackail, Sir George Newman, Sir Charles Peers and Mr. H. G. Wells; and Prof. Albert Einstein, Prof. Johan Hjort and Prof. Max Planck.

The following doctorates have been conferred:—D.Litt. on Mr. C. E. M. Joad, of Birkbeck College; D.Sc. in chemistry on Mr. F. D. Miles, of the Imperial College (Royal College of Science); D.Sc. in engineering on Mr. S. J. Davies, University reader at King's College.

Dr. C. D. Ellis has been appointed as from October 1 to the Wheatstone chair of physics tenable at King's College. Since 1923 he has been lecturer in natural science at Trinity College and lecturer in the Department of Physics in the University of Cambridge.

The London (Royal Free Hospital) School of Medicine for Women has received an anonymous gift of £11,000 to endow "The Free Woman's Lectureship in Clinical Medicine". Dr. Una Ledingham, assistant physician, Royal Free Hospital, has been appointed to the lectureship. The Aldrich Blake travelling scholarship (1936) has been awarded to Miss Geraldine Barry, assistant surgeon, Royal Free Hospital.

DR. J. M. GULLAND has been appointed to the Sir Jesse Boot chair of chemistry in University College, Nottingham, in succession to Prof. F. S. Kipping, who is to retire at the end of the session. Dr. Gulland is at present reader in biochemistry, University of London, and senior assistant in biochemistry in the Lister Institute. Prof. W. H. McMillan, head of the Department of Mining and Fuels of the College, has submitted his resignation on being appointed to the James A. Hood chair of mining in the University of Edinburgh and the Heriot Watt College, Edinburgh. Prof. McMillan was the first occupant of the chair of mining established at Nottingham in 1911.

Science News a Century Ago

The Entomological Society

AT a meeting of the Entomological Society held on April 4, 1836, the Barons Ocskay de Ocsko, and De Chaudoir, M. Fahraens, Governor of the Province of Gottenburg, and several other distinguished entomologists were balloted for and elected foreign members of the Society.

The Horticultural Society

AN exhibition by the members of the Horticultural Society was held on April 5, 1836. This exhibition, said the *Athenæum*, was of much greater interest than recent displays, "and though late in the season for Camellias, was very rich in specimens of that beautiful tribe, it being understood that medals would be bestowed for the best Chinese varieties and English seedlings. Those plants that were still in bloom therefore in the collections of the most celebrated growers of these plants, were brought into contrast. . . . The Camellias from Mr. Donald's nursery were remarkable on account of their being from the open ground and only slightly protected in the winter; the plants averaging in size from two to four feet in height and from six to nine feet in circumference".

Louise-Philippe and the French Surgeon Desault

QUOTING from *Galignani's Messenger* on April 6, 1836, *The Times* said: "It is well known that his Majesty Louis Philippe, in his youth, besides the usual studies of his age and rank, applied himself to the acquirement of many of the useful arts and sciences, and, among the rest, to surgery, in which he became the pupil of the celebrated Desault. Being informed that a subscription was being made for raising a monument to the memory of this restorer of surgery in France, in his native town of Lure, in the Upper Saone, he desired the list of subscribers to be brought to him, and inserted his name for the sum of 300 f., writing at the same time the following note:—'Desault was my master and professor in surgery. I assisted him as one of his dressers, and it was he who put the lancet into my hands, causing me to bleed patients at the Hôtel-Dieu of Paris'."

Desault was born on February 6, 1744, became surgeon of the Hôtel-Dieu in 1788 and died on June 1, 1795.

Progress in Medicine

IN his inaugural address (*Gazette des hôpitaux*, April 7, 1836) at the Hôpital de la Charité, M. Bouillaud, professor of clinical medicine in the Paris Faculty, said it was difficult to understand how some persons could assert that there was no progress in medicine. Every discovery of facts, every theory, doctrine or system was progress, so that to deny the existence of progress was almost as ridiculous as to deny the existence of motion. Physics at the present time was not that of antiquity, the chemistry of Fourcroy was not that of Berzelius, Thenard, etc., nor was modern philosophy that of Socrates or Plato. Physics, chemistry and all the other accessory sciences were indispensable to the physician, for how could the theory of movement, the chemistry of the organs, circulation, etc., be interpreted without a more or less profound knowledge of the laws governing inorganic bodies? The ancients knew nothing of physiology. They did not possess the knowledge of etiology which we have, although Hippocrates had studied the influence of air, waters and places. Treatment, the corollary of pathology, had made undoubted progress, though it was still far from perfection, for it was often irrational and empirical. Without going into further details, percussion, auscultation and mensuration were obvious proofs of the progress of medicine. Men of progress were rare. If one compared the progress of medicine from Hippocrates to Morgagni with that made from Morgagni and Bichat down to the present time, one would realise the immense strides made by medicine in the last century. France was one of the most progressive countries and one in which medicine had not lagged behind the other sciences.

