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## The Delusion of Race

RACE classification, it has been asserted by an authority of no little experience, is the most difficult of the tasks of the anthropologist. The difficulties of the man of science in connexion with a technical point are not, as a rule, of immediate concern outside professional circles ; but in this instance the inability of the anthropologists to clarify opinion by a generally acceptable definition of 'race', and their failure to arrive at an agreement as to its implications have had serious repercussions in the outside world, as is now familiar to everyone. Extreme and biased views have been accepted as endorsed by science because no voice is raised to contradict them with full and unquestioned authority.

It is unfortunate that striking distinctions between peoples and between individual members of population groups, which are immediately obvious, should afford ground for popular judgment on questions of race, upon which the anthropologist, with full technical equipment, hesitates to arrive at a final conclusion. It is still more unfortunate that, so far from the disparity between the hesitancy of science and the dogmatic certainty of popular opinion being a matter of merely academic interest, up to the present the popular judgment has prevailed in practical affairs. Racial distinctions have emerged from the sphere of intellectual inquiry and have been made the practical basis of discrimination and a justification for actions such as social ostracism, legal disability and group persecution which have brought disaster to society and the individual throughout the whole course of history.

It is, of course, patent to anyone familiar with the analytic methods of the scientific study of peoples and population groups that the popular

judgment in racial matters is in fact based on a composite body of evidence. It is usually initiated by the stimulus of certain obvious and distinctive physical characters exhibited in the individual. More often than not, one character only is taken into account, such as colour ; and this is reinforced and confirmed by the interpretation of other characters, which the more precise diagnosis of science assigns to the influence of one or other of at least three factors—race (in the sense of the inheritance of certain physical characters and also, presumably, certain mental qualities, though on the latter most anthropologists would hesitate to dogmatise), environment and culture. Of the two latter, one stands for the physical conditions, the other for the social and material circumstances in which the individual organism has developed and by which it has been moulded while plastic.

The precise determination of the respective spheres of the influence of the three factors—race, environment and culture—is often difficult to discern ; but owing to the failure of the popular judgment to discriminate, even on broad lines, between the parts played by them in the life-history of the individual and the group, there arise such popular confusions as that between nationality and race, as in the fallacy of the 'French race', or between linguistic affinity and race, which is responsible for the 'Latin races' and the 'Celtic race', or in the mistaken identification of a cultural quality as racial, as for example colour preference in dress, or even gesture or intonation in speech.

However much the more instructed observer may attempt to discount their influence, there is no doubt that cultural characters play a large, but not always consciously realised, part in racial identifications, which do not depend upon exact



measurement. The conscientious anthropologist, however, would hesitate to say at present whether or not some of such cultural characters may have a diagnostic value in racial discrimination, in a broad sense, between discrete groups—in other words, how far, if at all, culture is a function of race. A priori argument might well maintain that a specific culture is as much a product of the discriminatory process of natural selection as the evolved race by which it has been developed.

The difficulties of the problem, of which not a tithe of the more obvious are here suggested, may be gauged from the fact that a committee of the Royal Anthropological Institute and the Institute of Sociology, appointed in April 1934 to frame a simple definition of race to serve as a guide to the general public in the discussion of the problems of to-day and to indicate the relations of race and culture, has only now reached the stage of an interim report\* dealing with the definition of race. The committee had for chairman Sir Grafton Elliot Smith and later Prof. H. J. Fleure. Its members are distinguished anthropologists and biologists, and include Profs. J. B. S. Haldane, Ruggles Gates and Le Gros Clark, and Dr. G. M. Morant. Even after this term of deliberation, which it may not be regarded as unfair in the circumstances to designate 'lengthy', the committee was not able to arrive at complete agreement. Not only are alternative definitions offered, but also several members append independent observations which at times almost amount to minority reports.

The definition of race put forward by the committee is as follows :

"A Race is composed of one or more interbreeding groups of individuals and their descendants, possessing in common a number of innate characteristics which distinguish them from other groups. The innate characteristics mentioned are held to be such as usually apply to the generality of the individuals studied, and not to be pathological characters, or features (such as red hair) which characterise only a relatively small percentage in a population. In the present state of our knowledge we are dependent on characters recognised as physical for the purpose of differentiating races, though innate psychological characters may later be found to differentiate them."

The alternative definition preferred by some members is :

"By race is meant a biological group or stock possessing in common an undetermined number of

associated genetical characteristics by which it can be distinguished from other groups and by which its descendants will be distinguished under conditions of continuous isolation (that is, so long as the stock is preserved against internal dilution)."

These definitions are unexceptionable, each in its respective field and so far as it goes. The second is perhaps to be preferred, as it brings the study of man more nearly into relation with the present trend of biological research in other fields. In view, however, of the special purpose of the committee to provide assistance for the general public in current discussion, certain limitations might have been pointed out. In so far as the races of man are concerned, these definitions, far from being generalisations from concrete realities and empirical, are no more than logical concepts, postulated for purposes of classification and investigation. In face of the actual facts of the distribution of physical characters among the population groups of the world, as they exist at the present moment, race is a pure abstraction. The races or types into which the anthropologist groups the varieties of *Homo sapiens* are ideal types built up to explain congeries of characters in individuals and groups, derivative from a variety of strains, in some sort of a phylogeny. Man seems to be almost infinitely variable within a wide range, and since upper palaeolithic times in the course of world-wide migration has interbred freely, with the result that the ideal types of anthropological classification, if they ever existed at all in any degree of purity, have become a matter of faith rather than of evidence. Characters on which classifications have been based are found everywhere to overlap, and both individual and population group bear witness to their inextricably mixed descent.

Modern facilities of transport have naturally added considerably to the trials of the anthropologist. Some indications of the combinations in breeds and the complicated character of the results within a comparatively short period is afforded by conditions in South Africa, of which an interesting account is given in a study of some racial crosses to be seen there by Prof. H. B. Fantham, now of McGill University and formerly professor of zoology in the Witwatersrand University, Johannesburg (see p. 665). In South Africa, as has been shown by recent discussion of the native 'Cape franchise' in the Union Parliament, the racial question is acute. It has the somewhat peculiar feature that the policy of segregation adopted by the white population as a protective measure against the

\* Race and Culture, Pp. 24. (London: Le Play House Press; Royal Anthropological Institute, 1936.) 18.



domination of the black by force of numbers, is also strongly supported by the latter, or at least its better elements. On both sides there is a fear of racial deterioration and degradation. It is interesting, therefore, to see what are the actual results of some of the crossings which have come under Prof. Fantham's observation.

A family which arose from a Dutch-Xosa miscegenation, repeated by one son, while other children married 'Cape coloured', consisted of fifteen individuals in two generations, who varied from black to three members who pass as white. The hair varied from frizzy or crimp to fairly straight. The white members are described as "more temperamental". Another family, also of Dutch-Xosa origin, investigated in three filial generations, shows the same variation in pigmentation, feature and hair form between the European and the black parent; while the most marked range of variation is shown, as might be expected, by the intermarriage of two families, who had a mixed descent of Portuguese, Dutch, Huguenot, Basuto and Javanese (Malay).

The interest of these studies, of course, is that they are a precise and exact record of a state of affairs which is known to have been in being since

the sixteenth century, when the whites first began to come in numbers to the Cape. Further, the native peoples with whom the whites intermarried were not themselves 'pure'. Not only had they interbred freely, or at least with some freedom, but also some of them had been in contact with Arabs and other early visitors to Africa.

South Africa, however, is not singular in this matter of racial crossing, though the facts can perhaps be followed there with greater certainty than in some other parts of the world. The conditions there, in fact, reproduce what has been taking place on a greater or lesser scale in all parts of the world since man first began to move about at all freely. The remarkable results noted by Prof. Fantham and the records of other observers go to show how it has come about that individuals and populations, when submitted to detailed examination, exhibit combinations of characters which set precise classification at defiance, if more than a very limited range of characters is taken into account. This fact certainly lends every support to those who would maintain that the significance attached to race in current political argument is a delusion which, in its inflammatory tendencies, is fraught with no little danger.

## The Art of Plant Description

### Phytography as a Fine Art:

Comprising Linnean Description, Micrography and Penportraits. By Dr. J. W. Moll. Pp. xix + 534. (Leyden: E. J. Brill, Ltd., 1934.) 15 guilders.

THE late Prof. Moll's book on phytography is remarkable in several respects. Written between the ages of seventy-two and eighty-two years by a blind man suffering from gradually increasing deafness, with the aid of three successive secretaries and the use of Braille, it represents a triumph of human will-power and endurance over grave bodily disabilities. The subject of the work is stated to be the improvement of the art of phytography in all possible directions. The book actually consists, however, of a highly complex morphological system by the aid of which a fairly adequate description may be drawn up in a more or less mechanical way, even by a botanist who possesses little or no natural aptitude for the task. The system is valuable also to the skilled describer, since it may frequently serve as a reminder to

include essential characters which might otherwise be easily overlooked.

The monumental nature of this system is illustrated by the author's statement that "a complete pen-portrait of a higher plant will easily take a man's work during a whole year". On this basis, the completion of a work comprising the pen-portraits of all known plants would cost at least 150,000 years of a man's working life: even with 1,000 collaborators it would still take 150 years. This amounts to an impossibility, and it seems clear that the description of the plant world will continue to proceed largely by means of those approximately accurate generalisations regarding taxonomic groups commonly called 'descriptions' of sections, genera, tribes, families, etc. Indeed, one of the earliest lessons that the budding taxonomist should learn is to exclude well-established generic characters from his specific descriptions.

The volume is divided into five 'books', the first (pp. 3-22) being introductory. The value of the



'Linnean method' of description is shown to reside in its terse style, relatively complete enumeration of members of the plant body, and the rigorous order of succession in which they are described. This simplifies the comparison of descriptions. The Linnean method was extended to micrographical descriptions by Moll in 1907, and was further developed in this direction by Moll and Janssonius in 1923. The art of plant description, as expounded by Moll, rests on two essentials: "a fixed universal and rational terminology, based on General Morphology"; and "the use of guiding schemes for facilitating the work of description and raising its efficiency". These are included in Book 2 (pp. 25-462), together with a series of morphological notes dealing with difficulties or controversial points. The third 'book' (pp. 463-479) contains "Results of the application of the method of pen-portraits in phytography and . . . other sciences", while the fourth (pp. 481-495) and fifth (pp. 497-523) deal respectively with "Education in Phytographical Methods" and "The Distribution of the Subject Matter in Text-books".

The "Synopsis of General Morphology" included in Book 2 is actually a collection of about 2,500 botanical terms, treated in 751 articles connected by cross-references. The article on transverse æstivation (p. 156, S. No. 263) may be taken as an example. It starts with a dichotomy between the open and closed types of æstivation, the latter being again divided into the "valvular or valvate" and the "imbricative or imbricate" modes. Under valvular æstivation are the induplicate, reduplicate and involute modifications. Imbricative æstivation is divided into six kinds, namely, quincuncial, cochlear, contorted, equitant, vexillary or descendant, and ascendant. Here the system is defective: quincuncial and cochlear æstivation are special types applying only to whorls consisting of five parts each, and therefore do not contrast properly with the contorted type, which may apply to whorls consisting of any number of parts from two upwards. Furthermore, the cochlear arrangement, as defined by Moll, includes two separate types, in one of which the single outer and inner members are adjacent, while in the other they are separated (*v. J. Bot.*, 56, 210; 1923). The corresponding guiding scheme (p. 407, No. 34) is on the same lines. The experienced systematist will be able, however, to make such modifications as may be required in this and other schemes.

The guiding schemes for general and special histology form perhaps the most valuable part of the book, since they afford a much-needed framework for systematic descriptions of anatomical characters. In Solereder's "Systematic Anatomy of Dicotyledons", "we seek in vain for anything

like a regular method of micrography". The scheme for the "histological determination and description of emissaries (hydathodes)", being comparatively short, may be given as an example, the various degrees of indentation in the original table being indicated below by means of the punctuation.

1a. epidermal emissaries: 2a. ordinary emissaries: 3a. unicellular; 3b. pluricellular—2b. trichome emissaries.

1b. emissaries provided with the ends of xylem bundles: 2a. water-pores wanting: 3a. excreting cells; 3b. ends of xylem bundles—2b. water-pores present: 3a. water-pores: 4a. number and arrangement; 4b. shape (see guiding scheme No. 71)—3b. epithema; 3c. ends of xylem bundles—2c. apical openings: 3a. cuticle; 3b. cavity; 3c. ends of xylem bundles.

Moll was perhaps less at home in the description of macroscopic characters. Thus his inclusion of "lanceolate" (p. 430) among those shapes with the greatest breadth in the middle part is not in accordance with modern practice, although it conforms with the Linnean definition. Sometimes, however, his departures from orthodox terminology constitute an improvement, as in the case of pedicel (pedicellus) defined as "the special and relatively small stalk of a single flower", whether this flower is solitary or forms part of an inflorescence. This seems more logical than the usual restriction of the term to the final axes in an inflorescence. His definition of a rhizome as a metamorphosed caulome or cormus directs attention to the fact that the lateral phyllomes are included under the term rhizome only when they are reduced to scale-leaves: in fact, a rhizome, as commonly defined, is not a single morphological entity. Four types of marginal indentation of a phyllome are very neatly defined by means of the obtuse or acute nature of the angles and of the sinus, a dentate margin, for example, resulting from the combination of acute angles with obtuse sinus, and a crenate one corresponding with obtuse angles and acute sinus.

In addition to its chief purpose as a handbook for plant description, Moll's "Phytography" forms a useful guide to general morphology. This part of the work was compiled from five botanical text-books, namely, those of Oudemans, Sachs, Van Tieghem, Oudemans and De Vries, and the third edition (1908) of the English translation of Strasburger, Noll, Schenck and Karsten. Had Asa Gray's "Structural Botany" been included, the results might have been more in accordance with the best modern taxonomic practice.

Prof. Moll's book is one which must be used to be appreciated. It would be idle to pretend that it is either attractive or readable. Perhaps it may best be compared with a vast and forbidding



quarry from which the skilled phytographer may hew the stones with which to build the stately edifices of his descriptions. Plant description is truly an art that cannot be taught, and no textbook will enable a botanist to make a really good pen-portrait of a plant if he possesses no aptitude

for the task. All those whose work lies in the description of plants may nevertheless profit in varying degrees from a study of Moll's "Phytography", which will long remain as a memorial to his industry and undaunted spirit.

T. A. SPRAGUE.

## Time-Space

### Geometry of Time and Space

By Dr. Alfred A. Robb. Pp. vii+408. (Cambridge: At the University Press, 1936.) 21s. net.

THE null results of experiments designed to detect motions relative to the *aether* gave rise to many outstanding achievements. But none of them possesses the qualities of survival to a greater degree than the work of Dr. Alfred A. Robb, which has now been republished, with certain modifications, improvements and additions. Dr. Robb, inspired by the influence of Sir Joseph Larmor, was early in the field, even before the publication of Einstein's "Restricted Theory of Relativity". The latter's work was very unsatisfactory from a philosophical point of view, so Dr. Robb persevered until, in 1911, he was able to publish his "Optical Geometry of Motion" which contained some of the germs of his major work, finally published under the unfortunate circumstances of 1914.

Many relativitists have felt uneasy about such concepts as "world-wide instant," the "relative character of simultaneity", etc. These concepts owe their existence to the method of approach employed by Einstein and his followers, notably Minkowski. They were led to regard kinematics as a kind of four-dimensional generalisation of ordinary Euclidean geometry, in which the time co-ordinate, multiplied by  $\sqrt{-1}$ , appears on the same footing as the space co-ordinates. Dr. Robb ultimately arrives at the same goal, but his starting point and method are fundamentally different. In particular, he has no use for those dubious instruments—the calibrated clock and transportable rigid measuring rod—by whose aid the geometry of space-time is usually set up.

The occurrence of *time* before *space* in the title is significant. The author adopts the view that the fundamental reality for an individual is the linear series of events which form his own temporal experience, and bear to one another the relations *after* or *before*. But a sense of vision, together with the properties attributed to light, supply him with a criterion for judging whether certain

other events, outside himself, are *before* or *after* an event of his own experience. This latter set of events forms a series in conical order. Relativitists will recognise this series as constituting the light-cone. This idea of conical order is the foundation and core of Dr. Robb's work, and though frequent use is made of the light-cone model for illustration purposes—a model which may be very misleading in certain circumstances—the proofs in no way depend upon its use.

The method throughout is the method of pure geometry. The assumptions are clearly formulated in a series of twenty-one postulates, and the theory developed in a sequence of some two hundred theorems, definitions being given whenever a new term or concept is introduced. Co-ordinates are introduced at the end of the work so that, if desired, further developments can be achieved by the methods of co-ordinate geometry.

It is easily seen that the relation *after* (or its converse, *before*) is simpler than the relation *between* usually postulated in treatises on the logical foundations of geometry. The latter relation requires three elements for its fulfilment and the former only two. Another distinguishing feature of this geometry is the natural manner in which the idea of congruence emerges without having to be imposed from without by special postulate. As the author remarks in the introduction: "if *before* and *after* are used as basis, *congruence* appears as an intrinsic part of the subject". Of course, segments of arbitrarily chosen lines are not comparable in respect of congruence unless they are lines of the same type. In the language of relativity, *time-like* intervals are not to be compared with *space-like* intervals. There are, in all, three types of lines: the optical, inertia and separation lines. The first is the path of a light ray, the second the path of an unaccelerated material particle, while the third is the space-like line of relativity.

To each type of line there corresponds a plane and a three-fold, each with its own peculiar geometry. In particular, the geometry of a *separation* plane (or three-fold) is formally equivalent to Euclidean geometry. Parallelism and



normalism are defined in a simple manner for all types of line, plane and three-fold. The optical parallelogram (having optical lines as sides and an inertia and separation lines as diagonals) plays a conspicuous role in the development of the theory and serves to pave the way for the introduction of congruence, without the need of using measuring instruments.

Special interest attaches to Postulates XIX and XX. The former requires four dimensions for its fulfilment, while the latter limits the dimensions to just this number. But no one would be able to read these implications into them without a knowledge of the preceding work. In order to appreciate their significance they should be compared with the corresponding *axioms* in treatises on the logical foundations of geometry as, for example, in Hilbert's "Grundlagen der Geometrie".

Postulate XVII is the analogue of the axiom of Archimedes, but without the idea of congruence, though, later, the axiom in its entirety is shown to hold in this geometry. Peano's axioms for line and plane are also shown to be true.

A detailed discussion of the postulates would be out of place in a general review. It must suffice to state that they correspond closely to certain simple, readily accepted, optical facts. The author points out that some of them are redundant but

that it is convenient to retain them for special purposes. A formal proof of the compatibility and independence of the remainder is not given. That they are compatible is fairly certain, but it would be interesting to get an answer to the question of their independence or otherwise. Postulate IV indicates the limitation of the geometry, so far as its application to the physical world is concerned. It implies that the series of events forming the temporal experience of an individual constitutes a continuum. But it is questionable whether personal experience can be chopped up indefinitely in this manner. Shades of the quantum creep in at this point, and the question must be left open.

The author has shown elsewhere that the theory is readily extended into  $n$  dimensions when Postulate XX is discarded. In this connexion it is interesting to note that, of the  $n$  mutually normal lines meeting in a point, one is an inertia line, while the remaining  $(n - 1)$  are separation lines. This fact allows the setting up of a co-ordinate system of the Minkowski type.

The importance of Dr. Robb's work cannot be over-estimated, and every effort should be made to bring it to the notice of all serious students of relativity, as well as those interested in the logical foundations of pure geometry. T. LEWIS.

## Roman Mines and Mining Methods

### Roman Mines in Europe

By Oliver Davies. Pp. xii+292+12 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1935.) 30s. net.

IN this book, the author has brought together from numerous and widely scattered sources a large amount of interesting information relating to mining activity in Europe during Roman times. In it he includes observations made during his own extensive travels, carried out for the purpose of making first-hand investigation of the gold, silver, iron, copper, lead, mercury and tin ore deposits in which the Romans were interested and on which they carried out their mining enterprises.

In a general conspectus of sixty-two pages, which forms the first part of the book, the author deals with general considerations of Roman mining under the headings legal position, economic aspects, organisation, labourers, mining technique and metallurgical technique.

As regards legal position, not much information is available; but it is clear that in Roman times

the State took a great deal of interest in minerals, and in many cases ownership of the minerals was vested in it. Under the later Empire, the State allowed private parties to work mines subject to the payment of ten per cent of the output to the Imperial Treasury and ten per cent to the surface owner, but, as regards the actual amount of the royalty charged, no doubt the amount varied with times and circumstances. The imposition of royalties on mineral output by the State and surface owners is thus a very ancient practice. In many cases, however, the Roman and other ancient States not only claimed ownership of minerals, but also actually worked the mines, using slave labour.

Economic conditions were much simpler, of course, than in modern times, machinery being of the very simplest and markets very much more restricted. Plenty of ore was available at and near the surface, and human energy was cheap. Mining methods, moreover, were wasteful; and much ore that we should consider good was thrown away as useless, only the best being recovered.