The Adelaide Street Gallery of Science

IN *The Times* of April 8, 1836, appeared the advertisement: "SPLENDID EXHIBITION. Adelaide Street Gallery.—The Council of this Institution, anticipating numerous visitors at this season, have directed for *Exhibition* the most familiar yet brilliant chymical and other experiments, the Microscope (very frequently repeated), Magnets, Cosmoramas, Steam-Gun, Combustion of Steel, Rope Dancers, Chinese Jugglers, Silk Looms, Printing Press, Minerals, Paintings, Tapestry, Sculpture, Models—Nautical, Mechanical, Architectural, etc. Open from 10 till 6 o'clock. Admission 1*s.* or annual subscription £1."

Statue of Cuvier

ON April 9, 1836, the *Athenæum* said: "M. David has now finished his second statue of Cuvier. It is in an erect posture and robed in the costume of Counsellor of the University, and is to be placed in the new gallery of Mineralogy at the Jardin du Roi. M. David has aimed at the expression of consummate genius in the head, as he had, in the previous statue for Montbeliard, conveyed the impression of deep thought. The same distinguished sculptor has just executed a colossal bust in marble of the great Berzelius, whose nuptials in Sweden have just been celebrated."

Epidemic Disease in France

ACCORDING to a note in the *Gazette médicale de Paris* of April 9, 1836, the Royal Society of Medicine of Marseilles was offering a prize of 500 francs for the best essay in French or Latin dealing with the following two questions: Has the recent occurrence of cholera in France sufficiently settled our views as to its mode of propagation as to justify a modification of the existing sanitary legislation? (2) Up to what point have our ideas on the propagation of typhus, yellow fever and plague been modified by the great epidemics in France, and to what extent may the legislation on these diseases be modified? The Society, in accordance with the views held by the great majority of French practitioners, regarded cholera as not contagious. This conviction, however, was not obligatory for candidates, who were free to express their personal opinions on the subject.

Societies and Academies

DUBLIN

Royal Irish Academy, March 16. STEPHEN SHEA: Observations on the structure of the pulmonary alveolar wall in the adult rat, guinea pig and rabbit. A variation of the method of using acridin red as a stain was employed. Thick benzol colophonium was found to retain the stain in the tissues. It was demonstrated that the tissue separating the blood capillaries from the alveolar air consisted of three distinct layers—and an outer cellular membrane. The cell nuclei of the outer membrane closely embrace the capillaries. Fine prolongations of cytoplasm extend over the alveolar aspect of the capillaries completing the membrane.