As regards mining science and technique, the Romans had only a scanty knowledge of geology and minerals, and veins lost by faulting were lost for good so far as their mining methods are concerned. They knew something about prospecting, however, and recognised many indications of ore, such as the coloured oxidation products of copper ore. They recovered gold by 'hushing', that is, by impounding or canalising waters which they directed in strong currents on to the soil or alluvium to wash away the lighter minerals and thus concentrate the gold. Their other mining methods included shaft-sinking, the driving of galleries and adits, and primitive efforts at lighting, ventilation and drainage. They used water-wheels, also iron, wood and stone tools including rilled hammers, specimens of which are often found in Roman mine-workings.

The metallurgical procedure of the Romans included crushing, washing on tables for the purpose of concentration, roasting and smelting in different kinds of furnaces. Thus their mining science was very defective, but their technique, though primitive, showed much skill and variety, and up to the standard of their requirements, was quite effective.

The remaining and larger part of the book is given to an account of mineral areas of Europe in which the Romans were interested and their mining work in these areas, including Italy, Gaul, Spain, the British Isles, Rhineland, Upper Danube provinces, Illyrian provinces, Dacia, Moesia, Macedonia, Thrace and Greece. The book has a topographical as well as a subject index, and is provided with useful maps and diagrams.

However pleasant the task of compiling this mass of interesting information may have been to Mr. Davies, it must have involved a large amount of painstaking work. Students of archaeology and the history of mining will be grateful to him for the trouble he has taken to make the information available in such a handy form.

#### Forensic Chemistry and Scientific Criminal Investigation

By A. Lucas. Third edition. Pp. 376. (London: Edward Arnold and Co., 1935.) 18s. net.

"FORENSIC CHEMISTRY" is not a very intriguing title but, interpreted in the generous spirit of the author of this work, it covers a varied range of phenomena, and it is certainly interlinked with some of the most tragic dramas of the century. The book may be considered under two aspects. It is primarily a text-book for the expert witness, or for him who would aspire to reach that third and highest plane. For him Mr. Lucas gives clear and meticulously careful advice on the manner of preparation of a report, and

macroscopical, microscopical and general and special analytical methods are described which cover almost every happening in the annals of crime. The help that physical science may give is not forgotten, and X-rays, ultra-violet and infra-red photography, and methods for the determination of specific gravities and refractive indices are all pressed into service.

The work has, however, dramatic elements in it which should attract the general scientific reader as well as the specialist witness. In the service of detection nothing is too great, nothing too trivial, and we pick up by the way much lore concerning the age of inks, the date of the introduction of black-lead pencils, the deciphering of documents, the composition of their seals, the making of plaster casts of footprints—in fact, we learn that Dr. Thorn-dyke is a very real person, and Sherlock Holmes's immortal treatise on the varieties of tobacco ash almost finds its fellow in Mr. Lucas's chapter on tobacco.

"Sand taken from the stomach and duodenum of a drowned man was examined and, as the quantity available was very small, only a microscopical examination was possible. The material was found to consist essentially of colourless grains, all very angular, and many having definite crystalline form that proved to be selenite; there was an absence of quartz, but on one slide there was part of a diatom. The presence of selenite in large proportion and the absence of quartz seemed to preclude the Nile valley and suggested the northern shores of Egypt. It was probable, therefore, that the man was drowned off the coast where his body was found and that he had not been transported there after having been killed elsewhere, as was at first thought might possibly have been the case."

Surely this is in Dr. Thorn-dyke's best manner?

Specialist and general reader alike will echo Mr. Lucas's wish that the scientific part of the evidence in the otherwise admirable reports of some well-known criminal trials should be given in full. The obscurities which result from condensation are peculiarly irritating.

A. F.

#### The Social Economy of the Himalayans:

based on a Survey in the Kumaon Himalayas. By Dr. S. D. Pant. Pp. 264+23 plates. (London: George Allen and Unwin, Ltd., 1935.) 15s. net.

DR. PANT'S book, an account of a too-little known people of the Kumaon Himalayas, is a serious contribution to the social anthropology of Indian peoples by one of themselves, based upon nearly five years of first-hand observation and investigation. The author gives a detailed account of the social and economic institutions of the Bhotiyas and other peoples of the district under survey, their methods of agriculture, their industries, trading activities, recreations and religious festivals. The governing factor in their economy is a climatic environment which makes of them seasonal nomads, migrating from lowland to upland and back as winter changes to summer and then returns—a mode of existence of special interest to both anthropologist and geographer.



### The Water Line of the City of London after the Great Fire

By Sydney Perks. Pp. v+38+13 plates. (London: Taylor and Francis, 1935.) 12s. 6d. net.

AN interesting feature in connexion with the rebuilding of London after the Great Fire of 1666 is that, at the outset, "it was decided that the buildings which had existed up to the edge of the River Thames should not be re-erected on the old sites; that no new structure should be built within 40 feet of the river; and also that wharves or quays should be constructed from London Bridge to the Temple". Mr. Sydney Perks, late Architect and Surveyor to the Corporation of the City of London, with his exceptionally privileged opportunities of consulting old records not generally accessible to the public, has been at considerable pains to investigate how far these proposals were adhered to, and the volume under notice gives a documented account of the result of his researches. There is a certain amount of contradictory evidence which is carefully sifted and the grounds for acceptance or non-acceptance stated. Much of the information has had to be collected from widely different sources—minutes of committees, survey books, site plans, cash books dealing with coal dues, etc.—and pieced together so as to form a connected picture of the course of local events, which, as Mr. Perks laments, failed to engage the attention and recording ability of Pepys, busy as he was with national affairs.

Mr. Perks's exhaustive survey leads him to condemn the water-line with an area of open land corresponding to the regulation width, shown on the plan of Ogilvy and Morgan, published in 1677: it existed, he says, only in the minds of those map-makers. He finds that the original idea for a "Key or Wharf" along the river front was to facilitate dealing with buildings on fire, and that, at first, the owners of land refrained from building within 40 feet of the water line, but that, so early as 1669, the new Fishmongers' Hall constituted an important encroachment, which, though challenged, was allowed to remain, and that thereafter other builders followed the example which had been set, so that the original intention was gradually abandoned. B. C.

### Gmelins Handbuch der anorganischen Chemie

Achte Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. System-Nummer 4: Stickstoff. Lief. 1. Pp. 282. (Berlin: Verlag Chemie G.m.b.H., 1934.) 43 gold marks.

THE first volume on nitrogen deals with its occurrence in Nature, its fixation in the soil by natural processes, its isolation from air and from compounds, its general properties and with numerous researches upon active nitrogen. A condensed summary of forty-five independent determinations of the atomic weight of the element will be found.

There is also a detailed account of investigations upon the nucleus, which have been classified as transformations, since all observed cases of nuclear disintegration have also been nuclear syntheses. The bombardment of certain atoms with fast-moving

particles has revealed the existence of isotopes of nitrogen, which have escaped detection by the mass-spectrograph. Thus whereas the atom of boron  $B^{11}$  when bombarded by an  $\alpha$ -particle yields a neutron and ordinary nitrogen  $N^{14}$ , the isotope  $B^{10}$  produces the interesting radioactive nitrogen  $N^{13}$ , which disintegrates into a positron and the carbon isotope  $C^{13}$ . Radionitrogen has also been produced from  $C^{13}$  and deuterium  $H^2$ . Nuclear transformations have also yielded two heavier isotopes,  $N^{15}$  and  $N^{16}$ , and heavier products, fluorine and oxygen.

Distinction is drawn between electrically active and chemically active nitrogen, since the two properties are independent of one another although they may co-exist. The term 'active nitrogen' is generally used to describe the electrically excited variety first produced by Strutt in 1911, which is characterised by its after-glow. It is also chemically active, but chemical activity can be produced in other ways. Electrically active nitrogen is believed to be a mixture of metastable molecules with ordinary and metastable atoms. The possible existence of triatomic molecules is also discussed. It has been shown that the removal of all ions is without effect upon both chemical activity and after-glow.

### Industrial and Manufacturing Chemistry

Part 2: Inorganic. A Practical Treatise. By Dr. Geoffrey Martin. Vol. 1. Fifth edition, revised by Geoffrey Martin. Pp. xx+496. (London: The Technical Press, Ltd., 1935.) 28s. net.

DR. MARTIN'S compendia are well known; their wide utility is proved by the succession of editions. The present volume has been kept well up to date, partly with the aid of practical suggestions furnished to the author; he has had the assistance of ten contributors, all of whom are well known as practical chemists.

The scope of the work includes fuels, industrial gases, water technology, inorganic acids and alkalis, gypsum and barium salts, the chlorine industries and the nitrogen industries. No better introduction to any of these is required than is here furnished, and the volumes may well form the foundation of any chemical engineer's library.

### The Foundations of Human Nature:

the Study of the Person. By Prof. J. M. Dorsey. (Longmans' Education Series.) Pp. xiv+488. (New York, London and Toronto: Longmans, Green and Co., Ltd., 1935.) 12s. 6d. net.

THIS volume in Messrs. Longman's Education Series is written by Dr. Dorsey, who is associate professor of psychiatry at Michigan for educators and social workers who are striving, very often unsuccessfully, to learn all about personality. There is a great deal of common sense in the book, and those who work steadily through it cannot fail to benefit. The author wisely points out that most juvenile delinquents can recite the Ten Commandments, but that those who taught them to recite did not at the same time obtain *rappport* with their personalities and teach them how to apply what they so glibly recite.



## Spectrographic Equipment of the 200-inch Telescope

PREVIOUS to the designing of the  $f/0.36$  spectrographic object-glass referred to in Dr. G. E. Hale's article (see special supplement to NATURE of February 8) observations made at Mount Wilson Observatory by means of the  $f/0.59$  Rayton lens had shown that the apparent velocities of recession of the more remote nebulae are extraordinarily high and that they increase with the distances of the nebulae. These observations had been extended as far into space as appeared to be practicable with the  $f/0.59$  Rayton lens, and it was with the object of increasing the range within which the nebulae could be investigated spectrographically that the designing of a spectrographic lens of larger aperture was undertaken by the British Scientific Instrument Research Association.

The equivalent numerical aperture (0.85) of the Rayton lens was already very nearly as large as could be obtained in any well-corrected 'dry' lens, and it was obvious that an 'immersion' lens would be needed if any large increase of aperture were to be achieved. With an object-glass designed to be used with a fluid of chosen refractive index between the last lens and the photographic film or plate, the limit of numerical aperture theoretically obtainable is equal to the refractive index (1.55) of the gelatine of the photographic emulsion. This limit cannot be reached in practice, but it appeared probable that a numerical aperture of 1.4 might be obtainable, which would represent approximately a three-fold increase in 'rapidity', very nearly doubling the range within which the apparent velocities of the nebulae could be investigated. On general grounds it was considered worth while to aim at a design which would give a flat field over the range of spectrum which is of main interest in studying nebular velocities, in order that difficulties associated with the use of curved films might be avoided. A preliminary exploration of possible designs indicated that a system to fulfil these requirements should be capable of being produced without great difficulty, and, out of the designs considered, one was selected for detailed computation.

It was foreseen that difficulties might arise in the subsequent use of the lens if the immersion fluid to be used with it should prove to have any deleterious effect on the usual photographic emulsions. Experimental tests on plates which had been immersed for several days in the selected immersion fluid showed that this liquid had no

perceptible action on the plates, and that the liquid could be removed quickly and completely in readiness for the plates to be developed. As a precautionary measure the lens was designed so that, if necessary, the thickness of the back lens could be reduced sufficiently for the lens to be used with specially thin plates with their glass sides in immersion contact with the back lens; it was, however, made up to be used in direct immersion contact with the coated sides of ordinary photographic plates. In the work which has been done with the lens, there has been no evidence of action between the immersion fluid and the emulsion.

A lens designed for spectrographic work may be considered as distinct from all the usual types of object-glasses. It is required to form separate line-images from a series of beams of parallel light of different colours all travelling along directions inclined at different angles to the axis of the lens. The corrections required for a lens to be used in this way are unlike those necessary in photographic lenses, telescope object-glasses, etc., and can be obtained by somewhat different methods. Achromatism, for example, as the term is ordinarily used, is not essential, and a certain amount of astigmatism can be tolerated in the images formed on either side of the axis. A lens entirely free from secondary spectrum and with an anastigmatically flattened field would, it is true, be ideal for use as an astrospectrographic object-glass, but in view of the impossibility of producing such a lens with an adequate aperture for the problem in hand, alternative methods of obtaining the necessary types of corrections were investigated.

An ordinary achromatic object-glass, corrected so as to give an anastigmatically flattened field, would be of little value as a spectrographic object-glass except with *curved* films. Its secondary chromatic errors would cause light of different colours to be brought to focus in different planes, so that the surface passing through the images formed by light of different colours would be curved. An achromatic object-glass having a curved field when used as an ordinary lens could, however, give an accurately focused spectrum on a flat plate, provided that the curvature of field were exactly compensated by the variation of focal distance due to the residual (secondary) chromatic errors of the lens. In designing a lens of numerical aperture 1.4, it is necessary to follow the general lines adopted in the designing of



microscope object-glasses of large aperture. The residual chromatic errors of such lenses are small, and the field-curvature is so large that it would more than compensate for the curvature which these residual chromatic errors would introduce in the focal surface of a well-dispersed spectrum. It is permissible, however, to ignore any slight astigmatism of a spectrographic object-glass, provided that the *tangential* astigmatic images of the spectrum lines are brought to focus on the photographic film or plate. Thus, it is permissible to compensate for the curvature of field left unbalanced by the 'secondary spectrum correction', by introducing corrections which would flatten the focal surface passing through the tangential astigmatic images.

The method used to flatten the tangential astigmatic field was one which, in addition, introduced under-correction for spherical aberration in oblique image-forming rays. For the complete system under consideration, comprising the collimator, prisms, and the  $f/0.36$  lens, the obliquity of the ray-systems on one side of the axis increases as the wave-length of the light becomes shorter, and the under-correction at increased obliquity can be made to balance the over-correction due to shortening of the wave-length. Hence, proceeding outwards from the centre of the field, correction for spherical aberration can be maintained over a considerable distance. On the other side of the axis the obliquity of the ray-systems increases with increase of wave-length, and spherical aberration is increased more rapidly than it would be if the field were not flattened. Since, however, the important range of spectrum to be investigated is confined to the shorter visible and near ultra-violet radiations, imperfect imaging of the yellow and red regions of the spectrum is of no importance, and satisfactory imaging over the required range can be ensured by designing the lens so that some selected blue or violet radiation would pass axially through it.

The design of the lens followed the lines indicated by the considerations briefly outlined above. It was necessary, of course, to have particulars of the angular dispersion which would be given by the prism system to be used with the lens, and also to be informed of any residual errors of the collimator lens. The design as finally developed was for a lens of the required aperture, with full spherical correction and giving a flat field for dispersed parallel beams covering the range of wave-lengths between 3600 Å. and 5000 Å. In the design, also, special attention was paid to ensuring that the sine condition should be fulfilled and to eliminating any independent coma of a higher order, so that the entire spectrum should be free from coma.

The mounting of the back component of the lens system required special consideration to ensure that optical contact should be maintained between the back lens and the photographic plate during the longest exposures likely to be given. In view, also, of the very short 'depth of focus' of the lens, specially fine differential-screw focusing adjustments were provided and the plate-carrier was designed as an integral portion of the lens mounting. A sensitive tilting adjustment was also fitted to the plate carrier in order that the plane of the photographic plates could be brought into coincidence with the focal surface. Both these adjustments were provided with clamping systems so that, when once the lens and plate-carrier had been set in their proper relative positions, plates could be changed with the certainty that each plate would automatically be brought into the proper focal plane.

When the collimator, prism system, and large aperture lens had been constructed, the complete system was examined optically in the laboratories of the British Scientific Instrument Research Association, and was found to realise fully the expectations founded on the calculations made during the designing of the lens. By adopting a similar method of examination, it will be possible at any time to mount the complete outfit in a telescope, ready adjusted, so that loss of time in testing the adjustments by trial exposures on astronomical objects may be entirely avoided.

The complete spectrographic equipment was delivered to the California Institute of Technology in December 1934 and was tested on the 100-inch telescope at Mount Wilson after the necessary mountings had been completed. In the tests first carried out on the remote nebulae, the results obtained were disappointing. Work on other astronomical objects showed, however, that the optical performance of the system is of the high order indicated by the calculations and by the tests made before dispatch, and that the disappointing results obtained on the nebulae were due to fogging of the spectra by light from the night-sky at Mount Wilson. To a large extent this is scattered light from the towns in the San Gabriel valley; at Mount Palomar, where the new 200-inch telescope is to be erected, the night-sky is appreciably darker, and it is confidently hoped that, when the lens comes to be used there, it will fulfil the purpose for which it was originally designed; although a limit to the range within which the nebulae can be explored may possibly be set by the natural brightness of the sky due to auroral light.

In the meantime, the lens is proving of very great value in investigating differences between



the radial velocities of the individual stars in star-clusters in the extra-galactic nebulae, and a wide variety of other uses is foreshadowed for which the lens is peculiarly fitted owing to its extreme rapidity.

Dr. Hale, in a letter describing some of the

results already obtained, refers to the lens as "a great success optically", and expresses his congratulations on "a truly remarkable achievement". It reflects great credit on the optical industry of Great Britain to have produced a lens having such outstanding possibilities.

## Matthew Boulton as Scientific Industrialist

THE commemoration in January last of the bicentenary of the birth of James Watt naturally directed attention to the notable part taken in the development and application of the steam engine by his partner Matthew Boulton, and in his "James Watt, Craftsman and Engineer", Mr. H. W. Dickinson expresses regret that hitherto no separate biography of Boulton has been written (see NATURE of January 25, p. 129).

The career of Boulton, of course, has not escaped the writers on Watt and the steam engine, and Smiles in particular dealt at considerable length with many of his activities. But the life of Boulton, relating to which we imagine there is much unexplored material, deserves still closer study, for in the history of the industrial progress of Great Britain during the latter half of the eighteenth century, there is no more engaging figure. He was a man of admirable character, broad-minded, generous, energetic and far-sighted, displaying many of the attributes of a statesman. Unlike many of his contemporaries in the field of industry, he started life with social advantages, and early in life was a man of means. But if, as he himself declared, he loved money-getting projects, he was still more concerned that nothing but the highest standard should be aimed at, whether it was in connexion with his own affairs or those of the nation. As a captain of industry he had no equal, and was alike at home whether dealing with his employees, his partners, privy councillors or prime ministers.

Boulton was the senior of Watt by more than seven years, having been born in Birmingham in September 1728. The two first met when he was nearly forty years of age, and was the head of the largest manufacturing concern in the country. His father had begun as a silver stamper and piercer, and when he died in 1759 he left his son a well-established business for the manufacture of trinkets, steel buttons, buckles and the like. In 1762, Boulton married Ann Robinson of Lichfield and with her came a fortune of £28,000. This accession of wealth, instead of diminishing his interest in trade, enabled him to launch out on

new ventures and he proceeded at once to erect the famous Soho Manufactory about two miles north of Birmingham, having for his partner John Fothergill. When completed, the Manufactory could house six hundred workpeople, and by 1767 the firm had a turnover of £30,000. No mean inventor himself, versed in the science of his day and possessing artistic tastes, Boulton introduced new machinery and processes, and was at as great pains as Wedgwood to apply art to industrial products. He had agents in many foreign capitals, his showroom in London was visited by dukes and lords, and at his house at Soho he dispensed a princely hospitality.

Like other manufacturers, one of the problems Boulton had to face was that of power supply, and one of the reasons for placing the factory at Soho was that water-power could be obtained from the Hockley Brook. The supply, however, was unreliable, and even before Watt first visited Birmingham, Boulton had already considered the proposal to instal a 'fire engine' for pumping the tail race water from the water wheels back to a reservoir. When Watt went to Soho in August 1768, Boulton was, therefore, ready to seize on any project which would effectively overcome his difficulties, and it is a remarkable tribute to his judgment of men and to his insight into the future of the steam engine that, although no patent had yet been secured and no full-sized engine erected embodying Watt's principle of the separate condenser, Boulton was ready at once to stake his all on the success of the new engine.

The patent was secured in January 1769 and a month later Boulton wrote to Watt that his "idea was to settle a manufactory near to my own by the side of our canal where I would erect all the conveniences necessary for the completion of engines, and from which manufactory we would serve all the world with engines of all sizes". Though in his short intercourse with Boulton he had conceived a great liking for him, to the nervous, desponding and impecunious Watt such a scheme might well have appeared rash, almost to madness, and as a matter of fact five valuable



years were allowed to slip by before Boulton saw his way clear to carry his plans into effect.

Without attempting to trace again the interesting story of the development of the engines with which the names of Boulton and Watt are inseparably connected, it may be said that if Boulton claims our admiration as a judge of men, an industrialist and an organiser, he also deserves recognition as one of the few manufacturers of his time who were devoted to scientific pursuits. Had he lived to-day, he would undoubtedly have been one of the keenest advocates of scientific research for industrial purposes. As a boy he studied mechanics and chemistry, in middle age he was one of the most prominent figures in the celebrated Lunar Society, which included among its members Watt, Priestley, Wedgwood, Withering, Erasmus Darwin, Keir and Galton; and when immersed in the difficulties of negotiations with Cornish miners could write: "chemistry has for some time been my hobby-horse . . . I am almost an adept in metallurgical moist chemistry. I have got all that part of Bergmann's last volume translated, and have learnt from it many new facts". Years

before, in 1757, when in correspondence with Benjamin Huntsman, the pioneer of the steel industry of Sheffield, he wrote: "I hope thy Philosophic Spirit still laboureth within thee, and may it soon bring forth Fruit useful to mankind, and more particularly to thyself".

The philosophic spirit possessed Boulton all his life, and when seventy years of age and holiday-making at Cheltenham, he must needs have his chemical apparatus so that he could make careful analysis of the waters of the place, the results of which were all duly entered in minute detail in his memorandum books.

The chief activity of the later years of Boulton were connected with the improvement in coining and the coinage of the country. He improved the processes of minting out of all recognition, and at Soho laid down a plant which for many years served as a model for this and other countries. In his enterprise he showed the same thoroughness, the same power of organisation, the same appreciation of the application of science and art to a great practical need that marked his work on the steam engine.

## Obituary

### Sir Joseph Petavel, K.B.E., F.R.S.

BRITISH applied science suffered a grievous loss in the death of the director of the National Physical Laboratory, Sir Joseph Petavel, on March 31. Sir Joseph, who was sixty-two years of age, was second director of the Laboratory, succeeding Sir Richard Glazebrook in 1919 and surviving him by only a few months.

Sir Joseph, who was born in London on August 14, 1873, was a son of the late Rev. E. Petavel. He received his early scientific training at University College, London, under Sir Ambrose Fleming, with whom he collaborated in his first published paper, on the alternating current arc. With the aid of an 1851 Exhibition Scholarship, he then worked under Dewar for three years at the Royal Institution and Davy Faraday Laboratory, where he studied the thermal emissivity of platinum at high temperatures and pressures. In later years he had many reminiscences to tell of his experiences at the Royal Institution.

Then came Petavel's election in 1900 to the John Harling research fellowship at Owens College, Manchester, following which he became lecturer in mechanics under Schuster. He published notable contributions on very high pressures as generated, for example, by solid and gaseous explosives. In 1904 he was responsible at the St. Louis Exhibition for the management of the liquid-air plant which was shown by the British Royal Commission. Four years later, Osborne Reynolds resigned the chair of engineering,

and Petavel was elected in his place as professor of engineering and director of the Whitworth Laboratories at the University of Manchester. Further outstanding papers had meanwhile been published jointly with R. S. Hutton, on electric furnace reactions under high pressures and the effect of pressure on arc spectra.

About this time Petavel was developing an interest in meteorology and aeronautics, and collaborated in an investigation on kite soundings as applied to upper-air temperatures. In 1909 he became a member of the original Advisory Committee for Aeronautics, and presently took up the study of the stability of aeroplanes. His enthusiasm led him to qualify as a pilot, an accomplishment by no means free from danger with the experimental aeroplanes of those days. It was during this period that he was the victim of a serious accident which might well have proved fatal, and indeed left its mark on him all his life. When the Aeronautical Research Committee was formed in 1917, Petavel was appointed chairman of the Aerodynamics Sub-Committee and a member of several of the other sub-committees. He also served as vice-chairman of the main Committee for many years until his death. In these various capacities he exercised a profound influence on the progress of aeronautical research in Great Britain.

From 1911 until 1916 Petavel had been a member of the General Board of the National Physical Laboratory, and when the directorship of the



Laboratory became vacant in 1919, he was called to fill Glazebrook's place. The new responsibility was one which might well have daunted many men; but Petavel brought to bear all his experience and great natural powers, and has left behind him a record of devoted and successful direction which will be long remembered. He fully maintained the high traditions set by his predecessor, and under his guidance the Laboratory steadily enhanced its influence and prestige. The staff grew to nearly seven hundred strong, and the former grounds of Bushy House were expanded from twenty-three to some fifty acres, so that adequate provision was made for future extensions of the work of the Laboratory to meet the ever-increasing demands of industry.

Petavel was a man of tenacious views and had a highly-developed critical faculty which stood him in good stead, and which he was accustomed to apply to everything that came before him whether significant or trivial. Few men can have had so fine an eye for detail, whether as the courteous and charming host or as the head of a great Laboratory for which he slaved unremittingly, working long hours into the night. At all times, the Laboratory came first and foremost in his thoughts, and nothing was too unimportant to escape his attention among the vast ramifications of interests with which he had to deal. He always emphasised the paramount importance of ensuring the high national and international authority of a National Physical Laboratory test or investigation: the accuracy must be unquestionable. His memory was encyclopædic, accurate and long-lived, and he kept himself singularly well informed of the progress of the almost countless developments in the various departments of the Laboratory. He possessed the faculty of trenchant comment, and would infallibly diagnose the strength and the weaknesses of a scientific report or paper. He had a liking for the parable and the metaphor in speech, often combined with a turn of whimsical humour. His staff came to realise his faculty for wise counsel, and even when it was unpalatable the recipient found it tempered by the kindly smile which accompanied it.

Petavel could always be relied upon to make major and constructive contributions to the manifold problems connected with the design and layout of new and unique equipment or buildings, the erection of which went on almost unceasingly during his directorship. Among these were individual laboratories for research in high voltages, physics, acoustics and photometry, a compressed air tunnel for aerodynamical research, further wind tunnels of the open-jet type and an additional tank for testing ship models.

Petavel was made a K.B.E. in 1920, a fellow of the Royal Society in 1907, and a member of the Athenæum under Rule II in 1920. He presided over Section G (Engineering) of the British Association in 1919. His duties on Government and other committees were exceptionally heavy. Among them were numerous boards and committees of the Department of Scientific and Industrial Research, the British Electrical and Allied Industries Research Association, and the British Standards Institution. He was, or

had been, a member of the National Radium Commission, the Board of Visitors of the Royal Observatory, Greenwich, and of the Engineering Board of Studies of the University of London.

Sir Joseph commonly gratified his taste for wide travel during vacations, but at home two great delights occupied his private life—Bushy House and its garden. Bushy House, the former royal residence of Queen Adelaide, which since the foundation of the Laboratory has served as the director's residence, he lovingly adorned with period furniture and transformed into a house of beauty and refinement. He gave like attention to the 200-year-old garden, which he largely remodelled, and to the grounds of the Laboratory, which he constantly sought to beautify. Each spring tens of thousands of daffodils have given delight to his visitors and staff and they will long serve as beautiful if poignant reminders of him who gave them being.

Nothing pleased Sir Joseph more than to share his house and garden with his guests, and there are very many who will treasure happy recollections of his overflowing hospitality and the spirit which prompted him to cheer his parting guests with large bunches of flowers lavishly culled from his garden. He greatly interested himself in the welfare and social activities of the staff of the Laboratory, by whom the sense of profound personal loss occasioned by his early death is felt acutely and universally from top to bottom. Many of them cherish tokens of his kindness and friendship.

Sir Joseph, who was unmarried, showed great and characteristic fortitude to the last in his painful illness. He was interred at Highgate Cemetery on April 4. A memorial service was also held at Hampton Parish Church at which the president of the Royal Society, Sir William Bragg, paid a touching and eloquent tribute to Sir Joseph's life and work.

G. W. C. KAYE.

### Sir Frederick Norman

SIR FREDERICK NORMAN, who died on March 17 at Runcorn, was one of those pioneers of applied science whose life was devoted to his work and to local affairs. He was difficult to know intimately: always pleasant, well-informed and interesting, he was a man of high character and had very great local influence, particularly as a Cheshire magistrate and as chairman of the Runcorn Bench. He suffered a severe loss at the end of the Great War in the death of his only child, Stanley, a young chemist of very great promise. He was a man of great generosity to local institutions and lent a helpful hand to very many in all stations of life.

Norman, who was born on February 18, 1857, began at Wiggs Brothers' works at Runcorn, which later became part of the United Alkali Co., and he was always in command of the works on the Cheshire side of the River Mersey, which he advocated as the finest site in the world for the production of heavy chemicals. The main development of the United Alkali Co. was then on the Lancashire side, the salt, which is the basis of this industry, being in Cheshire.



It is worthy of note that the original works of Gossage and others were put on waste ground at Widnes, so that the escaping acid fumes did least harm under the prevailing wind conditions to the neighbours.

Time has already largely proved that Norman was right. His early work was concerned with the recovery of copper and precious metals from burnt ore, and he devised a process for the production of a red oxide of iron pigment from the spent liquors, which was worked successfully for many years by the Liverpool and Hull Red Oxide Company.

Norman's interest in metals continued throughout his life, and he was in close contact with leading men at home and abroad on developments in the metallurgy of iron, copper, zinc, etc. In copper recovery he early recognised the merits of the Ramén mechanical furnace, and continually studied other aspects of copper recovery until post-War developments at home and abroad reduced to small dimension in England what had been a large and profitable business.

It was at Wigg Works that the Raschen process for cyanide manufacture was successfully operated for some years from 1898 on until, like other processes of the period, it had to yield place to the Castner method of starting from metallic sodium. The Raschen process was based on the oxidation of sodium sulphocyanide by air, using nitric acid as an intermediary in the oxidising vessels and regenerating this in towers from the liberated nitric oxide. Such production of nitric acid from nitrogen oxides is now carried out on an immense scale in the present-day methods of nitric acid manufacture. Prior to 1900 it was difficult, more especially in construction and design of plant and choice of material. It may be recalled that an accident on the Wigg plant demonstrated the violently explosive character of the endothermic nitric oxide—a property then barely known, but one which had to be guarded against.

In 1928, Sir Frederick gave up his position as manager of the United Alkali Company, after fifty-seven years' service, to become consultant on non-ferrous metals for Imperial Chemical Industries, Ltd. He was knighted in 1914 and for his services during the Great War made a deputy lieutenant of Cheshire.

#### Prof. F. B. Jevons

WE regret to record the death of Prof. F. B. Jevons, formerly professor of philosophy and a vice-chancellor of the University of Durham, which took place on February 29 at the age of seventy-seven years.

Frank Byron Jevons, second son of John William Jevons of Doncaster, was born on September 9, 1858. He was a scholar of Wadham College, Oxford, taking first class honours in Classical Moderations and in *Literæ Humaniores*. In 1882 he was appointed to the staff of the University of Durham, where he spent the whole of his academic career, being classical tutor in 1882–1910 and professor of philosophy in 1910–30. He held a number of high

offices in the University, and was vice-chancellor in 1910–11.

In his early work as a classical scholar, Jevons already showed, notably in "The Prehistoric Antiquities of the Aryan People", in his edition of Plutarch's "Roman Questions" and in his "Manual of Greek Antiquities", that his bent lay not so much in the direction of pure scholarship as in the study of the development of the religious and philosophical conceptions of the peoples of antiquity. A "History of Religion", which had already reached its seventh edition in 1896, traced the origin of religion to totemism, and established Jevons, in company with such men as Robertson Smith and Andrew Lang, as one of the protagonists in the discussions on the origin and development of religious ideas, which were a marked feature of anthropological thought at that time. His "Idea of God in Early Religion" appeared in 1910, and he was also the author, among other works, of "Religion in Evolution" and "A Study of Comparative Religion". Although recently, the diversion of anthropological studies to other methods of approach has somewhat obscured his contribution to humanistic studies, his work is of enduring value, his profound knowledge of the conceptions of antiquity compensating in some degree for his lack of first-hand knowledge of the ideas of primitive people—a lack which, indeed, he shared with the more prominent of the controversialists who were his contemporaries.

BOHEMIAN palæontology has suffered a great loss by the death of Prof. C. Klouček on October 11, 1935. He was born in 1855 and began life as a sculptor. In 1903, when more than fifty years of age, he started collecting fossils from nodules and stones on the land in the neighbourhoods of Rokycany and Prague. In these (Lower Ordovician *Dγ*) he found many new species of trilobites and other forms of life. He likewise proved that the Osek-Kváň series of Ordovician age represented two distinct faunistic horizons. But his greatest discovery came from his study of the Tremadocian, which he began in 1913. Before his day, these beds were little known, so that he can be regarded as the discoverer of the Tremadocian in Czechoslovakia. He did very important work in the stratigraphy of these beds, dividing them into various horizons, according to the type fossils.

WE regret to announce the following deaths:

Prof. Robert Barany, of the University of Uppsala, who was awarded the Nobel Prize in medicine in 1914 for his work on the physiology and pathology of the ear, on April 8, aged fifty-nine years.

Major W. H. D. Clark, O.B.E., sometime chief examiner and later Assistant Comptroller of the Patent Office, on April 9, aged seventy-six years.

The Hon. Stephen Coleridge, director of the Anti-Vivisection Society and formerly president of the League for the Prohibition of Cruel Sports, on April 10, aged eighty-one years.



## News and Views

### The Race Problem

THE analysis of factors contributing to popular judgment in discriminating between races, which appears in another column of this issue of NATURE (see p. 635), agreeing substantially with the views expressed by Prof. Julian Huxley in his Friday Evening discourse before the Royal Institution on March 27 (see NATURE, April 4, p. 570), also lends support to his contention that a serious effort should be made to put an end to the propagandist exploitation of pseudo-scientific inference, depending upon the use of the term 'race', in political and nationalist activities. It is problematic, however, whether any pronouncement following on an international inquiry, which Prof. Huxley suggests as a possible remedy, would be effective, whatever the course adopted to secure that it should be widely known and generally accepted. Apart from practical difficulties, which are considerable, but of course not insuperable, clearly such a pronouncement, if it is to go beyond the fact, which is patent, that scientific terminology is being abused, must be based upon some agreement as to the meaning of the term, of which it attempts to regulate the use. It is open to question whether such agreement could be attained at present among representative students of man—students of man's structure, descent, heredity, varieties and distribution—even without entering upon the thorny problems of racial psychology and culture. If, however, the major objective of such an inquiry were the purely scientific aim of clarifying current ideas on race among anthropologists, even though it ended indecisively, or, as is not impossible, in a deadlock—*Germania contra mundum*,—it would clear the way, at present blocked, for rapid progress in racial studies. It might even be found desirable that a term of coinage now so debased should be eliminated entirely from scientific use. In the meantime, it is a function of science to expose ruthlessly on every occasion loose thinking and an inexact terminology; and perhaps, in this way, the pitfalls of 'race' can best be brought home to the man in the street.

### Fire-Walking

BULLETIN II of the University of London Council for Psychical Investigation consists of a report on two experimental fire-walks in which the preparation and performance were submitted to careful observation. Of the many accounts of fire-walking in different countries, this is the first to give a detailed description of the preparation of the fire, the internal and surface temperatures, and the times of contact of the skin with the embers. For the first time, therefore, an estimate of the magnitude of the performance can be made: it does not consist of wandering amongst flames with a look of exaltation, but of four rapid steps on charcoal at 430° C. with an average time of contact of half a second per step. Nevertheless,

amateurs are not able to equal this, and the two who tried to imitate Kuda Bux developed blisters after only two steps. In attempting to account for the greater immunity from burning of Kuda Bux, chemical treatment need not be considered, since very careful tests were made to exclude this possibility.

Two hypotheses require examination, apart from obvious factors such as skill in the manner of walking, knowing the correct stage during the combustion of the fire at which the ash (which might adhere to the feet) must be raked, and, after a suitable interval, the attempt made. First, the increased immunity may be due to practice, for it is well-known that constant handling of hot materials produces an insensibility to heat which is accompanied by an absence of reddening and blistering although the skin may not appear in any way abnormal. Secondly, it is possible that a certain induced mental state is required, for it has been observed that under hypnosis, for example, very unusual bodily reactions may occur. This would account for the elaborate ritualistic preparation adopted in many countries and for Kuda Bux's assertion that 'faith' was necessary. Kuda Bux's own preparation appeared to consist merely in reciting a few lines from the Koran. One thing is certain: if the fire-walk is performed regularly the first hypothesis cannot be excluded. Whether or not the second hypothesis must be made in addition is a question that requires further research. The bulletin contains an extensive bibliography and nineteen plates which illustrate clearly the conditions under which the experiments took place.

### Prices for Electric Supply

THE paper read by Prof. Miles Walker to the Institution of Electrical Engineers on April 2, discussing the prices for electric supply in Great Britain, will interest all who try to see the reasons for the great disparities in the prices charged. It would naturally be thought that low prices would only be found where distribution costs per unit are low. But this is not the case, for they are found also in residential areas where higher prices might reasonably be expected. As an example, Prof. Walker quoted the Oxford supply, where a company had been in existence for about forty years; when, in 1931, the supply was taken over by the municipal authorities, drastic reductions were made in the cost of supply. The result has been that the total net income earned is now a greater percentage of the total capital involved than when the prices were high in 1931. In other words, if the company had had the courage to reduce the prices from almost the highest in the country to almost the lowest for that kind of district, it would have been able—provided it managed as well as the corporation—to pay a slightly larger dividend. In Prof. Walker's opinion, the main



difficulty is to evolve some method of charging which will apportion to each consumer his proper share of the standing charges. He made a most ingenious suggestion for constructing meters the rates of which would depend on the times of the day at which the consumer would be taking his loads. We foresee that there would be great difficulties in explaining this system of charging to new consumers and serious difficulties with electric motor-clocks, and humming noises would have to be overcome.

ANOTHER suggestion made by Prof. Walker for improving the load factor of our central stations and thus enabling prices to be reduced is to utilise the potential power load of motor-cars and omnibuses for equalising the load. Much has been said about the advantages of making petrol and oil from British coal; but if the problem is to transfer the energy stored in our coal to the axles of our motor-cars, it is very much more efficient to generate electrical energy by means of big turbo sets, store it in batteries, and empty it in electric motors, than it is to convert only a fraction of the coal into petrol and employ that in internal combustion engines. If the distribution of electricity were on a national scale, we should have to dot about the country hundreds of battery stations at distances not greater than ten miles apart. Electric cars could be built taking batteries of a standard size. The driver of the car would only have to stop at a station every 20 miles or so and change his battery. It could be mounted and wheeled about in such a way that the process of changing it would be as easy as filling up with petrol. If it were necessary to have a tax, it could be imposed upon the charged battery. The gain to the State would be millions of pounds per annum, at present paid to foreign countries for petrol. Our central stations would be kept busy during the early hours of the morning in charging the traction batteries. It would lead to increasing the output of our central stations without increasing their capacity. Another help for reducing the price of electricity would be to educate consumers to reduce their bills by keeping down their maximum demands by using a special indicator.

#### Electrical Equipment of Automobiles

THE electrical equipment of a motor-car is now an essential portion of the whole vehicle. This is proved in a paper by Mr. E. A. Watson (*J. Inst. Elec. Eng.*, March) describing the progress made during the last three years in the electrical equipment of cars. In the modern car, the driver should never be called upon to resort to hand-starting. The starter handle is carried separately in the tool kit, and in many designs can only be inserted with difficulty, its main function being to turn the engine round for adjusting purposes and not for starting. The ignition now is almost always by electric coil and not by a magneto. To assist the convenience in driving, electric petrol pumps, windscreen wipers and horns are used. Recently the remarkable progress made in the combined textile and rubber driving-belt has led to a reversion to the belt-driven dynamo. These are entirely

satisfactory and have a normal life of 20,000 miles or more. This drive possesses the advantage of quietness and simplicity, as compared with the gear or chain drive. The modern head-lamps, designed with a parabolic reflector and a focused filament, produce a beam which is slightly divergent. By means of prisms, some of the light is diverted on to the sides of the road and some in front of the car. The anti-dazzle problem has been partially solved, but the greatest problem of all has been, and it looks as if it always would be, driving in fog. The only alleviation seems to be to use a fog lamp which throws the light directly downwards on the road. This eliminates any rays in an upward direction which might be reflected back to the driver's eyes.

#### Discoveries at Sakkara

DISCOVERIES of great interest and importance are announced from Sakkara, where excavations are being carried on by the Egyptian Department of Antiquities under the direction of Mr. Walter Emery and Zaki Effendi Saad. These discoveries were made in a tomb of the first dynasty, which was partially excavated in 1931 and then appeared to have been completely rifled. Further excavation in the present season, however, in a series of forty-two store chambers in the superstructure of the tomb which previously had escaped notice, has brought to light the complete grave furniture of Hamaka, the Vizier of Pharaoh Den of the first dynasty (c. 3,000 B.C.). At present about half these chambers have been cleared. They have yielded a large number of objects. Among them are numerous jars for containing wine, which bear seals giving the names of Hamaka and his king, implements, such as wooden sickles with flint teeth, the wooden handles of large adzes, and a number of large flint knives of advanced technique, of which some are more than a foot in length. A quiver contains reed arrows with tips of bone or flint, and a spear has a head of ivory, while an inscribed ebony tablet bears the name of the Pharaoh Zer. Remarkable as are some of these objects, such as the flint knives, in coming from a tomb, the discovery is given a unique character by a large number of disks of stone, bronze or ivory, for which the excavators are as yet not prepared even to conjecture the purpose. Some of the disks are inlaid with different varieties of stone, and one showing hounds chasing a gazelle is in a style which is said to remind the observer of the products of Minoan art of some fifteen hundred years later.