PARIS

Academy of Sciences, February 24 (*C.R.*, **202**, 601–704). ALFRED LACROIX: Chemical composition of the lavas of Easter Island. Complete analyses of sixteen rocks, and remarks on the lithological classification. GABRIEL BERTRAND and HERMANUS L. DE WAAL: The comparative amounts of boron in plants cultivated on the same soil. Results of determinations of the amounts of boron in thirty species of plants: the boron found ranges from 2·3 mgm. per kilogram of dry material in barley to 94·7 mgm. in the poppy. The cereals contain the smallest amounts of boron. PIERRE LEJAY: Gravimetric map of Indo-China. From values of g measured at ninety-seven stations a chart showing the anomalies of g has been deduced. JEAN CABANNES, JEAN DUFAY and JUNIOR GAUZIT: The presence of radiations of wave-lengths below 3000 A. in the spectrum of the night sky, and the probable existence of two luminescent layers in the upper atmosphere. As a working hypothesis to cover the known facts, the existence of two light-emitting layers is assumed, one, at a very high altitude, directly excited by electronic collisions, the other, lower, connected with the transformations accompanying the formation or destruction of ozone. HARALD CRAMÉR: A property of the law of Gauss. PAUL VINCENSINI: Certain congruences of spheres. PER GOTAAS: Formulæ of recurrence for semi-invariants with some laws of distribution with several variables. S. MAZUR and W. ORLICZ: The divisibility of abstract polynomials. CHARLES BLANC: The type of Riemann surfaces simply convex. F. H. VAN DEN DUNGEN: The properties of oscillations. CHARLES JAEGER: The theory of the water 'hammer' in water mains with characteristic multiples. The case of periodic movements. PAUL SCHWARZ: The movement of Bénard-Kármán vortices in a rectilinear canal. A. LABARTHE and R. VICHNIEWSKY: Study of the vibratory phenomenon accompanying combustion in internal combustion motors. Photographic recording of the pressure-time diagrams by the Labarthe photocathodic method showed parts of the diagrams corresponding to the existence of a vibratory phenomenon with a frequency of about two thousand periods per second. It was proved that this was not due to period of vibration of the metallic membrane used. ALEXANDRE FAVRE: A new hypo-supporter method: wing with a wall of mobile extrados. RENÉ DUGAS: The reality of quantic mechanics. A discussion of Einstein's criterium of reality. RENÉ LEDUC and JEAN VILLEY: The yield of propelling tuyères. ALEXANDRE PROCA: The definition of the electro-magnetic field by potentials: the magnetic moment of the electron. MARCEL LAPORTE and MLLE. PIERREJEAN: The fine structure of the flashes of light obtained by discharging a condenser through a tube containing gas. GASTON DUPOUY: The thermomagnetic study of some salts of the rare earths in aqueous solution. HENRI BIZETTE and BELLING TSAÏ: The magnetic rotatory power of nitric oxide. The Verdet constant of nitric oxide, compressed to 90 kgm./cm.^{2}, for the green line of the mercury arc is $-0{\cdot}0068'$. AUREL NAHERNIAC: Study of the absorption spectrum of alcohols in the near infra-red (about 1 μ) as a function of the temperature up to the critical point and above. The curve showing the intensity of the OH band as a function of the temperature is given: this curve resembles the curve of densities up to the critical point. GEORGES DÉJARDIN and LEWI HERMAN: Remarks on the fluorescence of sodium salicylate. A. ROUSSET: Measurements of the polarisation in the spectrum of molecular diffusion of liquid carbon tetrachloride. CHARLES LAPICQUE: The retinal image of a distant point for different sizes of the pupil. JEAN CAHOUR: The hardness of electrolytic deposits of nickel. The hardness of the deposit varies definitely with the nature and physical state of the supporting metal. Factors tending to diminish the size of the crystals cause an increase of hardness. CLÉMENT DUVAL: Remark on the boiling point constants. ANDRÉ BOULLÉ: The potassium metaphosphates prepared by dehydration of monopotassium orthophosphate. The variations of viscosity of the colloidal solutions studied do not appear to correspond with changes of crystalline structure, and do not indicate with certainty the existence of varieties capable of existing at the ordinary temperature. MLLE. BLANCHE GREDY: Comparison of the Raman spectra of some *cis* and *trans* cinnamic derivatives. JOSEPH BIECHLER: Researches on the aromatic nitrogen substituted cyanamides. E. ZMACZYNSKI: A reaction of sulphur and some ketone-alcohols in glycerol containing iron. A colour reaction capable of detecting 1 mgm. of sulphur in 1 c.c. of glycerol. LÉON ENDERLIN: Contribution to the study of the reversible oxidisability of organic compounds: a monoxide reducible but not dissociable of bis-*p*-bromophenyldiphenylrubene. PIERRE BEDOS and ADRIEN RUYER: 1.3-cyclohexadiene and on the structure of the monoepoxide of this hydrocarbon. F. BLONDEL and J. BONDON: The mineralisation of the Pre-Cambrian of the Anti-Atlas. A. LENOBLE: The discovery of a fossil fauna and flora in the schist formations of the schisto-quartzo-limestone formations of the centre of Madagascar. EUGÈNE AUBEL and FUSIO EGAMI: The deamination of alanine. ALBERT MAIGE: The physico-chemical properties of the plastidal stroma and imbibition. RENÉ SOUÈGES: The embryogeny of the Hypericaceæ. The development of the embryo in *Androsæmum officinale*. EMILE MIÈGE: The injurious influence of continuous culture of the potato on the level in Morocco (1934–1935). The results confirm the views of agriculturists, that the cultivation of the potato in North Africa is impossible without fresh importation of seed potatoes. P. LAMARQUE: Histo-radiography. HENRI BIERRY and BERNARD GOUZON: The spectral detection of the œstrogenic hormone in the urine of a pregnant woman. The method appears to be specific and sensitive. PIERRE FEYEL: The influence of the food regime on the renal secretion of urea in mice.