#### Road Testing

THE Department of Scientific and Industrial Research has just completed a road testing machine which is stated to be the largest of its kind in the world. According to *The Times* of April 8, road making and upkeep cost Great Britain about fifty million pounds a year, and thirty thousand pounds is being spent annually by the Department on research work on road engineering. The new testing machine consists of a 12-ton lorry, tethered to a central post by a 5-ton structural arm driven by a 180 horse-



power electric motor. It travels round a track 110 feet in diameter and wears two tracks on the test road. Its maximum speed is 40 miles an hour. Special safety devices have to be incorporated both in the design of the machine and of the building in which it is housed. If it broke away from the centre post when travelling at full speed, it would release energy equivalent to that of a six inch shell. The building containing the machine is roofed so that test roads may be laid in any weather. There are two other machines carrying out similar tests on a smaller scale. In the case of one of these machines the road revolves and drives the wheels, the maximum speed being nine miles per hour. A week's use of one of these machines sometimes represents a year's wear on the ordinary highway. It has been found out that the road generally wears out before the tyre gives way. Physical and chemical tests of roads and road making materials are also carried out at the laboratory. An appliance can bore out a cylindrical core of concrete from a road so that the texture and constituents of the mixture may be examined and its mechanical strength found. Tests on skidding are also made: theoretically, by a small apparatus in the laboratory which finds out the slipperiness of a lubricant, and practically, by means of a special motor cycle and sidecar.

#### British Empire Cancer Campaign

At the recent quarterly meeting of the Grand Council of the British Empire Cancer Campaign, a communication was received intimating that His Majesty the King had been graciously pleased to become patron of the Campaign. The following grants amounting to £5,530, and making a total to date of £30,990 for the year 1936, were approved: £1,100 to the Radium Beam Therapy Research; £1,750 (in addition to the grant of £1,850 already made for the year 1936) to the Mount Vernon Hospital; £500 (in addition to the grant of £600 already made for the year 1936) to the Marie Curie Hospital; £100 and £80 to Dr. C. R. Amies, at the Lister Institute and Dr. P. R. Peacock, of Glasgow, respectively, for the purchase of special types of centrifuges; £1,000 to the Manchester Committee on Cancer to cover the cost for two years of investigations to ascertain whether there is any connexion between the use of heavy oils in motor-vehicles and the apparent increase in the incidence of cancer of the upper air passages and the lung; £1,000 to the North of England Branch of the Campaign to meet the cost for the second year of the short-wave investigations being carried out at Newcastle, on behalf of the Campaign, under the direction of Prof. W. E. Curtis and Dr. F. Dickens. In this connexion the Council expressed its appreciation of the technical assistance afforded the workers by the technical staff of the Marconi Company. The Royal Society and the Medical Research Council have nominated Prof. Matthew Stewart, of the University of Leeds, to succeed Prof. R. T. Leiper, who has retired, as one of their five nominees on the Scientific Advisory Committee of the Campaign.

#### A New Hydraulic Laboratory

HYDRAULIC laboratories are in use for a variety of purposes, including the training of engineers, tests of turbines and pumps, model experiments on ships and seaplane floats and for research on river, reclamation and harbour problems. In the *Engineer* of April 3, Dr. F. V. A. E. Engel reviews some of the aspects in the design of such laboratories and gives a detailed description of the new hydraulic laboratory at the Park Royal works of Messrs. Electroflo Meters Co. Ltd., erected for the routine work of testing and calibrating meters and for the development and improvement of fluid flow measuring devices. A factor of importance in the design of a meter test plant, he says, is the maintenance of a constant head in the test line. In the plant at the Park Royal works, water is drawn from a sump by two electrically driven centrifugal pumps and delivered to an overhead tank 65 feet above the ground floor. The water then flows through the test line, where Venturi tubes and orifice plates may be installed in a straight pipe 60 ft. long. From the test line the water passes into a settling tank and two measuring tanks, and so back to the sump. For timing the tests an interesting device has been adopted which automatically operates the stop watch. When the flow of water entering one measuring tank is switched over to the other, the water jet from the change-over valve interrupts a beam of light impinging on a photo-electric cell, and by means of a thermionic amplifier and relay the stop watch is controlled. In the new laboratory, investigations are in progress on a model of a large Venturi flume recently constructed at the West Middlesex sewerage works at Mogden.

#### Botanical Acquisitions at the Natural History Museum

CAPT. F. KINGDON-WARD has presented more than 1,100 specimens collected on his recent expedition to Tibet to the Department of Botany of the British Museum (Natural History). Mr. R. F. Jones has made a collection of plants during the Percy Sladen Expedition to Lake Hula. The lake and its adjacent swamp, an area of about seventeen square miles, was concentrated upon, as the flora will disappear with drainage, and the flora of the hills of Palestine is fairly well known. The collection is of more than four hundred numbers and includes all groups. The investigation was mainly ecological, but the collection contains several new records of flowering plants. Lieut.-Colonel F. M. Bailey, British Envoy Extraordinary and Minister Plenipotentiary at Katmandu, Nepal, has presented 488 flowering plants and 42 vascular cryptogams. These make a useful addition to the valuable Nepalese collections already in the Department.

#### Indian Helminths

G. D. BHALERAO has prepared a list of the helminth parasites hitherto recorded from domesticated animals in India (Imperial Council of Agricultural Research. Scientific Monograph No. 6. Pp. 365. Delhi, 1935. 13s. 3d.). A brief account of the technique of collecting, preserving and preparing the parasites for



examination precedes the systematic account, which is provided with the usual keys and with illustrations to facilitate identification and to show structural features. The illustrations are for the most part satisfactory, but the author's photograph of a much distorted transverse section of *Parascaris equorum* could have been omitted. The memoir will be helpful to those who are interested in the helminths of Indian domestic animals. It is marred by a considerable number of misprints which necessitated the addition of a slip correcting more than fifty errata. One of these is "for Linneas read Linnaes" and on reference to the page cited we find "Linneas 1858" which should, of course, be "Linnaeus, 1758"; more care in reading the proof would have been well repaid in the result.

#### Fungi of South Australia

THE South Australian Branch of the British Science Guild is making a determined effort to interpret the flora and fauna of the southern parts of Australia to students of biology in that region. It has on one hand the sympathy and active financial support of the South Australian Government, and on the other hand the authors of a series of handbooks, who prepare their manuscripts gratuitously. The latest volume to be added to this list is the second part of "Toadstools and Mushrooms and other Larger Fungi of South Australia" (Adelaide: Govt. Printer. 5s. net. Pp. 177-362. June 1935). Prof. J. B. Cleland, who is also chairman of the Committee responsible for the handbooks, has written the volume, which deals with polyporous and coral fungi, with puff-balls, jelly-like fungi, and the larger Ascomycetes and Myxomycetes. The volume forms, with Part 1 (published in June 1934), a complete guide to the grosser fungi of the area mentioned in the title, and it is no fault of the author that the Hymenomycetes are in great preponderance. Ascomycetes receive somewhat scant treatment upon five pages, whilst Myxomycetes receive slightly less, but the treatment of the Basidiomycetes should make the volume into a mycological classic. The classification adopted is a combination of the systems propounded by Carleton Rea and P. Claussen. It is easy to follow, though a purely English reader might have preferred to see either the modern thoroughness and authoritative dignity of Rea, or the comprehensive well-tryed simplicity of Claussen, adopted throughout.

#### Aims and Methods of Medical Science

THIS was the title of the inaugural lecture delivered on November 26 by Prof. John Ryle, the new regius professor of physic at Cambridge, and now available in attractive book-form (Cambridge University Press, 1935, 2s. net). Prof. Ryle reviews the scope and present shortcomings of medical science, and concludes that among the great body of practitioners and laboratory workers there is too large a proportion whose standards of accuracy are defective, and whose judgment is crippled. These shortcomings are ascribed to three primary errors: (1) faulty selection of men, or misdirection of their energies after quali-

fication; (2) complicated and unwieldy systems of education and examination; and (3) the spread of the cult of specialism. Prof. Ryle does not condemn specialism as such, "for good specialism is essential to all scientific progress"; but condemns only excessive, premature and misdirected specialisms for the subversive influences which they have had upon medical thought, action and education. In seeking a remedy, Prof. Ryle reviews some of the recent achievements in medicine, and finds that the clinician has himself experimented, or that there has been intimate collaboration between experimenter and clinician. Observation and experiment are both essential, but they must go hand in hand. Prof. Ryle envisages that in the future the younger men will turn more frequently to the study of problems at the bedside, and that a happier partition of problems and a closer collaboration between the wards and the laboratory, between students of normal and students of morbid physiology, than obtains at present, will play their part.

#### Report of the Rockefeller Foundation

ACCORDING to the annual report which has recently been published, the Rockefeller Foundation expended 12,679,775 dollars during the year 1934. In public health, field researches were undertaken on yellow fever, malaria, hookworm disease, tuberculosis and several other diseases, and the organisation and maintenance of essential State and national health services in various parts of the world were promoted. In the medical sciences, many university departments and others received aid for psychiatry, and the Lister Institute funds for the purchase of an ultracentrifuge. In the natural sciences, grants were made for promoting experimental biology and genetics, physiology and endocrinology. In the social sciences, the largest grant went to the Welfare Council of New York City, and several universities, including Oxford, and other bodies, received support. In the humanities, grants supplementing former assistance were made to the Bodleian Library and the Bibliothèque Nationale in Paris, and the Foundation appropriated funds for the "Dictionary of American Biography", the "Historical Dictionary of American English", and the "Virginia Historical Index"—works now in course of preparation.

#### Reports of the Smithsonian Institution, Washington

THE annual reports for 1933 and 1934 of the Smithsonian Institution of Washington, both of which have recently been received, give details of the operations and expenditures during the sessions in question (Superintendent of Documents, Washington, D.C. 1 dollar). In both volumes, reports are given summarising the year's activities, finances, grants, publications, library, etc. These are followed by detailed reports which include those of the Bureau of American Ethnology, National Zoological Park, Astrophysical Observatory, Division of Radiation and Organisms, International Catalogue of Scientific Literature and the International Exchange Service. The greater part of each volume is, however, used



for the publication of articles and addresses by well-known men of science, most of which have already appeared in previous publications such as *Philosophy*, *Technology Review*, *Geographical Journal*, *Scientific Monthly*, Report of the British Association, *Science Progress*, *NATURE*, etc. This general appendix of well-chosen lectures, addresses and papers adds greatly to the value of these annual reports.

#### The Pacific Science Congress

THE Report for the year 1933-34 of the National Research Council of Japan contains the resolutions passed at the Fifth Pacific Science Congress held in Victoria, B.C. and Vancouver in June 1933. Steps were taken to secure more accurate information as to the depth, salinity and temperature of the ocean, the life conditions of halibut, salmon and whales in it and to prevent the discharge of oil from vessels on it. Plant diseases and parasites of the cereal crops and timber grown on the coasts and mountain ranges bordering them are to be studied more thoroughly, atmospheric circulation is to be investigated by pilot balloons, and the necessity of continuing magnetic, electric and oceanographic work by means of a new non-magnetic ship to replace the lost *Carnegie* was emphasised. Seismological information is to be spread by wireless as soon as it is available.

#### Principles of Field Experimentation

THE Empire Cotton Growing Corporation has recently issued a volume of one hundred pages entitled "Principles and Practice of Field Experimentation", by J. Wishart and H. G. Sanders of the School of Agriculture, Cambridge. This is really the third edition of the volume, the first two, written by Engledow and Yule, having appeared in 1926 and 1930 respectively. Perhaps the most important improvements in method in the last ten years are the recognition of the usefulness of the factorial type of design, the confounding of main effects and high order interactions, the analysis of covariance and the fruits of many studies on sampling technique with cereals and root crops. Except for confounding, which is considered by the authors to be beyond the scope of the book, these topics are dealt with in this volume in a very readable manner. The section on practice contains much good advice on the planning and carrying-out of a field experiment, and is particularly welcome in that it answers many of the objections which have been raised by the so-called 'practical' man to modern methods of field experimentation.

#### Statistical Abstract for the British Empire

PROBABLY the most generally useful statistical publications issued by H.M. Stationery Office are the various Statistical Abstracts, such as the Statistical Abstract for the United Kingdom, the Abstract of Labour Statistics and the Statistical Abstract for the British Empire. The sixty-fourth number of the last named has recently been published (H.M. Stationery Office, 3s. 6d.) and contains a great wealth

of statistical information relating to the exports and imports of the various Dominions, Colonies and Dependencies for each of the ten years 1925-34. It is, however, less complete than previous issues, which also included information relating to finance, production, prices, etc., but it is intended to publish the Abstract in complete form in alternate years. Those who have frequent occasion to refer to statistical data will find this and the other Statistical Abstracts invaluable as a means of obtaining convenient summaries of official statistics drawn from very varied sources.

#### Science Abstracts

THE issue of the index parts completes vols. 38 of *Science Abstracts* for 1935. The physics volume extends to 1,569 pages, 315 of which are occupied by a detailed subject index and key, and a name index. The electrical engineering volume has only 899 pages, 157 of which are index. Both are about the same size as the corresponding volumes last year. The average length of an abstract continues to be a little less than a quarter of a page, which experience seems to show is sufficient to allow an expert to give the gist of a paper, and allow a reader to keep abreast of research work in his own and kindred fields.

#### Memorial to X-Ray Workers

A STONE memorial to a hundred and sixty medical men, physicists, chemists, laboratory workers and nurses whose deaths were due to working with X-rays, was unveiled on April 4 at St. George's Hospital, Hamburg. The countries represented on the memorial are Germany, France, Great Britain, the United States, Italy, Hungary, Switzerland, Austria, Denmark, Czechoslovakia, Spain, Belgium, Finland, Russia and Holland. The British names inscribed are R. G. Blackall, C. R. C. Lister, Melville H. Walsham, C. Williams, E. E. Wilson, W. H. Fowler, J. S. Hall-Edwards, J. W. L. Spence, J. R. Riddell and W. I. Bruce Pirie.

#### Announcements

HIS MAJESTY THE KING has been graciously pleased to grant his patronage to the Iron and Steel Institute. The Institute was similarly honoured by the late King George and by King Edward VII before him, both of whom had previously shown their interest in the Institute's activities by consenting to accept honorary membership. His Majesty King Edward VIII was also an honorary member until his accession to the throne.

THE Faraday Medal of the Institution of Electrical Engineers will be presented to Sir William Bragg at the ordinary meeting of the Institution to be held on Thursday, April 23, at 6 p.m. The presentation will precede the twenty-seventh Kelvin Lecture, which will be delivered by Dr. J. D. Cockcroft, on "The Transmutations of Matter by High-Energy Particles and Radiations".



THE following have been elected members of the Athenæum under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service: Mr. Henry Balfour, curator of the Pitt-Rivers Museum, Oxford, and Dr. W. D. Ross, provost of Oriol College and University lecturer in philosophy, Oxford.

THE RIGHT HON. THE EARL OF ATHLONE, Chancellor of the University of London, will open the new High Voltage Laboratory at Queen Mary College, London, on Wednesday, May 6, at 3.30 p.m.

DR. J. T. IRVING, lecturer in physiology at the School of Medicine, University of Leeds, has been appointed head of the Physiology Department of the Rowett Research Institute in succession to Dr. R. C. Garry, who has accepted the chair of physiology in the University of St. Andrews.

DR. ANTOINE BÉCLÈRE of Paris, formerly professor of clinical medicine in the University of Paris, the nestor of röntgenology, celebrated his eightieth birthday on March 17.

It is announced in *Science* that Prof. Franz Boas, who has been professor of anthropology in Columbia University since 1899, will retire on June 30 at the age of seventy-eight years.

MR. C. C. PATERSON will deliver the twenty-sixth annual May Lecture of the Institute of Metals on May 6 at 8 p.m., in the hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. The subject of the lecture will be: "The Escape of Electricity from Metals: its Practical Consequences".

ON the occasion of the twenty-fifth anniversary of the publication of the first edition of Ramon Turro's work on "The Origins of Knowledge", the Barcelona Society of Biology has offered an international prize of 2,000 pesetas for the best original and unpublished essay containing a critical study of Turro's scientific work. The essay, which may be in Catalan, Castilian, French, English, German or Italian, should be sent to the Secretary of the Society, Calle del Carmen 47, Barcelona, before May 25.

THE *Proceedings and Transactions of the South London Entomological and Natural History Society* for 1934-35 form a record of a successful year's activities. In addition to the accounts of the field and other meetings, together with annual reports, etc., the journal contains a number of articles written by various members of the Society. These contributions cover a wide range of subjects bearing upon insect life, and are of interest to the naturalist and student alike. The presidential address, by Mr. T. R. Eagles, dealing with the subjects of "Mendelism, Mimicry and Colour Conflict" is also included in the volume.

OWING to the present state of world affairs, the second International Congress of Mental Hygiene, which was to have been held in Paris next July, has been postponed until July 1937, when an international exhibition will be held in Paris. The exact date is not yet fixed, but it will probably be July 19 or 26.

THE International Health Division of the Rockefeller Foundation wishes to obtain strains of virus from different outbreaks of influenza in order to compare their immunological properties in a study now in progress. Health authorities are requested to notify Dr. Johannes H. Bauer, Rockefeller Institute, York Avenue and 66th Street, New York.

THE second International Congress of the World Fellowship of Faiths will be held in London on July 3-18. The subject of the Congress will be "World Fellowship through Religion". The international president is H.H. The Maharaja Gaekwar of Baroda, and the chairman of the British National Council is Sir Francis Younghusband. Further information can be obtained from the Organising Secretary, Mr. Arthur Jackman, 17 Bedford Square, London, W.C.1.

THE fourth International Congress for Experimental Cytology will be held in Copenhagen on August 10-15. The Congress will consider the following subjects; physical chemistry of the cell; histochemical problems and cell metabolism; experimental morphology; electrophysiology of the cell; experimental cell pathology and biology of irradiation. Further information can be obtained from the secretary of the Congress, Dr. Harald Okkels, Institute for Pathological Anatomy, 11 Frederik 5' Vej, Copenhagen, Denmark.

THE eighth International Medical Postgraduate Congress of the Tomarkin Foundation, New York, which has been organised under the auspices of the University of Athens in co-operation with the Greek Ministry of Health, will be held at Athens under the presidency of Prof. Dustin, rector of the University of Brussels, on September 7-21. Lectures will be delivered on cardio-vascular diseases, surgery, tropical medicine and infectious diseases, dermatology, endocrinology and tuberculosis. During the Congress homage will be paid to the memory of Manson, Ross, Laveran, Golgi and Marchiafava, whose researches contributed to the solution of the problem of a successful campaign against malaria. A special steamer will leave Marseilles for Athens on September 2 or 3. Further information can be obtained from the Tomarkin Foundation, 97 rue aux Laines, Brussels.

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

An assistant naturalist in the Fisheries Department of the Ministry of Agriculture and Fisheries—The Secretary, 10 Whitehall Place, S.W.1 (April 27).

A chemical assistant in the Public Health Department of the London County Council—The Clerk to the Council, County Hall, Westminster Bridge, S.E.1 (May 4).



## 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. 664.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

## Are Termites Descended from True Cockroaches?

MANY authors have given their opinion that the termites or white ants are nothing more than socialised cockroaches; but, so far, definite proof to this effect has been entirely lacking. The nearest approach to any scientific theory of descent is that of Crampton<sup>1</sup>, in which the author concludes that the termites come nearest to cockroaches in their morphology and are probably descended from some very remote ancestor, but not from true cockroaches.

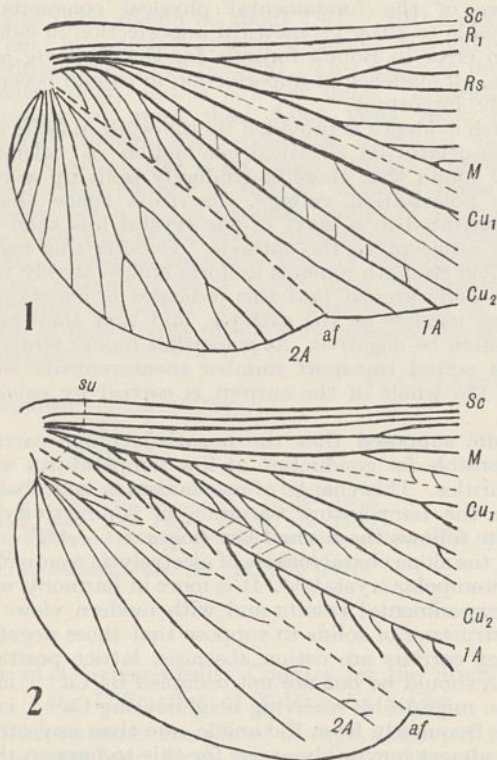


FIG. 1. *Pycnoblattina* sp., hindwing (basal half); Lower Permian of Kansas. FIG. 2. *Mastotermes darwiniensis*, Frog. Recent. North Australia. Usual notation for veins; *af*, anal fold; *su*, humeral suture.