Raymond Hamet: Modifications of the physiological action of 3,4-dioxyphenyl-β-aminobutanol by the substitution of a methylamino group for the amino group of this substance. Ph. L'Héritier and Georges Teissier: The proportion of the sexes in populations of *Drosophila* in equilibrium. Maurice Lecamp: The determination of the coaptative curvature of the anterior members in *Phasma*. Maurice Lemoigne, Pierre Monguillon and Robert Desveaux: The production of hydroxylamine by *Sterigmatocystis nigra* at the expense of ammonia. Hydroxylamine is formed by this mould either from nitrates or from ammonia. It thus appears to be a necessary term in the nitrogen metabolism of this plant. Maurice Piettre: Researches on the proteins of yolk of egg of the fowl. Constantin Levaditi and Mlle. Rachel Schoen: The virus of rabies and neoplasmic cells.

Cracow

Polish Academy of Science and Letters, January 13. F. Leja: A class of series with real terms. T. Banachiewicz: Photographic observations of Pluto. Pluto has been found on four negatives taken at Cracow on November 3–4 and 4–5, 1935, and its positions are given. M. Kamienski and M. Bielicki: The appearance of the Wolf Comet I in 1925. Results of calculations based on all the observations of this comet made in 1925, and a comparison of these calculations with the theory of the comet. J. Nowak: The Upper Cretaceous in the conglomerate of Sloboda Rangurska. M. Gatty-Kostyal and J. Tesarz: Nucleic acid from ergot of rye. After carrying out a series of comparative analyses of the nucleic acids arising from ergot of rye and from yeast, the chemical identity of these substances has been established. Mlle. J. Studentowicz: The behaviour of annelids belonging to the species *Enchytræus albidus* under the influence of light. T. Garbowski: The role of memory in a cat blind from birth. W. Heinrich: Monocular stereoscopy. M. Podhoredecki: Fixing attention on the lateral parts of the field of vision. W. Szewczuk: Researches on optical illusions.

Leningrad

Academy of Sciences (*C.R.*, 4, No. 3, 1935). L. V. Kantorovich: Some general methods of extension of Hilbert space. D. Sherman: Contribution to the solution of the second fundamental problem of the theory of elasticity in the case of a multi-connected plane. W. Freedericksz and W. Zwetkoff: Movements arising in anisotropic fluids under the influence of an electrical field. P. T. Sokolov and S. L. Sosinskij: Influence of electric fields on the viscosity of fluids. D. W. Konvisarov: Plasticity of deformed metals. L. Isakov: A system of masses of light atoms deduced from nuclear reactions alone (2). N. N. Kalitin: Some data on the transparency of ice for the ultra-violet solar radiation. N. I. Stepanov and S. A. Bulach: Rate of transformation in the magnesium-cadmium alloys. V. M. Timofejev: Absolute age of the oldest formations of Karelia. S. Heller: Contribution to the problem of the connexion between gravity and seismic activity. L. I. Sergejev, A. M. Lebedev and A. A. Akifjeva: Correlation of frost resistance and resistance to soil salination. S. S. Smirnov: A new genus of Cyclopinidæ (Copepoda) from Anatcha Bay (Kamtchatka). W. W. Popov: On the origin of the cell material during the formation of a heterogeneously induced extremity.

Forthcoming Events

Monday, April 6

Victoria Institute, at 4.30.—Dr. R. E. D. Clark: "The Present Position with Regard to the Origin of Species".

Tuesday, April 7

Royal College of Surgeons of England, at 5.—Sir Robert Muir, F.R.S.: Lister Memorial Lecture.

Institution of Civil Engineers, at 6.—Sir Robert Hadfield, Bt., F.R.S., and S. A. Main: "Corrosion of Iron and Steel".