It is universally admitted that *Mastotermes*, the giant termite of northern Australia, is the most archaic type by far within the order. Hence a grave difficulty in deriving termites from any other type of insects has been the peculiar method of folding of the hindwing in *Mastotermes* (Fig. 2). Alone among termites, this genus possesses a definite anal lobe, which is not homologous with the anal fan of other Orthopteroids, since it is not the complete anal area, folded about a convex groove between  $Cu_2$  and 1A,

but merely includes that portion served by vein 2A and its branches, and folds about a groove (*af*) lying between 1A and 2A.

The cockroaches, on the other hand, have a complete anal fan which folds in the usual Orthopteroid manner; in addition, that portion served by vein 2A folds up concertina-wise, and lies like a folded fan against vein 1A, under the rest of the wing. As it is clear that the cockroach condition is far more specialised than that of *Mastotermes*, it would seem impossible to derive the termites from cockroaches.

A fortunate discovery in the rather small cockroach fauna of the Kansas Lower Permian has enabled me to solve this problem. Among the material studied, I have found a hindwing of the genus *Pycnoblattina* (a true cockroach of the family Spiloblattinidæ) in which the anal area is completely preserved (Fig. 1). It will be seen at once from Figs. 1 and 2 that, not only is the anal lobe developed and folded exactly as in *Mastotermes*, but also a close correspondence extends to many other details of the venation. In fact, I would go so far as to claim, from this comparison alone, that *Mastotermes*, and therefore the whole order Isoptera, must have been evolved from a form differing very little from the genus *Pycnoblattina* itself. The chief lines of specialisation by which the Isoptera have been evolved are: reduction of the pronotum, lengthening of the wings, reduction of the basal parts of the wing, and development of the humeral suture (Fig. 2, *su*), along which the wings are cast off when shed.

We now see that it is the cockroaches which have gone ahead, since Permian times, in the development of the mode of folding of the hindwing, while the termites at first 'stayed put', like *Mastotermes*, and later eliminated the anal lobe entirely.

R. J. TILLYARD.

Canberra,  
Australia.  
Feb. 3.

<sup>1</sup> Bull. Brooklyn Ent. Soc., 18, 85-93 (1923).

## The Oil-Drop Method and the Electronic Charge

FOR several years it has seemed to us to be of interest to repeat the oil-drop method in order that this method may have an opportunity of contributing to the building up of the new value of the electronic charge, which is now going on. The only existing prototype, the famous oil-drop experiments of Millikan in 1913 and 1916, seems to predict an internal consistency somewhat less than that of the new spectroscopic X-ray and electron-wave<sup>1</sup> methods.



The first step in this direction was taken by Kellström<sup>2</sup> when he re-measured the value of the viscosity of air ( $\eta$ ), which is fundamental for this method.

We have now had the opportunity of performing some preliminary investigations by the oil-drop method. We wish to point out that the variations in velocity of the drops between the condenser plates are real, and therefore long series of observations are necessary to get the mean value free from influence of the Brownian motion. During this time it is necessary that the conditions should be as constant as possible, that is, the evaporation of the drops must be reduced to a minimum. For this purpose we have used Apiezon B oil with very good results.

In order to make the extrapolation for the  $[e_1^{2/3}, \frac{1}{pr}]$ -diagram as small as possible (the correction amounts to about 10 per cent in  $e$  for 1 atm.), it is of advantage to perform measurements also at pressures greater than 1 atm. Consequently the small preliminary apparatus was constructed for higher pressures. The measuring procedure—we have made observations up to 15 atm.—involves no difficulties. However, the resulting  $e_1^{2/3}$ -values showed a remarkable decrease from the straight line even at 5 atm., due to the increasing value of  $\eta$  with increasing pressures<sup>3</sup>. There are two ways of making the higher pressures useful for the method: first, to measure  $\eta$  at those pressures with the usual methods, and secondly, to perform the measurements with oil-drops of different radii at a number of different constant pressures, each pressure giving a straight line, and then apply an empirical procedure of a similar character to that used for the correction due to the invalidity of Stokes's law. Perhaps this may be also a method of determining the relative increase of  $\eta$  at higher pressures.

To show the possibilities of the apparatus, the following preliminary results may be of interest. These include *all* the nine drops taken at 1 atm. Up to 260 velocity observations during a period of 3 hours have been taken on one drop.

$p$ (cm. Hg, 0°)	$\frac{1}{pr}$	$e_1^{2/3} \times 10^6$	$e \times 10^{10}$
76-13	72-73	63-66	4-760
76-14	78-28	63-75	747
75-92	87-01	64-10	748
76-89	87-65	64-23	761
76-93	96-27	64-57	764
75-82	105-08	64-85	758
76-84	126-63	65-68	762
76-89	133-14	66-07	778
76-93	158-00	66-65	741
		Mean	4-7577

Average deviation from the mean  $\pm 0.008$  (2/3 of that of Millikan, 1916).  $r$  is computed in the usual manner with  $e = 4.80 \times 10^{-10}$ , and  $e_1^{2/3}$  with  $\eta_0 = [182.27 - 0.493(23-0)] \times 10^{-6}$  c.g.s. units,  $c = 3.000 \times 10^{10}$  cm./sec.,  $g = 981.9$  c.g.s. units. The least square method gives  $b = 0.000609$ , which is used for the values of  $e$  in the last column.

Condenser plates, diameter, 5 cm.; distance, 0.3787 cm. Distance of fall, 0.25597 cm. Density of oil, 0.8688 gm./cm. Times of fall, 7-33 sec. Number of charges, 2-9. Voltage about 750 volts.

The voltage (in international volts) was measured with a Wolff 5-decade compensating apparatus against a Standard Weston Cell which has been controlled for several years. The time observations were made by means of a 0.01 sec. stop-watch calibrated against a standard pendulum clock. Reduced to  $c = 2.9979 \times 10^{10}$  cm./sec. and abs. volts, the resulting value of  $e$  comes out as  $4.752 \times 10^{-10}$  abs. E.S.U. With Kellström's new value of  $\eta$

$$e = 4.800 \times 10^{-10} \text{ abs. E.S.U.,}$$

in very good agreement with the spectroscopic values. As the errors in the constants used (*except for*  $\eta$ ) are small relative to the average deviation from the mean (see table) the latter may be considered a true measure of the accuracy.

Further refinements of the apparatus are in progress and a detailed report will be given later. Our thanks are due to Ina Wennerlöf-Bäcklin, who has carried out the oil density measurements.

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<sup>1</sup> Sten von Friesen, Uppsala Univ. Årskr., 14 (1935).

<sup>2</sup> Gunnar Kellström, NATURE, 136, 682 (1935).

<sup>3</sup> Wien, Harms, "Handb. Exp. Phys.", IV, 4, 523 (1932).

### Electrical Evidence on Calcite Imperfection

IN view of the recent letter of Birge<sup>1</sup> concluding that the one remaining large discrepancy in the values of the fundamental physical constants is traceable to *either* geometrical imperfection in calcite or an error in Bohr's formula for the Rydberg constant, all evidence of imperfection in calcite becomes highly important.

Such evidence is provided by the work of Joffé and his associates on electrical conduction in calcite<sup>2,3</sup>. They found that there is gradually built up a very large polarisation voltage, due to a space charge concentrated in a layer of the crystal less than  $1 \mu$  thick adjacent to the cathode. Outside this region the field strength remains uniform and relatively very low. Joffé argued that this indicates a depletion of charge carriers at the cathode, and that they must therefore be negative. At somewhat higher temperatures actual transport number measurements show that the whole of the current is carried by calcium ions.

Joffé supposed that the negative charge carriers responsible for conduction at low temperatures were impurities. This change of mechanism is improbable, since the temperature variation of conductivity of calcite follows the normal law ( $\log \sigma = -A/T + B$ ) with the slope characteristic of electrolytic conduction in heteropolar crystals<sup>2,4</sup>. It is more in harmony with the experimental results and with modern views on the structure of solids to suppose that these negative charge carriers are cation absences, lattice positions which should be but are not occupied by  $\text{Ca}^{++}$  ions. These migrate by receiving neighbouring  $\text{Ca}^{++}$  ions, more frequently from the anode side than any other. It is almost inevitably easier for this to happen than for an ion foreign to the lattice to thread its way through where there is no room for it: calcite shows none of the properties of electronic conduction. There must be an equal number of anion absences, which are not mobile.

On this view, the depletion of charge carriers at the cathode becomes an approach to occupation of all available cation positions: alternatively stated, a removal of most of the mobile cation absences. They are not necessarily all equally mobile; on the contrary, anion absences will attract them, and it will require considerable energy to dissociate an adjacent pair of oppositely charged absences. Both the concentration and mutual distribution of anion



absences will be important in determining behaviour: both are probably frozen-in equilibria characteristic of some higher temperature. Thus various samples may have very different properties depending on past thermal history.

It is possible to calculate a lower limit to the concentration of absences in calcite from the figures given by Joffé. There is a potential distribution in the polarisation layer according to the law:

$$V = V_0 e^{-x/D}.$$

Hence the space charge density is

$$\rho = \frac{\epsilon}{4\pi} \frac{d^2 V}{dx^2} = \frac{\epsilon V_0}{4\pi D^2} e^{-x/D}.$$

The value of  $D$  remains constant for a given specimen at about  $4 \times 10^{-5}$  cm. up to a polarisation potential  $V_0$  of about 2,000 volts. The maximum space charge density is then:

$$\begin{aligned} \frac{\epsilon V_0}{4\pi D^2} &= (8.3 \times 2 \times 10^{13}) / (4\pi \times 4^2 \times 300) \text{ E.S.U./cm.}^3 \\ &= 2.75 \times 10^9 \text{ E.S.U./cm.}^3 \\ &= 2.88 \times 10^{18} \text{ Ca}^{++} \text{ ions/cm.}^3 \end{aligned}$$

Since there should be about  $1.64 \times 10^{22}$  molecules per cm.<sup>3</sup> in a perfect crystal of calcite, this indicates a deficiency of 0.018 per cent. This refers to mobile absences only, and is a lower limit. Polarisation potentials of more than 7,000 volts have been observed, though with somewhat increased values of  $D$ . Even so, this is six times Bearden's probable error for the density of calcite<sup>5</sup>, and 1.7 times the probable error of the 'grating value' of  $e$ , though only 4 per cent of the major discrepancy in  $e$ -values. Hence it appears that this type of imperfection in calcite, estimated as a lower limit, introduces a significant correction in the determination of the charge of the electron, but it only increases the major discrepancy.

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<sup>1</sup> R. T. Birge, *NATURE*, **137**, 187 (Feb. 1, 1936).

<sup>2</sup> A. F. Joffé, "The Physics of Crystals" (1928).

<sup>3</sup> A. F. Joffé, *Ann. Physik* (4), **72**, 473 (1925).

<sup>4</sup> B. Gudden, *Ergebnisse der Exakten Naturwissenschaften*, **3**, 134 (1924).

<sup>5</sup> J. A. Bearden, *Phys. Rev.*, **33**, 2089 (1931).

care was taken during the measurements in order to avoid influences of slow variations in the apparatus used. The angles of diffraction corresponding to maxima and minima of intensities as well as to inflection points are given in the accompanying table, together with the Cl—Cl distances deduced from these measurements.

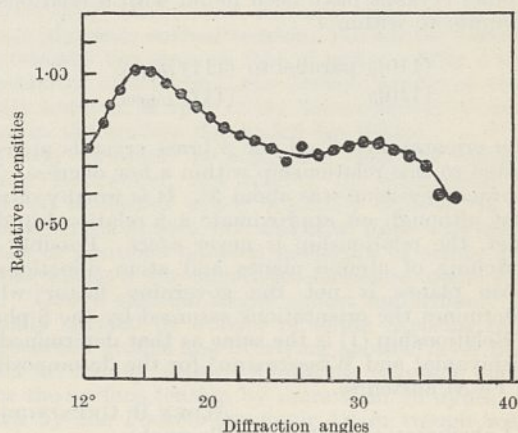


FIG. 1.

As may be seen, the agreement between the mean value 2.83 Å. and that (2.85 Å.) found by Degard, Piérard and van der Grinten<sup>1</sup> is very satisfactory.

	Angles	Cl—Cl distances
1st maximum	16° 10'	2.90 Å.
Inflection point	21° 10'	2.82 Å.
2nd minimum	25° 50'	2.82 Å.
Inflection point	28° 50'	2.78 Å.
2nd maximum	31° 00'	2.84 Å.
	Mean value	2.83 Å.

A more detailed account of this research is to be published later. We wish to thank Prof. P. Debye, under whose direction this work was carried out.

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<sup>1</sup> C. Degard, J. Piérard and W. van der Grinten, *NATURE*, **136**, 142 (1935).

## Use of a Geiger-Müller Counter for the Study of the Diffraction of X-Rays by a Gas

PHOTOGRAPHIC records of X-rays diffracted by a gas require long times of exposure. This feature suggests the interest of replacing the photographic plate by a Geiger-Müller counter.

We have succeeded in determining the diffraction curve of molybdenum  $K\alpha$  rays by gaseous carbon tetrachloride with the same precision as with a photographic method. The radiation (50 kilovolts, 20 milliamperes) was filtered through a 0.2 mm. thick plate of zirconium. In these circumstances, it was practically monochromatic, as has been shown lately in this laboratory by J. Piérard. Relative intensities were determined from the measurements of times necessary for the production of a constant number (500) of discharges in the counter (Fig. 1). Special

## Orientation in Peritectic Structures

PRELIMINARY results from an X-ray study of the peritectic reaction  $\alpha + \text{liquid} \rightarrow \beta$  in the Cu-Zn system prove that the orientations assumed by the  $\beta$ -phase are definitely related to the orientation of the  $\alpha$ -phase. Specimens suitable for accurate orientation studies (by means of back-reflection Laue patterns) were prepared by solidifying a pure  $\beta$ -alloy (52 per cent copper) under a uniform temperature gradient, and seeding the crystallisation with a copper single crystal. The resulting specimens then consist (in order, from bottom to top) of (a) copper crystal seed, (b) primary crystallised  $\alpha$ -phase having the same orientation as the copper seed, (c) large  $\beta$ -grains (2–5 mm.), the nuclei of which originated in the peritectic reaction  $\alpha + \text{liquid} \rightarrow \beta$ ; these  $\beta$ -grains have a narrow rim of segregated  $\alpha$ -phase. This sequence



of crystallisation is made possible, as was expected, by the diffusion of copper into the liquid  $\beta$ -brass adjacent to the solid copper crystal.

The orientation of the individual copper and  $\beta$ -brass crystals was determined by means of the back-reflection Laue X-ray method, with an accuracy of  $\pm 0.5^\circ$  or better. To date, only two (of twenty)  $\beta$ -brass crystals have been found with a relationship accurate to within  $1^\circ$ :

$$\begin{array}{l} (110)_\beta \text{ parallel to } (111)_{\text{copper}} \\ [1\bar{1}0]_\beta \quad \quad \quad [11\bar{2}]_{\text{copper}} \end{array} \quad (1)$$

The orientations of all the  $\beta$ -brass crystals approximated to this relationship within a few degrees. The average deviation was about  $3^\circ$ . It is worthy of note that although an approximate  $\alpha$ - $\beta$  relationship does exist, the relationship is never *exact*. Possibly the matching of atomic planes and atom directions in those planes is not the governing factor which determines the orientations assumed by the  $\beta$ -phase.

Relationship (1) is the same as that determined by Nishiyama<sup>1</sup> and Wassermann<sup>2</sup> for the decomposition of Fe-Ni austenite.

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<sup>1</sup> *Sci. Rep. Tôhoku Imp. Univ.*, iv, 23, 637 (1934).

<sup>2</sup> *Mitt. Kaiser-Wilh.-Inst. Eisenforsch.*, 17, 149 (1935).

### Sign of the Magnetic Moment of the Proton and of the Deuteron

THE experiments of Stern, Estermann and Frisch, which were later corroborated by us, show that the magnetic moment of the proton is about three nuclear magnetrons. This large value indicates that the theory which accounted for the electron moment will not suffice for the proton. Further, it is well known that deflection experiments are incapable of giving an indication of the sign of the nuclear moment. In the absence of a quantitative theory, this property of the proton and of the deuteron therefore becomes a matter of assumption.

We have succeeded in devising a method of making this observation of the sign which involves the use of non-adiabatic transitions in a weak rotating magnetic field: A beam of neutral hydrogen (deuterium) atoms is first deflected in a weak inhomogeneous magnetic field and then in a strong inhomogeneous field arranged to produce deflections in the opposite direction. For suitable values of the first field, it is then possible to focus atoms of all velocities in a given magnetic level on the slit of the Stern-Pirani detector. In a magnetically shielded region between the two fields is placed a set of wires carrying current which produce weak, rapidly varying magnetic fields to induce non-adiabatic transitions between the different magnetic levels. A movable selector slit allows one to sort out the atoms of positive overall moment from those with negative overall moment which have the same magnitude. On examining the moments from the two  $m=0$  levels of hydrogen, it was found that the atoms in the state with negative overall moment were capable of making the transitions, but those with positive overall moment were not. Since no transitions between the  $F=1$  and

$F=0$  levels are produced with the method, the state with positive overall moment has  $F=0$ ; the hyperfine structure multiplet is normal, and the magnetic moment of the proton is positive. Similar experiments with deuterium show that the deuteron moment is also positive.

Full details will appear elsewhere.

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### The New Electrodynamics and the Fine Structure Constant

THE new electrodynamics put forward by M. Born<sup>1</sup> changes the form of Maxwell's equations. The question arises, whether this generalisation is the only one which gives a finite mass for an elementary particle and becomes, for weak fields, the Maxwellian equations.

Starting from a new form of the variational principle<sup>2</sup>, it is possible to show that, by accepting quite obvious assumptions, there exists a group of action functions, depending on a parameter, say  $\beta$ , which leads for every  $\beta > 0$  to a unitarian field theory, fulfilling both the conditions; that is, giving finiteness of energy and Maxwell's equations as a limiting case. Born's action function corresponds to  $\beta = 1$ . The choice between all the different theories can be made only by applying criterions arising from the further development of the theory. A very simple theory corresponds to the limiting case  $\beta = 0$ . The Lagrangian takes in this case the form (for the sake of simplicity we assume that  $L$  is dependent only on  $F$ ):

$$L = \frac{1}{2} \log(1 + F) = \frac{1}{2} \log(1 + \vec{B}^2 - \vec{E}^2) \dots (1)$$

Calculating the mass  $m$  of an elementary particle, we find in natural units (in which  $e = 1$ ,  $c = 1$ ,  $b = \text{absolute field} = 1$ ):

$$m = \sqrt{\frac{8}{3}} \times 1.2361 \dots (2)$$

slightly different from the value 1.2361 obtained in Born's theory.

Heisenberg and Euler and Kockel<sup>3</sup> have shown that the scattering of light by light can be expressed as a result of non-linear correction terms to Maxwell's equation, corresponding to a Lagrangian (still in natural units):

$$L = \frac{1}{2} (\vec{B}^2 - \vec{E}^2) - \frac{1}{90\pi} \frac{1}{m^4} \frac{1}{\alpha} (\vec{B}^2 - \vec{E}^2)^2 + \dots (3)$$

$\alpha$  being the fine structure constant. Putting in (3) the value (2) for  $m$  and comparing it with the Lagrangian (1)

$$L = \frac{1}{2} (\vec{B}^2 - \vec{E}^2) - \frac{1}{4} (\vec{B}^2 - \vec{E}^2)^2 + \dots,$$

we can calculate  $1/\alpha$ , and find  $1/\alpha = 130$ , which is close to 137, whereas Born's theory gives  $1/\alpha = 82$ .

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<sup>1</sup> M. Born, *Proc. Roy. Soc., A*, 143 (1934); M. Born and L. Infeld, *Proc. Roy. Soc., A*, 144, 425 (1934).

<sup>2</sup> L. Infeld, *Camb. Phil. Soc.* (in the press).

<sup>3</sup> Heisenberg and Euler, *Z. Phys.*, 98, 714 (1936); Euler and Kockel, *Naturwiss.*, 23, 246 (1935).



### Deviations from the Maxwell Equations resulting from the Theory of the Positron

IN spite of its well-known inconsistencies, Dirac's theory of the positron enables one to calculate some physical processes in an unambiguous way; for example, pair creation by photons or by charged particles. Another consequence of this theory, which results from it unambiguously, is the coherent scattering of light by electrostatic fields. It is easily shown that in the latter problem no divergencies occur. The calculation of the polarisability of the vacuum or of scattering of light by light, however, leads to divergent series. To avoid this, Dirac and Heisenberg<sup>1</sup> suggested a convention which allows these infinite expressions to be subtracted.

Owing to the arbitrariness of this formalism, its quantitative results are open to doubt. Among these results are the non-linear additional terms to the Maxwell equations derived by Euler and Kockel<sup>2</sup>. They describe the behaviour of an electromagnetic field containing only frequencies  $\nu \ll mc^2/h$ . They may be expressed by an addition to the Lagrangian  $L$  which for small field-strengths has the form:

$$L = \frac{1}{8\pi} (E^2 - B^2) + \frac{e^4 h}{m^4 c^7} \left[ \alpha (E^2 - B^2)^2 + \beta (EB)^2 \right] \dots i$$

$E$  being the electric,  $B$  the magnetic field strength. This follows directly from relativistic invariance, leaving only the values of the constants  $\alpha$  and  $\beta$  undetermined. With the convention mentioned above, these are found to be  $\alpha = 1/360\pi^2, \beta = 7/360\pi^2$ .