Official Publications Received

Great Britain and Ireland

University of Reading: The National Institute for Research in Dairying. Annual Report for the Year ending 31st July 1934. Pp. 86. (Reading: The University.) [173

Institute for Research in Agricultural Engineering: University of Oxford. Farm and Machine, Vol. 3: Comprising the Report of the Institute for the Year ended September 1935 and the Proceedings of the Oxford Conference on Mechanization in Mixed Farming, 1936. Pp. 256. (Oxford: Institute for Research in Agricultural Engineering.) 3*s*. 6*d*. [173

Observations made at the Royal Observatory, Greenwich, in the Year 1934 in Astronomy, Magnetism and Meteorology, under the direction of Dr. H. Spencer Jones. Pp. vii+A74+B10+Cix+C57+D66+E46+24. (London: H.M. Stationery Office.) 25*s*. net. [183

London County Council. Guide to the Collections in the Horniman Museum and Library, Forest Hill, London, S.E.23. Fourth edition. Pp. 128. (London: P. S. King and Son, Ltd.) 3*d*. [183

Report of the Broadcasting Committee, 1935. (Cmd. 5091.) Pp. 77. (London: H.M. Stationery Office.) 1*s*. 3*d*. net. [183

Other Countries

U.S. Department of Agriculture. Technical Bulletin No. 501: Relation between the Physical Properties and Chemical Components of Various Grades of Geranish and their Attractiveness to the Japanese Beetle. By F. W. Metzger and W. W. Maines. Pp. 14. (Washington, D.C.: Government Printing Office.) 5 cents. [163

Southern Rhodesia. Geological Survey Bulletin No. 29: Chemical Analyses of the Rocks, Ores and Minerals of Southern Rhodesia. By E. Golding. Pp. 105. (Salisbury: Government Stationery Office.) 6*s*. [173

Reports of the Biochemical Research Foundation of the Franklin Institute. Vol. 3: 1934–1935. Pp. v+340. (Philadelphia, Pa.: Franklin Institute.) [173

Imperial College of Tropical Agriculture: Low Temperature Research Station. Memoir No. 2: The Storage of Trinidad Citrus Fruits. By E. R. Leonard. Pp. 47+10 plates. 2*s*. net. Memoir No. 3: The Storage of West Indian Mangoes. By C. W. Wardlaw and E. R. Leonard. Pp. 47+9 plates. 2*s*. net. (Trinidad: Imperial College of Tropical Agriculture.) [173

Année polaire internationale, 1932–1933. Participation française. Tome 1: Introduction, magnétisme terrestre, aurores polaires, ozone atmosphérique, rayons cosmiques. Pp. v+414. (Paris: Gauthier-Villars.) 125 francs. [183

Contributions from the Physical Laboratories of Harvard University for the Years 1933 and 1934. Series 2, Vol. 1. 65 papers. (Cambridge, Mass.: Harvard University.) [183

U.S. Department of the Interior: Office of Education. Bulletin, 1935, No. 1: Educational Directory, 1935. In 4 parts. Pp. iii+41+27+53+47. (Washington, D.C.: Government Printing Office.) [183

Smithsonian Miscellaneous Collections. Vol. 94, No. 13: Morphology of the Coleopterous Family Staphylinidae. By Richard E. Blackwelder. (Publication 3343.) Pp. 102. (Washington, D.C.: Smithsonian Institution.) [183

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 88. Zoological Results of the George Vanderbilt Expedition of 1934. Part 1: Introduction and Itinerary. By James A. G. Rehn. Pp. 14. Part 2: The Forest Elephant of Africa. By Glover M. Allen. Pp. 15–44+4 plates. (Philadelphia: Academy of Natural Sciences.) [183

U.S. Department of Commerce: National Bureau of Standards. Miscellaneous Publication M 121: Units of Weight and Measure (U.S. Customary and Metric) Definitions and Tables of Equivalents. Pp. iv+62. (Washington, D.C.: Government Printing Office.) 15 cents. [183

University of California Publications in American Archaeology and Ethnology. Vol. 35, Nos. 3, 4 and 5: A Karuk World-Renewal Ceremony at Panaminik, by Philip Drucker; Karok Towns, by A. L. Kroeber; Wiyot Towns, by Gladys Ayer Nomland and A. L. Kroeber. Pp. 23–48. 1*s*. 3*d*. net. Vol. 36, No. 2: Sinkyone Notes. By Gladys Ayer Nomland. Pp. 149–178+plate 4. 1*s*. 6*d*. net. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) [203

Amani Memoirs. A Provisional Soil Map of East Africa (Kenya, Uganda, Tanganyika, Zanzibar), with Explanatory Memoir. By G. Milne, in collaboration with V. A. Beckley and G. H. Gethin Jones, W. S. Martin and G. Griffith, and L. W. Raymond. Pp. 34+map. (Amani: East African Agricultural Research Station; London: Crown Agents for the Colonies.) 5*s*. [203