We have succeeded in deriving the constants  $\alpha$  and  $\beta$  without making use of the subtraction convention of Dirac and Heisenberg. As mentioned above, the scattering of light by electrostatic fields can be calculated without having to deal with divergent expressions. We have done this for fields satisfying the condition

$$|\text{grad } E| \ll |E| \frac{mc}{h}$$

The cross-section for light with frequencies  $h\nu \ll mc^2$  is of the order of magnitude:

$$g \sim \left( \frac{e^2}{mc^2} \right)^2 \left( \frac{e^2}{hc} \right)^2 \left( \frac{h\nu}{mc^2} \right)^4 \frac{W}{mc^2}$$

where  $W$  is the total energy of the scattering field. The exact expression depends on the angles between the light vectors and the scattering electric field. As this scattering process can be considered as a consequence of non-linear field equations, it can also be calculated by means of the Lagrangian (1).

By comparing the former result with the expression derived from the Lagrangian, the constants  $\alpha$  and  $\beta$  are completely determined and one gets the same values as derived with Heisenberg's convention. Thus all the results following from the non-linearity of Maxwell equations, for example, the cross-section for scattering of light by light as found by Euler and Kockel, seem to be of the same trustworthiness as the cross-section for pair production derived by Bethe and Heitler.

The extension of this calculation to the scattering by the nuclear Coulomb field is in progress.

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### Pre-Gibbs Adsorption by Surface Rearrangement

IT has been an unresolved paradox<sup>1</sup> that for many solutions such as soap the surface tension is only a fraction of that of water, and yet the Gibbs theorem strictly requires that in the neighbourhood of the surface there should be proportionately more water than in the bulk of the solution. When the solution is thoroughly mixed and uniform right up to the surface (dynamic surface tension), the surface tension is practically the same as that of water. After a few thousandths of a second, the surface tension is very greatly lowered, in spite of the accumulation of more water in the surface demanded by Gibbs.

It may therefore be suggested that the surface tension is lowered, not merely by orientation of dissolved molecules which originally chanced to be exposed on the surface, but also that there is an interchange of positions between molecules of solute and solvent within a few molecular diameters of the surface. Thus a solution might almost immediately be partially covered by a layer of solute exposing only hydrocarbon groups and overlying another layer that would be mainly water. Complete coverage could lower the surface tension by more than 30 dynes, as shown by the Pockels-Langmuir-Adam trough with oleic acid on pure water. This would also account for the observation that oleic acid will not spread on the surface of a soap solution, although it does so immediately upon water and upon solutions of most substances.

The conception of pre-Gibbs adsorption by surface rearrangement arises primarily from a series of studies by my collaborators, Drs. T. F. Ford, D. A. Wilson and Mr. G. F. Mills, using solutions of substances such as phenol, caprylic acid, and especially hydrocinnamic acid.

The surface tension of a solution of the latter containing 1.5 gm. per litre is almost instantaneously lowered by at least 10 dynes, but the microtome method shows that the Gibbs adsorption is negligible, the average composition of the surface sandwich layers being still that of the whole solution. The Gibbs adsorption requires many (12) hours to rise to its approximately complete value. Again, an insoluble substance spreads on these freshly swept solutions almost as freely as on water; whereas, after Gibbs' adsorption occurs, spreading is slow and difficult. Further evidence is obtained from the surface tension of freshly swept surfaces and of samples from the same container poured from underneath the surface, from a surface that has been allowed to stand, and from a frothed surface. Our conception, together with the observation that the Gibbs layer is relatively slowly soluble, would explain the fact that a moving bubble may yield reproducible values for adsorption which range from many times smaller to many times larger than Gibbs.

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<sup>1</sup>J. W. McBain and D. A. Wilson, *J. Amer. Chem. Soc.*, **58**, 379 (1936).

### Adsorption of Nitrogen on Tungsten

IN a recent paper<sup>1</sup>, it has been shown that it is possible to study the adsorption of hydrogen and oxygen on a tungsten wire and to measure the heat evolved and the amount of gas adsorbed. Experiments have now been carried out with similar apparatus using nitrogen, and they have shown that, if less

<sup>1</sup>P. A. M. Dirac, *Proc. Camb. Phil. Soc.*, **30**, 150 (1934). W. Heisenberg, *Z. Phys.*, **90**, 209 (1934).

<sup>2</sup>H. Euler and B. Kockel, *Naturwiss.*, **23**, 246 (1935).



nitrogen than is sufficient to cover the bare wire is admitted, the whole of this nitrogen is rapidly adsorbed on the wire, that is, the residual pressure is negligible. The behaviour of nitrogen is thus similar to that of hydrogen. The adsorption of the whole charge shows definitely that the effects observed cannot be due to impurities of, for example, oxygen in the nitrogen. The experiments were carried out at room temperature.

In previous work on the adsorption of nitrogen on tungsten, no evidence for this type of adsorption has been found, but, as in the case of hydrogen, only a slow (activated) adsorption. In view of the present results, this failure must be taken as being due to the presence of adsorbed films of impurities on the tungsten. The thermionic method has also failed to detect the adsorption of nitrogen<sup>2</sup> on tungsten, presumably owing to the high temperatures necessary to obtain appreciable emission.

The properties of the nitrogen film are being studied in detail and the results will be published in due course.

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<sup>1</sup> Roberts, *Proc. Roy. Soc., A*, **152**, 445 (1935).

<sup>2</sup> Langmuir, *Phys. Rev.*, **37**, 1006 (1931).

### Preparation of Stereoscopic Red-Green Wall-Diagrams

I SUPPOSE that, during the course of teaching most science subjects, there are occasions when students would be able to visualise more quickly what the lecturer is trying to describe if they could be shown the object in three dimensions. Wall-diagrams of the stereogram type and models are all right as far as they go, but they cannot show the relations of internal structures as well as they would if they were stereoscopic and completely transparent. So far as I know, the use of stereoscopic red-green wall-diagrams is rarely resorted to, yet they are extremely efficient and, within limits, are not difficult to produce. The details of the method I have found satisfactory are these:

First of all the necessary plans and elevations are prepared to some definite scale and from these a perspective drawing is made. The angle of view chosen depends, of course, upon the shape of the object but as, for purposes of accuracy, the larger the drawing is the better, and as an exaggerated perspective is to be avoided, the principal vanishing points should not be more than about 40° and 50° to the principal visual ray. As two drawings have to be made with the same vanishing and measuring points, the most convenient method is to have a sheet of paper filling the board and marked with the horizon line, ground line, principal visual ray, and vanishing and measuring points. On this is fixed, over the appropriate area, a smaller sheet of paper upon which the parts of the above lines and those points within its area are traced. The first drawing, marked 'left', is then made (Fig. 1) and finished off in Indian ink or process black. The horizon line must also be inked.

The greater dimension of the drawing is then measured and the magnification, to enlarge it to fill adequately the sheet to be used in making the wall-

diagram, estimated. Two and a half inches (the normal inter-pupillary distance) is then divided by this magnification factor and the dividend is the actual distance which the nearest point of the object must be moved to the left in making the second drawing. (It simplifies the technique a little if this point is on the picture plane.) It does not matter if, for the sake of getting a convenient length to measure, rather more than 2.5 in. is taken: up to a point such an alteration will only enhance the stereoscopic effect.

The first small sheet is removed and the second drawing is made on another one with the nearest point of the object in its new place, inked in and marked 'right'. These two drawings are then successively photographed and their negatives projected on to the diagram sheet, care being taken not to make any camera or projector adjustments between the exposures and to use sufficiently good lenses to avoid spherical aberration. There will be a difference in the actual width of the two drawings, but any modification thus introduced in the final magnification is immaterial. These photographic and projection stages have to be introduced into the process as the making of a perspective drawing of adequate size by the direct method is impracticable.

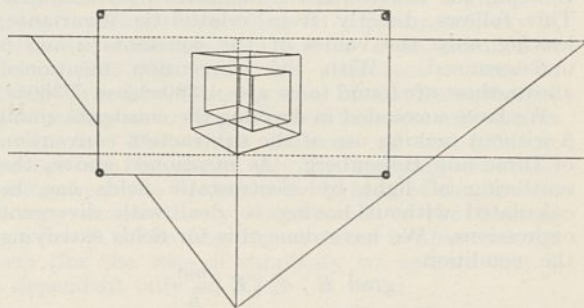


FIG. 1. The first drawing on its sheet, which has been pinned over the appropriate area of the large sheet.

If the left eye of the spectacles to be used is red, the bright lines of the left negative are lightly registered on the paper with a green pencil. The horizon line is also marked, but only at the edge. The right negative is then substituted, its horizon line adjusted to that marked on the sheet and the position of the nearest point of the object decided upon. If it is placed upon the same spot as that of the first drawing, the object will appear just behind the paper. If, however, it is placed 2.5 in. to the left, the object, a perfect ghost, will appear halfway between the observer and the paper. This can be helpful to the student as, standing 8-10 ft. away from the diagram, he can with a pointer actually follow the solid shape and is only worried because the pointer has the curious habit of hiding edges behind which it obviously lies! A greater divergence than 2.5 in. should not be employed owing to the difficulty of dissociating eye-accommodation from eye-convergence, which is introduced. For ordinary use in the lecture theatre, a diagram with the nearest points of the two drawings coincident is perhaps the most satisfactory as the object then appears full size.

After the second negative has been registered with a red pencil, the diagram is inked, using very broad nibs, such as Mitchell's Pedigree Round-Hand No. 1. The inks I have used have been made from Pinatype



Complementary Red and Green D, but they and their dilution depend upon the paper and the spectacles being used. The kind of spectacles we have are of cardboard with celluloid eyes costing four shillings a dozen, so the outlay even for a large class is not serious. Having found the right strength of ink, use the green first, as the red has a tendency to run along the wet green lines if they are used in the reverse order.

It improves the general appearance and ease of interpretation of the diagrams if the near edges are made at least twice as wide as those at the back (the others very roughly in proportion) and if the parts needing special emphasis are cross-hatched. By the latter means parts are given a solidity which, however, is translucent and so the relation of internal structures to the parts in front and behind them is easily appreciated.

These wall-diagrams are perfectly satisfactory even when viewed from a fair distance or from the side. Their only disadvantage compared with the ordinary kind is that the lecturer cannot successfully *point* to any part (except the nearest point when they are drawn coincident) as the apparent position varies with the view-point. This, however, is more than compensated for by the ease with which the shape is seen and can be described and, anyhow, the parts can easily be lettered.

To anyone familiar with perspective drawing technique the production of these wall-diagrams is not difficult unless there are many curved surfaces to be represented. These can only be reproduced by drawing their lines of curvature, the projection of which is a laborious task. In many instances, however, such a task can be avoided by substituting polyhedral surfaces for the curved ones. I have, for example, made a pair of diagrams to show the invagination of the optic vesicle to explain the reason for the appearance of the choroid fissure, the relation of the retinal and pigment layers, etc., with this modification, and it is quite satisfactory.

In the above account I hope I have omitted no important detail of the method, but, if any reader has any question to ask, I shall be happy to try to answer it.

G. L. PURSER.

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Aberdeen.

### Shadows of the Retinal Blood-Vessels seen by Monochromatic Light

It is well known that the shadows of the retinal blood-vessels may be seen if a pinhole is held in front of the eyes near to the anterior focus and moved from side to side. They are also sometimes seen in a microscope field, though they disappear if the eye is held still and comfortably adapted. During some observations with a monochromator, I noticed that the patterns could easily be seen in the field when blue light was used, but that they could not be seen at all with green light. Further experiments, with about ten observers, showed that most people could see the patterns easily with light of  $\lambda$  4078 and  $\lambda$  4358 (violet and blue), much less easily with light of  $\lambda$  4916 (blue-green) and not at all in the range  $\lambda$  5000- $\lambda$  6000 (green and yellow). They could be seen again in the red, but not nearly so easily as in the blue and violet. By removing the

prism and substituting a plane mirror, so as to retain the same geometrical arrangement, I found that they could be seen with white light. Dilution of the blue with a little green made the patterns much less clear.

On examining the pinhole effect with monochromatic light, I found that the patterns could be seen by any colour if the pinhole was moved rapidly, but only by blue light if it was moved very slowly. The effect depends on so many factors that it is not possible to give any quantitative data, but the minimum speed for green appeared to be about five times as great as that for blue light. The patterns were more easily seen with strong light than with weak, up to the limit of comfortable illumination.

It is usual to explain the fact that these patterns are not seen in ordinary vision by assuming that the eye has some compensatory mechanism for ignoring them. Thus the receptors on which the shadows normally fall may become hypersensitive, so that they give a full response when stimulated by the small amount of light passing through the vessels. They are seen in the pinhole experiment because the retina is illuminated by fairly narrow pencils of light. When the pinhole is moved, the direction of illumination changes and the shadow moves from one set of receptors to another so rapidly that the compensation is defeated. In the microscope field the effect is produced by flickering of the eye when it is not comfortably adapted. In seeking to apply this explanation to the experiments with monochromatic light, we may note that the effect is supposed to depend on the rate at which the adaptation is able to take place. Our results could be explained if either, (a) for blue light a given movement of the pinhole produces a greater movement of the shadows than for other parts of the spectrum, or (b) for blue light the adaptation is more rapid. At first sight, supposition (a) appeared very attractive. If the reception action takes place mainly as the light is absorbed in the visual purple, we should expect that the reception of the blue and red would take place mainly at a greater depth than reception of the blue and green (owing to the strong absorption in the green). This would mean that for a given change in the direction of illumination the shadows would move farther for blue than for green. This explanation had to be abandoned because direct experiments show that there is no difference in the depth of the different receptors<sup>1</sup>. On the other hand, if explanation (b) is correct, we should expect to find effects of a corresponding nature in experiments on fatigue. I can find no evidence of such results, though there is no definite negative evidence.

According to Roaf's theory of colour-vision, blue light stimulates the rods rather than the cones, and this might suggest a reason for a different rate of adaptation to changing illumination. It would not explain the difference between red and green found in the experiments with the monochromator. This difference, which was small, may have been due to some subsidiary effect, especially since it could not be found in the pinhole experiment.

R. W. DITCHBURN.

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Dublin.  
March 10.

<sup>1</sup> Koster, *Archiv Ophthalmologie*, 41, 1. In view of the fact that Koster's results were in conflict with earlier work, I have repeated some of his observations and confirmed his conclusions.



## Recent Research on Cancer

IN his reply in NATURE of February 22 to our criticism, Mr. Lockhart-Mummery has set out what he considers are the "exact facts". In fairness to my co-workers and myself, I must point out that the exact facts are as follows:

The actual statement made by myself in my annual report reads: "While our experiments are as yet unfinished we feel we are on safe ground when we say (1) that given a full mixed diet, infestation with the parasite *Gongylolema neoplasticum* induces no changes other than perhaps an occasional trivial hyperkeratosis of the squamous epithelium—certainly there is no papillomatosis and nothing resembling malignant disease: (2) that, given a diet deficiency of the natures stated, the parasite appears to induce some hyperplasia and papillomatosis but again nothing resembling frank malignant disease." Mr. Lockhart-Mummery's paraphrase in his editorial reads: "While no difficulty was found in establishing the presence of the parasite in the oesophagus and stomach of the rats, and in parts of the pharyngeal tract, the experiments have been almost entirely unsuccessful in producing cancer. Since no doubt exists that it was Fibiger's parasite which was employed, the experiments appear to show that, provided the rats are fed on a correct diet, cancer does not develop as a result of this parasitic infection." Thus Mr. Lockhart-Mummery paraphrases part (1) of my sentence only and makes no mention of the highly relevant part (2). If it had been included, it is obvious that there would have been no grounds on which the writer of the article in NATURE, or anyone else, could reasonably have made the statement to which we originally took exception.

Again, in his comment in NATURE of February 22, Mr. Lockhart-Mummery purports to quote me verbatim. It will be seen, however, that he omits the whole of part (2) of my sentence. The omission of part (2) of my sentence makes the quotation incomplete, while the omission of "(1)" conceals the fact that only part of my sentence was quoted.

The inclusion of the word 'almost' in Mr. Lockhart-Mummery's editorial is quite inaccurate in a scientific report. We were *entirely* unsuccessful in producing cancer; my annual report made this quite clear.

R. D. PASSEY.

Department of Experimental Pathology  
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March 26.

## Chromosomal Relationship between Males and Females in Hymenoptera Symphyta

A RECENT cytological investigation by me of chromosome individuality in three arrhenotokously parthenogenetic species of Hymenoptera Symphyta has yielded evidence which indicates that the relationship between the females and males is not one of diploidy:haploidy, but is of tetraploidy:diploidy. This concept leaves considerably less to be explained with regard to the occurrence of parthenogenesis; but the matter of the abortive meiosis in the spermatogenesis of impaternal males would seem, at first sight, to be elevated thereby to the rank of a first-

rate problem. Resolution of this, however, is still possible along cytogenetic lines on the basis of a principle of gene-controlled meiosis.

Extended application of the idea renders intelligible the phenomena of 'pre-conjugation' observed during maturation of the gametes in the bee, as demonstrated by Nachtsheim<sup>1</sup>, and in *Cynips kollari*, as found by Hogben<sup>2</sup>, as the occurrence in a derived tetraploid of a more or less vestigial synapsis interfering with functional synapsis.

Still more recent work on certain arrhenotokous Tenthredinidæ reveals leptotene and syndesis during prophase of the abortive division. It cannot, however, at present be stated whether the threads entering the syndetic knot are of a dual nature and synaptically paired.

The significance of the observations may be that the appearances represent true synapsis in an organism hitherto regarded as haploid and really diploid, or that they are of stages through which chromosomes pass, at this stage of gametogenesis, irrespective of whether homologous mates are present or not. In the former case emphasis would be placed on failure of the spindle mechanism, known to occur, in securing non-reduction.

FRANK GREENSHIELDS.

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March 10.

<sup>1</sup> Nachtsheim, *Archiv Zellforsch.*, 11 (1913).

<sup>2</sup> Hogben, *Proc. Roy. Soc.*, B, 91 (1920).

## Accommodation Coefficient of Deuterium

IN attempting to find the relative times of life of hydrogen and deuterium molecules on a bare platinum surface, preliminary results have been obtained for the accommodation coefficients of hydrogen, deuterium and helium relative to a normal (that is, unflashed) platinum wire, the wire having been annealed at red heat in air for about one minute to remove strain.

The publication of these results may be of interest on account of their applicability, at least in so far as relative magnitudes are concerned, to determinations, by methods of thermal conduction at low pressures, of deuterium concentrations in hydrogen.

With the wire at a mean temperature of 100.7° C. and the surrounding gas at temperatures of about 16° C., the accommodation coefficients of hydrogen, deuterium (99.2 per cent) and helium were found to be 0.24<sub>3</sub>, 0.30<sub>3</sub> and 0.29<sub>4</sub> respectively.

In calculating the value of the accommodation coefficient, the ratio of the specific heats of deuterium in this temperature range has been assumed equal to that of hydrogen. The deuterium used was the product of the total decomposition by sodium of heavy water of guaranteed 99.2 per cent content of deuterium oxide. While the actual proportions of D<sub>2</sub>, HD and H<sub>2</sub> molecules are not known, the percentage of these two latter is not sufficient to affect the result obtained for deuterium.

W. B. MANN.

W. C. NEWELL.

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March 21.



### A Simple Method for Testing Homogeneity of Wood

SOME time ago<sup>1</sup> we found that there seems to be a characteristic difference in the structure of the wood used for the building of string instruments: X-ray investigations have shown that the top always exhibits a very marked fibre structure, whereas the back in instruments of good tone quality is nearly homogeneous.

The question arises whether it is possible to find these differences by methods which might have been available to the Italian makers of the classical period? I found that it is possible to obtain this information by using heat conductivity in the different directions of the wood as an indicator of its homogeneity. It is well known that a thin layer of wax applied to a crystal face will melt into a figure of definite contour (isotherm) if the crystal is touched at one point with a hot wire. The same method can be easily applied to wood, and one finds that the isotherm on a piece of wood cut vertical to the fibre is always a circle, except where a knot produces an inhomogeneous region. The isotherm on a cut parallel to the grain varies in its outline for different materials. The ratio of the axes for pine used for the top of violins has been found as high as 1.95, and for nearly homogeneous maple used for the back 1.15. We have obtained recently, through the courtesy of Dr. A. Koehler, director of the U.S.A. Forest Products Laboratory, Wisconsin, some samples of white ash which range, as revealed by X-ray investigations, from very marked fibre structure to almost complete homogeneity. The same variation and exactly the same order has been found by using the isotherm method.

It is possible that such a method, discovered accidentally, may have been used by the instrument makers, since many of the old instruments exhibit branding marks even if the maker did not use a brand for the identification of his instruments.

K. LARK-HOROVITZ.

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Feb. 17.

<sup>1</sup> NATURE, 134, 23 (1934).

### The Structure of Light Waves

I WAS very much interested in Sir J. J. Thomson's letter<sup>1</sup> in which he suggests that light waves are axially symmetrical systems of electro-magnetic waves propagating *along* the axis of symmetry, as I made the same suggestion in 1929<sup>2</sup> and then repeated it in my recent papers in the *Philosophical Magazine*<sup>3</sup> where this kind of Maxwell waves was discussed in detail; on the basis of this discussion a theory of elementary "material" particles (like electrons and protons) and of the photons was developed, according to which these entities were regarded as certain axially symmetrical systems of Maxwell electro-magnetic waves.

Similarly to Sir J. J. Thomson, I used the Maxwell equations in *cylindrical* co-ordinates, and I have transformed these equations practically into the same form as Sir J. J. Thomson does<sup>4</sup>, only a little more generally, and correspondingly obtained a solution<sup>5</sup>

of which Sir J. J. Thomson's solution  $Q = A\rho + B/\rho$  represents a particular case<sup>6</sup>.

This particular case is, however, *unsuitable* for free electromagnetic waves, for  $Q$  becomes infinity, either at  $\rho = 0$  or  $\rho = \infty$ , or both. Sir J. J. Thomson tries to avoid this by putting  $A = 0$  when  $\rho > a$ , and  $B = 0$  when  $\rho < a$ . But then we shall obviously obtain not *free* electromagnetic waves, but electromagnetic waves propagating along a cylinder of radius  $a$ , co-axial with the axis of symmetry of the waves, made either of conductive material with infinite conductivity or an insulator with infinite dielectric constant (when the magnetic lines of force are circular while the electric lines of force are situated in axial planes) or alternatively, of ferro-magnetic material of infinite permeability (when the electric and magnetic lines of force are situated vice versa)<sup>7</sup>. Otherwise the Maxwell equations would be no longer valid at the surface of this cylinder, owing to the discontinuity of the axial component of the vector situated in axial planes and, as is not difficult to find, proportional to  $A$ .

For this reason I have not considered in detail the particular case which was used by Sir J. J. Thomson, but discussed a more general solution in which the *phase along the radius was variable*<sup>8</sup>.

However, later I found that even this more general solution was not satisfactory for various reasons, and, therefore, I based my further discussion on solutions in the form of Bessel functions, in which no such discontinuity exists<sup>9</sup>. This discussion led eventually to the above-mentioned theory of elementary particles, including photons, which explained their fundamental properties, classical as well as wave mechanical and relativistic, and also the actual numerical value of the mass ratio between the proton and the electron, on the basis of Maxwell electrodynamics.

In conclusion, I would like to express the hope that Sir J. J. Thomson's letter will increase the interest in the axially symmetrical electromagnetic waves, for I am convinced that this study must contribute essentially to the solution of various problems of physics. The fact that Sir J. J. Thomson arrived at the conclusion as to the importance of this kind of waves without being aware of my previous results makes his opinion still more valuable as a stimulus. The value of this stimulus is not affected by the unsuitability for the free electromagnetic waves (and hence for light waves) of the particular solution which Sir J. J. Thomson tries to apply.

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Feb. 10.

<sup>1</sup> NATURE, 137, 232 (Feb. 8, 1936).

<sup>2</sup> Z. Phys., 54, 1 and 2, 121 (1929).

<sup>3</sup> Phil. Mag., 19, 954 (1935); *ibid.*, 20, 441, 646, 695 and 702.

<sup>4</sup> See equation (24) in Z. Phys., *loc. cit.*, from which Sir J. J. Thomson's equation  $\frac{d}{d\rho} \left( \frac{1}{\rho} (eQ) \right) = 0$  is obtained as a particular case by equating the constants  $l = 1$  and  $k = 0$ .

<sup>5</sup> See formula (27) in Z. Phys., *loc. cit.*, Sir J. J. Thomson's solution is obtained as a particular case by putting  $l = 1$  and  $k = 0$ .

<sup>6</sup> The notation used in my paper differs from the notation in Sir J. J. Thomson's letter. His  $Q$ ,  $e$ ,  $A$  and  $B$  correspond to my  $Y$ ,  $r$ ,  $\sqrt{C_1}$  and  $C_2\sqrt{C_1}$  respectively.

<sup>7</sup> The solution suitable for *free* axially symmetrical waves of this kind requires that the radial component of the electro-magnetic vector at  $\rho = 0$  should not only be finite, but also equal to zero (see Z. Phys., *loc. cit.*, 116).

<sup>8</sup> Z. Phys., *loc. cit.*

<sup>9</sup> Phil. Mag., *loc. cit.*



### The Solar System and its Origin

IN Prof. H. N. Russell's recent book of the above title, the belief is expressed that the assumption of the sun having been originally one component of a binary star would help to resolve certain difficulties. To get rid of the other member an almost central collision with another star is invoked, but I have shown that a close encounter of the sun's companion with another star may disrupt the system, both stars escaping from the sun.

If we assume that during such an encounter a filament of material is ejected between the two stars, then it is natural to suppose that the velocities of the various portions of this filament relative to the sun will be distributed more or less uniformly between the velocities of the two escaping stars. Under a wide variety of conditions of encounter, a reasonable proportion of the filament may be left with velocities

less than that of escape from the sun, and in this way the primitive planets formed. Further, it can be shown with no severe restriction on the encounter that the angular momentum per unit mass may have been in the same general direction round the sun, though very different in amount for the various condensations in the filament.

These primitive planets, having all been produced in a comparatively small region, will return to somewhere near the region, and accordingly there is an opportunity for the subsequent production of satellites by close encounters between the planets themselves. In this connexion, it is interesting to note that the moon could have been produced by an encounter of the earth with Venus.

RAYMOND A. LITTLETON.

Princeton University Observatory.

March 3.

### Points from Foregoing Letters

DR. R. J. TILLYARD gives a drawing of the veins of the wings of a recently found fossil cockroach of Lower Permian age and compares it with that of the present day giant Australian termite *Mastotermes*, which represents the most archaic type of that order. The close correspondence in the vein arrangements indicates that termites and cockroaches have a common ancestor, and that while the wings of the cockroaches have developed, those of termites have been in part eliminated.

Preliminary results obtained by Dr. E. Bäcklin and H. Flemberg with an improved apparatus for determining the charge of an electron by means of the oil-drop method give a value of  $4.800 \times 10^{-10}$  abs. e.s.u., which is in closer agreement with the value obtained from X-ray spectrographic data than the previously accepted value ( $4.752 \times 10^{-10}$ ).

F. C. Frank discusses the question whether the value for the electronic charge obtained from X-ray measurements on calcite may not be vitiated by imperfections in those crystals. From the work of Joffé on electrical conduction in calcite, he infers that imperfections (unfilled lattice spaces) exist; this would apparently increase the value of the electronic charge by about 1 part in 5,000.

In recording X-ray diffraction by gases, one may replace the photographic plate by a Geiger-Müller counter (for counting ionising particles), according to W. van der Grinten and Dr. H. Brasseur. The authors submit a curve of intensities obtained by passing X-rays through carbon tetrachloride gas, and deduce a value for the distance between chlorine atoms in good agreement with that previously known.

By seeding a brass alloy containing 52 per cent copper in process of solidification with copper crystals, and analysing with X-rays the orientation of the resulting crystals, A. B. Greninger finds a sequence of crystallisation from bottom to top: (1) copper crystal seed, (2) primary crystallised  $\alpha$ -phase having the same orientation as the copper seed, (3) large  $\beta$ -grains having a narrow rim of segregated  $\alpha$ -phase.

By means of apparatus which enabled them to sort out the atoms of positive from those of negative overall moment (of the same magnitude), J. M. B. Kellogg, Prof. I. I. Rabi and J. R. Zacharias find that the magnetic moment of both the proton and deuteron are positive.

DR. L. Infeld states that it is possible to formulate a simple unitarian field theory which, when used in the formula for the scattering of light by light derived by Euler and Kockel, enables the approximate determination of the fine structure constant.

Drs. N. Kemmer and V. Weisskopf have derived the deviations from the Maxwell equations caused by the existence of the positron in a manner free from the ambiguities formerly attached to this calculation.

The surface tension of certain soap solutions passes through a minimum and rises again with increasing concentration, while still remaining considerably below the surface tension of water. Gibbs's theory would then require that there should be more water and less soap in the surface layer than in the interior of the solution, which is not the case. Prof. J. W. McBain considers that the possible existence of another preliminary factor contributing to the lowering of surface tension, namely, the interchanging of positions between molecules of solute and solvent within a few molecular diameters of the surface, may explain the apparent paradox.

It has long been known that, under suitable conditions of illumination, the shadows of the retinal blood-vessels can be seen. Prof. R. W. Ditchburn has examined this effect with monochromatic light and finds that the shadows are much more easily seen with blue light than with green. Reasons for this difference are suggested.

F. Greenshields reports that in certain insects which lay eggs without fertilisation, the cells contain twice the basic number of chromosomes in the male (diploidy) and four times the number in the female (tetraploidy). This observation makes it necessary to find a new explanation for the sterility of the fatherless male offspring. It throws some light, on the other hand, on the 'pre-conjugation' observed during the maturation of the reproductive cells in the bee and gall-wasp.

A simple method of testing the homogeneity of wood, which may have been employed by famous makers of string instruments in the past, is described by Dr. K. Lark-Horovitz. It depends upon observing the heat conductivity of wood in different directions, by covering it with a thin layer of wax and noting the shape of the molten figure when a hot wire is applied to it at a given point.



## Research Items

### Racial Crosses in South Africa

In a study of racial problems in South Africa, which appears in the *Scientific Monthly* of February, Prof. H. B. Fantham, formerly of the University of the Witwatersrand, Johannesburg, records a number of observations of the results of crossing between the various racial groups in the population of the Union. Details are given of fourteen Eur-African crosses, ten Afro-Asian crosses and two Eurasian. Some of the Afro-Asiatic cases have European blood on the African side. There are also native hybrids, the ethnic melting-pot areas being the Kalahari (Bushman-Hottentot-Herrero-Bechuana), the junction of the Vaal and Orange Rivers (Bushman-Koranna-Hottentot-Bechuana) and the north-eastern Transvaal (BaPedi-BaThonga-BaVenda). While the predominant elements in the white population are English and Dutch, there are also survivals of Portuguese and Huguenots; and in recent times Germans and Jews, especially from Central Europe, have been added. There is also the Indian element and a remnant of Chinese labour. The 'Cape coloured', who are the result of Hottentot, Kafir and Malay admixture with Europeans since the days of early settlement, now equal in number one third of the white population. Some of the hybrid-coloured form distinct groups, such as the Griquas (Dutch-Hottentot-Bush) and the Rehoboth Bastards (Boer-Hottentot). A simple case of miscegenation, in which a fair-haired, blue-eyed Belgian married a Zulu woman, produced eight children, who classify themselves as black (2), white (2) and brown (4). In the first generation a 'black' woman married to a Zulu produced two black and two brown; a 'white' woman married to a Zulu produced one black and one white; while in the second generation a 'white' daughter who married her black cousin has a brown daughter. Of the fifteen descendants of the original couple, six approximate to the Zulu type (black), three to the European (white), and six are brown. Socially, the brown are despised by black and white alike. As a result of the observations, the racial crosses are not to be commended. The coloured race has neither the energy nor the persistence of the white, is less stable temperamentally, and is not controlled by the tribal conventions of the native.

### Barndoor Fowl in Egyptian Art

MR. G. D. HORNBLLOWER comments on the absence of the domestic fowl in ancient Egyptian art in describing a wooden spoon of unknown age and provenance, which he believes to be unique (*Ancient Egypt and the East*, 2; 1935). It was bought from a dealer in Cairo some years ago. Its dimensions are: length,  $8\frac{1}{2}$  inches; length of bowl,  $3\frac{3}{4}$  inches; breadth of bowl,  $1\frac{3}{4}$  inches. The bowl is delicately carved in an oval, such as is found in known specimens of the New Kingdom. The present example is remarkable in that it has a barndoor fowl carved at each end of the handle. The identity is clearly shown by the carriage and upright port of the tail, which differs from the drooping tail of the wild jungle fowl. The bird which usually decorates the finials of a spoon is the duck. The barndoor fowl, of which the

representation here appears to be unique, was not introduced into Egypt until the eighteenth dynasty, if not later. This late entry accounts for its absence in the history of art in the country. The conventions for pictures of ordinary life were fixed under the Old Kingdom, and were strictly maintained for later periods by religious conservatism. Therefore, although in Babylon the domesticated jungle fowl has some religious significance, in Egypt it was not admitted as a decorative element in art, unlike the duck and goose, which figure largely in the revered works of the Old Kingdom, and accordingly were admitted freely into later art.

### Mortality Rates for England and Wales

A NEW estimate of expectancy of life at various ages is given in the tables published in the Registrar-General's Decennial Supplement, England and Wales, 1931 (London: H.M. Stationery Office). Mortality rates show a great improvement in vitality at all but the most advanced ages. The improvement is most marked at the youngest ages. The probability that an infant will die within a year of birth has decreased between 1931 and 1911 by as much as forty per cent. On the other hand, at advanced ages the 1931 mortality rates are rather heavier than those of 1921 or 1911. The deterioration is compared with the 1921 rates; it first becomes apparent at sixty-nine years of age in males and at seventy-eight in females. This is attributed partly to the survival in the present generation of many of the weaker members of the community, who under former conditions would have succumbed before old age was in sight. The geographical distribution of mortality is of interest. It is heaviest among both sexes in the north of England, and becomes lighter towards the south. In county boroughs, that is, urban areas, mortality is usually heaviest for both sexes, and in rural districts where mortality is lightest the male rate is much lower in relation to the general average than the female. Detailed tables for Greater London show that the male death rates in that area are lighter than for the average of England and Wales up to forty-five years of age, and the female rate is lighter at all ages. However, the outer ring or London suburban area shows a lighter death rate for both sexes than the country as a whole, and lighter than the rates for other urban areas.

### Munida from the Falkland Islands

MR. G. W. RAYNER makes some very interesting observations on the two closely related species of *Munida*, *M. subrugosa* and *M. gregaria* (Discovery Reports, 10, 209-245; 1935). These two crustaceans are of much importance as food, especially for the whalebone whales, but also for the southern sea lions, fishes and sea-birds, the free-swimming post-larva of *M. gregaria* (the so-called "Grimothea") being met with in large swarms, sometimes covering an area of four miles in length. The larval stages are described, but the two species are much alike and have not been differentiated until the post-larval stage is reached. They are like *Galathea* in many ways and seem to link this genus with the larval species of *Munida* so



far known. The material available is large, especially of *M. subrugosa*, enabling the growth and distribution, as well as probable breeding seasons, of both species to be worked out. The gradual development of the male and female pleopods is described and figured in detail. Several parasites and epizoa are recorded. *M. subrugosa* is apparently more numerous in these regions, but not found in any numbers below 200 m.; both species occur near the coast, *M. gregaria* being remarkable for its neritic distribution and for the swarming habits of the post-larvæ, which have long been known. None of these peculiar swarms occurs far from land. They may be so dense as to give the water a reddish tinge, each swarm being spherical and from one to four feet in diameter, the patches looking like swarms of bees, with the individuals incessantly in motion.

#### Gastropods from the Dutch East Indies

THE larger marine gastropods from warm waters are well known, and there are no new species in the splendid collection of Mitridæ and Terebridæ now described by Dr. Dautzenberg (*Gastéropodes Marins*. 1.—Famille Terebridæ. 2.—Famille Mitridæ. Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises de LL.AA.RR. le Prince et la Princesse Léopold de Belgique. Mémoire du Musée Royal d'Histoire Naturelle de Belgique. Hors Série. Vol. 2, Fascicule 17, 1935.) Numerous striking forms familiar to conchologists are recorded, most of which have a wide distribution. The synonymy lists of some of them are enormous, sometimes filling two or three pages—in the case of *Mitra episcopalis* and *Terebra crenulatus* and *maculata* they occupy more than four each. Only the shells are described. The collecting grounds in these regions must be exceedingly prolific, judging from the present monograph consisting of 208 pages and illustrated by beautifully coloured plates. Besides the better-known and larger forms there are several small species of *Mitra* and allied genera, and here there are several new varieties and new names, whilst there are a few new varieties and new names among the species of *Terebra*.

#### Marine Fishes of Nova Scotia

Two descriptive accounts of the marine fishes of regions not adequately dealt with hitherto have recently been published. In a paper on "The Marine Fishes of Nova Scotia" (*Proc. Nova Scotian Inst. Sci.*, 19, Pt. 1, December 1935), by Vladykov and McKenzie, a complete review is given of all the marine and anadromous fishes (151 species) found around the Nova Scotian coast, with the exception of the Gulf of St. Lawrence. The area under survey lies roughly between latitudes 42° 15' N. and 47° N., and between longitudes 57° W. and 66° 45' W. It covers approximately fifty thousand square miles of coastal and 'bank' waters. A key, designed to assist the non-specialist in the identification of native fishes, is given, and 129 outline drawings accompany the descriptions.

#### Soil Conditions and Lily Growth

THE Lily Conference of the Royal Horticultural Society held in 1933 raised some important questions as to the relation of certain lilies to the kind of soil in which they were grown. Dr. M. A. H. Tincker examined a large number of soil samples, showed that these plants were widely tolerant to acidity and

lime content, and has more recently published the results of his experiments on drainage conditions ("Experiments with Lilies at Wisley", R.H.S. Lily Year Book, 1935, pp. 68-75). Lily bulbs planted in the resting condition are very susceptible to water-logging. This fact was established for several species by culture in pots, where the drainage could be controlled artificially, and by plantings at various levels upon the side of a ditch. It is an interesting point that two of the species tested, namely, *Lilium pardalinum* and *L. superbum*, are found naturally in semi-swamp conditions; but an examination of the published records indicates that the bulbs were always well above the water-table.

#### Reserve Materials in the Felled Tree

AN interesting paper by S. E. Wilson on "The Fate of Reserve Materials in the Felled Tree" (*Forestry*, 9, No. 2; 1935) is of interest since it would appear to afford some light on seasoning investigations. As is well known, forest trees are usually felled in the winter when the sap wood contains abundant reserve food materials. These, as starch, sugar, fat materials, etc., occur within the living storage cells. The fate of the reserve materials is now shown to depend on the treatment of the timber after felling. If the log is kept whole, and the bark retained to prevent rapid drying, the storage cells continue alive until all reserves are exhausted; whereas if the timber is converted quickly, and the cells killed by desiccation or kiln-heat, the reserve materials remain intact and cannot thereafter be removed by any known treatment. Timber containing reserve materials is shown to be a ready prey to wood-tunnelling beetles, for example, *Lyctus*, and sap-staining fungi. The author puts forward suggestions for the co-operation of forest botanists with timber technologists in order to extend the knowledge of these important reserve materials with the view of the better utilisation of British (and it may be added tropical) timber trees.

#### Geology of Kap Dalton, Greenland

ONE of the three areas in Greenland where Tertiary sediments have been found is Kap Dalton in East Greenland. Here, well-preserved marine fossils and plant remains occur together, the age being probably Lower Eocene. During a second visit to the locality, a conglomerate consisting entirely of pebbles of igneous rocks—including highly alkaline types—was discovered at the base of the sediments by L. R. and H. G. Wager. In a report on the geology, L. R. Wager devotes special attention to these rocks, since they represent types not previously met with in the North Atlantic Tertiary Province (*Medd. om Grønland*, Bd. 105, No. 3; with coloured geological map and 6 plates of photomicrographs). The varieties described include malinite, monchiquite, kersantite, tinguaitite, soda-trachyte, trachyandesite, trachybasalt, leucite-nephelinite and nepheline-leucite. It is suggested that the pebbles are derived from a volcanic area, injected by hypabyssal and plutonic rocks, which once overlay the region about Davy Sound, and that the known alkaline intrusive rocks of Cape Parry, Cape Fletcher, Antarctic Harbour, etc., may be remnants of the same igneous field. The evidence available in 1918 suggested to Holmes that the later phases of igneous activity in the North Atlantic were the more alkaline; Wager now presents evidence that the earliest phases were also characterised by highly alkaline types. The petrological problem



offered by the area is like that of the Permo-Carboniferous association, in the Midland valley of Scotland, of vents of basic alkaline types with sills and dykes of quartz-dolerite.

#### Geology of San Juan, Colorado

THIS region is one of unusual geological variety and interest, and the summary description now presented by Whitman Cross and E. S. Larsen (U.S. Geol. Surv. Bull. 843, 1935) will be widely welcomed as a preliminary to the more detailed studies now in preparation. A long succession of Pre-Cambrian events is displayed in the San Juan Mountains, including the formation of important series of injection complexes. At some time between the late Pre-Cambrian and late Jurassic a stock of alkaline rocks was intruded about Iron Hill. The oldest rock of this complex is a limestone, believed to be of hydrothermal origin. This was followed by uncomphagrite, a coarse-grained melilite-rock, which in turn was followed by a large mass of pyroxenite. There were intruded successively ijolite, nepheline-syenite, syenite, nepheline-gabbro, and finally quartz-gabbro. The increasing silicification of the rocks is notable. Beginning in the Miocene, the great accumulation of volcanic rocks that makes up most of the mountains was built up. These are mainly andesites, quartz-latites and rhyolites with associated breccias and tuffs; they include the extensive Potosi series of the Miocene and, after the reduction of the region to a fairly smooth surface (the San Juan peneplain), the almost equally extensive Hinsdale series of the Pliocene. In Quaternary time, after the earliest stage of glaciation (three stages have been recognised) local flows of andesite were erupted in the south-east. The region has been famous for its sources of gold and silver, with some lead, zinc and copper. The deposits occur mostly about intrusive bodies of Tertiary age or along faults in the volcanic rocks.

#### Reception of Wireless Signals Underground

THE penetration of electric waves through the surface layers of the earth and the consequent possibilities of wireless reception underground are subjects of important scientific and technical interest. In a recent paper (*Hochfrequenztechnik und Elektroakustik*, 47, 12; 1936), Dr. D. Doborzynski describes the results of an experimental contribution to this subject. Simple tests of broadcast reception on the medium-wave band (250–550 m.) were carried out in two caves at the village of Ojców, near Cracow, Poland. These caves are about 20 metres and 25 metres respectively below the ground and are situated in the limestone region of the Jura Mountains. The caves are very wet inside, and stalactite and stalagmite formations are present. The experiments were made in the evening in July and August, 1935; and, using an inverted L aerial, the successful reception of signals from various European broadcasting stations was obtained at distances ranging up to 1,000 km. Although no actual measurements were made, the signals, in general, appeared to be of the same intensity as those observed under similar conditions on the surface of the ground above the caves. In the case of the local broadcasting station at Cracow, 17 km. away, there was a noticeable reduction in the signal intensity in the caves over the values observed on the surface. This matter is to receive special attention in a more detailed investigation to be carried out in the future.

#### Enzyme Action in Heavy Water

THE reports on the influence of heavy water on biological processes, including enzyme action, have been conflicting, and the data so far obtained for enzyme action are too meagre to be properly evaluated. Amylases catalyse hydrolytic reactions in which water is an important factor, and M. L. Caldwell, S. E. Doebbeling and S. H. Manian (*J. Amer. Chem. Soc.*, 58, 84; 1936) have described experiments with preparations of pancreatic amylase of exceedingly high purity and activity. The heavy and ordinary water used were carefully purified and were shown to be free from oxidising substances (ozone and hydrogen peroxide). It was found that 100 per cent heavy water has no marked influence on the hydrolysis of starch by pancreatic amylase, provided the conditions of the experiments are such as to minimise the deterioration of the enzyme. The inactivation of pancreatic amylase, however, is more rapid and more pronounced when the amylase is held at 25° in highly purified heavy water than in similarly purified ordinary water.

#### Approximate Heat Capacities of Gases

THE failure of the equation

$$C_p = a + bT + cT^2$$

to represent heat capacity data over large ranges of temperature has led to several other attempts to obtain a useful and sufficiently accurate formula. I. N. Godnev (*J. Amer. Chem. Soc.*, 58, 180; 1936) shows that the equation

$$C_p = C_{p_0} + \sum \varphi(\theta_x/T) + aT + bT^2$$

holds very satisfactorily if  $C_p$  is the value calculated from spectroscopic data, and  $\varphi(\theta_x/T)$  is the Planck-Einstein function, tables of which are available. The equation was applied to carbon monoxide, nitrogen and sulphur ( $S_2$ ) in the range 100°–5,000° K., in which interval it is allowable to put  $b = 0$ . The value of  $\varphi$  is taken, in these cases, for two degrees of freedom. This equation is not at all cumbersome in use, and its extension to other gases would be interesting.

#### Gasoline Efficiency

DR. M. R. FENSKE, of the Pennsylvania State College, recently reported to the American Chemical Society on the progress made by scientific workers in increasing gasoline efficiency. According to Science Service, of Washington, D.C., he emphasised the fact that efficiency of the modern gasoline engine depends on compression ratio. As this ratio is increased, 'knocking' appears, unless the octane number of the gasoline is correspondingly increased. Average automobile gasolines have an octane number of about 70 and gasolines of the ethyl type 78–80. Last year, however, chemists produced a gasoline having an octane rating of 92. One million gallons of this was ordered by the United States Government for use in army and navy aeroplanes. A similar quantity is to be delivered to the Government during the first six months of this year, and an intimation has been given that in future orders the octane number will again have to be increased. The primary cause for stress on gasoline efficiency is that the more miles of flight a gallon of fuel can produce the greater is the load the aeroplane can carry, and the longer its range of flight. These factors are of vital importance in the case both of commercial and bombing aeroplanes.



## Progressive Change in the Form of Growth Gradients

### GROWTH GRADIENTS IN THE ABDOMINAL LIMBS OF THE SHORE-CRAB

By Prof. J. S. Huxley

THE re-analysis of Shen's data (1935) on early post-larval development in *Carcinus maenas* has proved interesting in showing a graded change with time in the shape of the growth gradients of the abdominal appendages. Dr. J. H. Day's work on the abdominal segments of the same species (see below) has led to similar conclusions. Since the phenomenon has not previously been recorded, at least in quantitative terms, it was felt advisable to publish simultaneous notes on the subject.

Each point in the graphs in Figs. 1 and 2 represents a single individual, so that the results cannot pretend to such accuracy as Day's. None the less, the general results are clear. Two main phases are involved: (1) a chiefly regressive phase, during which the large Megalopa limbs are converted into the post-larval type; (2) a progressive phase, during which those limbs represented in the adult show varying degrees of high positive heterogony. At the 5th or 6th instar, there is evidence of the onset of a third phase, of stabilisation (and we may presume that sexual maturity will introduce yet a fourth growth phase). Growth-coefficients ( $k$ ) have been calculated according to the formula  $y = bx^k$ : carapace breadth has been used as standard ( $x$ ). When, as during the regressive phase, a part diminishes in absolute size, the growth-coefficients have been given a negative sign: these cannot have the same biological significance as ordinary growth-coefficients, but serve to show the relative intensity of regression.

In males (Fig. 1) the regressive phase becomes more active in stage B than at the metamorphosis (A), except that the first abdominal (first copulatory)

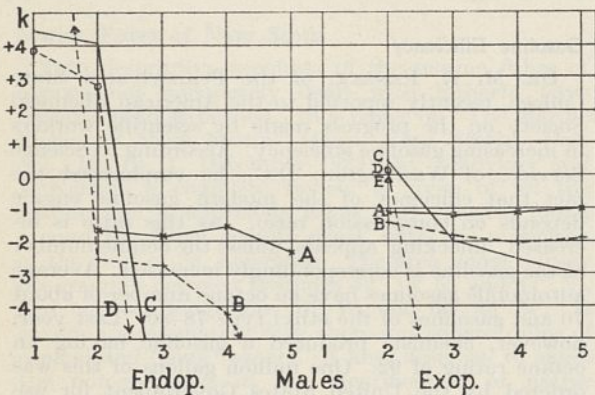


FIG. 1. Growth-gradients of endopodites and exopodites of the abdominal limbs of male *Carcinus maenas* in successive stages. Ordinates, growth-coefficients ( $k$ ); abscissae, abdominal limbs. Stages: A, metamorphosis (megalopa to 1st young crab instar); B, 1st-2nd instar; C, 3rd-4th; D, 4th-5th; E (shown for exopodites only), 5th-6th. Arrows indicate growth-coefficients of, or approximating to, infinity.

appendage, represented by endopodite only, first appears then. The second copulatory appendage does not begin positive growth until the next moult. The regressive gradient after stage A has its high

point posteriorly; the later positive gradient of appendages 1 and 2 has its high point anteriorly. The interaction of the two gradients is clearly shown, notably by the exopodites. These are all destined to disappear; but owing to the presence of the region of high growth in limbs 1 and 2, the regressive gradient in stage C is tilted upwards anteriorly;

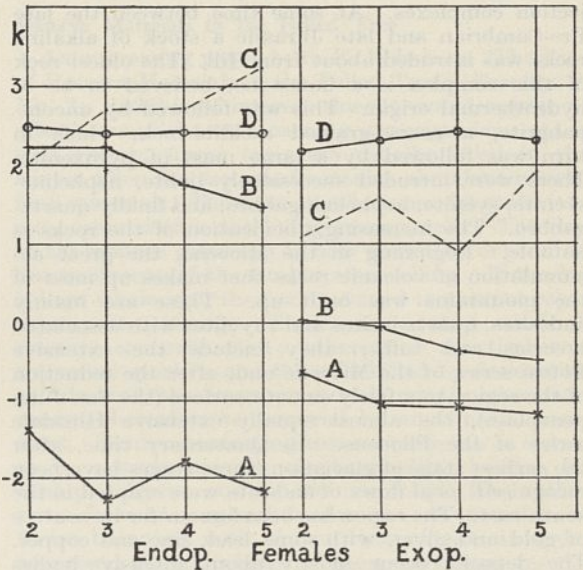


FIG. 2. Similar to Fig. 1, but for females. Stages: A, metamorphosis (as in male); B, 1st-3rd instar; C, 3rd-5th; D, 5th-7th.

exopodite 2 actually acquires positive growth-intensity in stage C, and in subsequent stages only loses it gradually. We can say that it is made to postpone its disappearance by becoming temporarily infected by the high positive growth-intensity in the endopodite and in limb 1. The intensity of growth-change, whether regressive or positive, is greater in each phase in the endopodites.

In females (Fig. 2), this last rule also holds. The tendency for regression to be more intense posteriorly is also obvious. But during the succeeding phase of positive heterogony, the high point is posterior (clearly shown in endopodites, stage C), perhaps in correlation with the similar-shaped gradient in abdominal segments (see Day's note). The gradient for the next stage (stability) is practically horizontal.

To sum up, both sexes show evidence of different growth-gradients succeeding each other in the same region, and the changes in growth-gradients are themselves graded. The changes in the female might be produced by a mere change of sign, but in the male a new growth-centre clearly originates in the anterior region, confirming Day's suggestion. Any changes are usually shown at an earlier stage by the high point of a gradient than by its lower portions. In addition, there is always a medio-lateral growth-gradient, shown by the fact that the growth-changes in the endopodites are always more intense (and are initiated earlier).



GROWTH GRADIENTS IN THE ABDOMEN OF THE SHORE-CRAB

By Dr. J. H. Day, Armstrong College Newcastle-on-Tyne

A STUDY of the growth gradients in the abdomen of *Carcinus maenas* gives results which may have a wider application.

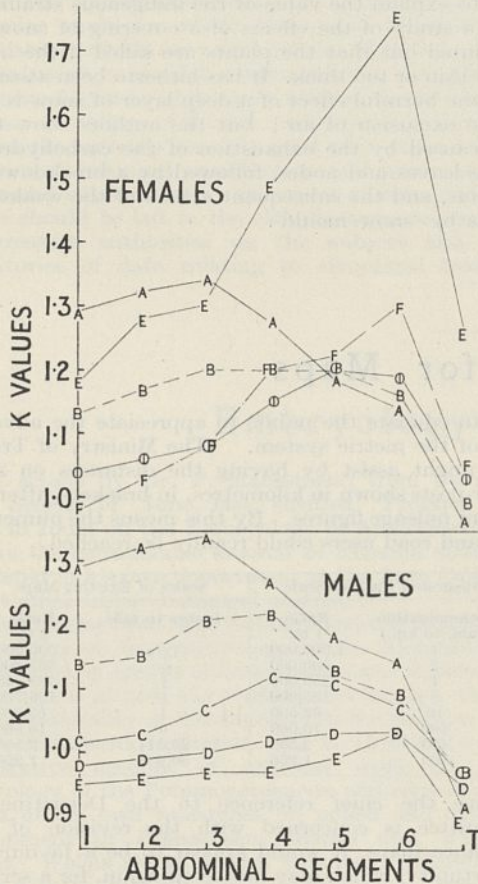


FIG. 3. Graphs of growth-gradients of males and females showing the distribution of growth-potential along the abdomen at different stages A, B, C, D, E and F. Sizes: (in carapace length range): A, 1.5-3 mm.; B, 3-6 mm.; C, 6-12 mm.; D, 12-21 mm.; E, 21-36 mm.; F, 36-55 mm. CD, denoted by  $\Phi$ , are identical in the female and EF, denoted by  $\Sigma$ , are identical in the male.

Measurements of the breadth of the abdominal segments taken from 560 crabs of all ages were plotted against the body-size on a double logarithmic grid. Growth coefficients were then determined from the value of  $k$  in Huxley's formula  $y=bx^k$ . A graph giving the distribution of these  $k$  values along the abdomen shows changes in the shape of the growth gradients of that organ during development (Fig. 3).

In the youngest or 'unsexable' crabs (graph A) the growth-centre or peak of the curve lies in segment three; at maturity (graph E) the growth-centre is in segment six. The intervening stages (graphs B, C, D) mark a transition from one centre to the other.

It must be stressed that gradients in the abdomen are parts of a more general gradient permeating the whole body, and that a change in one affects the other. Dealing only with the local gradients, however, it may be said that there are two possible explanations of the change in the position of the growth-centre. (1) The growth-centre actually migrates from segment three to segment six. (2) The growth-centre in segment six is of separate origin and its activity increases while the influence of the proximal centre declines, so that the high point of the curve moves from one centre to the other. These two possibilities are not mutually exclusive.

The arguments in favour of a separate origin of the growth-centre in segment six are too lengthy to be set out in detail here, but it may be stated that sexual differences in the growth of the abdomen appear first in the sixth segment, but not in the proximal segments until sexual maturity. The growth-centre in segment six is thus differential in regard to sex, whereas the proximal one is not. Also the distal growth-centre arises when differences in sexual appendages first becomes marked, and its influence increases with approaching maturity, when it dominates the growth of the whole abdomen. For these reasons we may correlate the gradient of which this is the centre with the phases of sexual development and call it a sexual growth-gradient.

It is believed that this is the first recorded case of an organ passing from the influence of one gradient to another, the second of which is correlated with sexual development.

A full report of this work has recently been published in the Report of the Dove Marine Laboratory (Third Series, No. 3).

Winter Hardiness of Crops

IN the U.S.S.R., where autumn-sown cereals may experience temperatures so low as  $-20^{\circ}\text{C}$ ., or a covering of snow for two or three months, winter hardiness, and particularly frost resistance, is an important aspect of crop studies. A recent publication of the Institute of Plant Industry (*Bull. App. Bot., Genetics and Plant Breeding*, No. 6, Series 3, Leningrad, 1935) is devoted to contributions on this subject, some of these coming from the Winter Resistance Laboratory of the Institute; adequate English summaries are provided.

Determinations of frost resistance were made by

bringing the plants, with the roots undisturbed in the soil, to the laboratory and subjecting them to temperatures such as  $-14^{\circ}\text{C}$ . The results show that the capacity of a crop to survive after such low temperatures varies during the winter period, and that it is much influenced by the conditions of growth in the vegetative period prior to the arrival of frost. Thus, the plants investigated became 'hardened' when subjected to suitable weather conditions in the autumn. The authors emphasize that, while it is important to sow in time for the crops to become 'hardened' before the advent of the severe



weather, it is equally important that the crop should not be so advanced that it emerges from the state of hardness before winter is over. Whether or not a plant is in the state that it can acquire or retain hardness, cannot be judged by external appearance; it is governed more by the stage of development than by state of growth.

In Great Britain, capacity to withstand water logging is a more important aspect of winter hardness than frost resistance, and it is interesting to note from these contributions that 'hardening' increases resistance to water-logging as well as to frost, and that the curves of both were similar from the time of sowing throughout the winter.

Moshkov makes an interesting contribution on photoperiodism and hardness, showing how plants introduced from regions of comparatively short day-length display a lowered resistance to frost when grown in regions with a greater length of day, such

as near Leningrad; the resistance is restored if the plants are shaded for some hours daily in such places, thus artificially shortening the day. The author is of opinion that plants are not so winter hardy when grown in places having a day-length differing from that of the region where they grow in the wild state. This work will probably throw light on some important problems connected with the introduction of strains of pasture plants from country to country, and help to explain the value of the indigenous strains.

In a study of the effects of a covering of snow, it is pointed out that the plants are killed if the layer is too thin or too thick. It has hitherto been assumed that the harmful effect of a deep layer of snow is due to the exclusion of air; but the authors show that it is caused by the exhaustion of the carbohydrates in the leaves and nodes, followed by a breakdown of proteins, and the subsequent attack of the weakened plants by 'snow mould'.

## Metric System for Maps

WE have received a copy of the memorandum submitted by the Council of the Decimal Association to the Departmental Committee on the Ordnance Survey, appointed by the Minister of Agriculture and Fisheries, now sitting. The memorandum urges the adoption of the metric system for British maps.

The Association is naturally strongly in favour of the suggestion of the Director-General of the Ordnance Survey that a metric grid for maps of Great Britain would be preferable to a yard grid (see NATURE, February 1, p. 196). It also directs attention to the want of simplicity which exists among the present scales of maps. Of the eight different scales, only three are simple ratios to the actual. The Association agrees with the Director-General that if a grid system is adopted there are great advantages in having map scales exact multiples of one another.

In the accompanying table the existing Ordnance Survey scales are contrasted with the scales which it is suggested should replace them.

"It will be seen," the memorandum remarks, "that, with one exception, there is only a negligible difference of ratio between the existing and the suggested improved scales." Whether these changes could be brought about or not must largely depend on being

able to educate the public to appreciate the advantages of the metric system. The Ministry of Transport might assist by having the distances on road finger-posts shown in kilometres, in brackets, after the present mileage figures. By this means the numerous map and road users could readily be reached.

Suggested Natural Scale		Scales of Existing Maps	
Denomination (mm. to km.)	Ratio 1 to	Inches to mile	Ratio 1 to
1	1,000,000	$1\frac{1}{25}$	1,000,000
2	500,000	$\frac{1}{10}$	633,600
4	250,000	$\frac{1}{4}$	233,440
8	125,000	$\frac{1}{2}$	126,720
16	62,500	$\frac{1}{1}$	63,360
100	10,000	6	10,560
400	2,500	25,344	2,500
800	1,250	50,688	1,250

Since the chief reference to the Departmental Committee is concerned with the revision of the Ordnance maps, it would appear to be a favourable opportunity, which may not occur again, for a serious consideration of the adoption of the metric system, now used in every Continental country. At the same time, a simplification of the scales could be taken in hand. Anyhow, nothing, we suggest, should be done to hamper the eventual adoption of the metric system, if it cannot be introduced at present.

## Design of Cargo Steamers

IN the aftermath of the Great War, probably no branch of activity suffered so much disorganisation as that of shipbuilding. To make good the deficiencies of the moment, standard ships were hurriedly built with little or no relation to the particular work which each would have to do, and with inadequate attention to other details of design. The lean years which followed made the times difficult even for the most efficient of fleets, and, without any foundation on which to build up a post-War policy, the business of shipbuilding has been in much the

same plight as a ship the steering gear of which has broken down.

From this unsatisfactory condition there is now some prospect of release, and in a paper entitled "New Cargo Steamers: Efficiency Problems" read before the North East Coast Institution of Engineers and Shipbuilders on March 6, Mr. J. Leslie Batey discusses the question of obsolescence and its bearing on the probable demand for new tonnage. A chart showing tonnage under construction in the United Kingdom since 1911 and the corresponding figure



of twenty years earlier gives a clear idea of the author's view that there will, in the next five years or so, be a considerable increase of shipbuilding, and, therefore, of prices above the present low levels. He points to the advantage, where immediate profits can be dispensed with, to be derived from building when prices are low and obtaining a few years later enhanced rates together with capital appreciation.

On the technical side it is shown that for efficiency, design and specification must be suitable for the particular trade for which the vessel is intended, that features which are nothing more than fads must be eliminated, and that accommodation for officers and crew should be such as to attract the best type of men. Drawings of the S.S. *Dumfries* are appended to show the author's idea of a good plain cargo vessel with a well-balanced specification and arranged on simple and efficient lines. Questions of strength and weight should be left to the classification societies as the greatest authorities on the subject and the depositories of data relating to structural trouble

experienced with ships in service. Stream-lining of the rudder and stern frame is recommended as one of the conditions essential to efficiency.

On the subject of service speed, the author indicates the retarding effects on a vessel in a sea-way due to rolling, pitching, heaving and yawing, and the additional fluctuations due to orbital velocity of the surface of the water which in waves 6½ ft. high and 100 ft. in length has been found to be as much as 2¾ knots. To maintain the service speed against such adverse conditions, he considers it advisable to give the vessel a form suitable for a speed ½–3 knots (according to trade) in excess of the service speed demanded, and suggests that on trial the engines should be able to develop 15 per cent surplus power on the Skelmorlie mile (or 10 per cent on Hartley). As a standard of propulsive efficiency, Ayre's basis is taken and data are adduced regarding four types of vessel, including one of the *B* Standard vessels, and their performances are analysed and compared in detail on this basis.

## Embryology of Angiosperms

AN article by Dr. P. Maheshwari from *Current Science* of June last, entitled "Progress of Work in India on the Embryology of Angiosperms", reviews the considerable amount of research already completed in his own department at the Agra College and at other Indian botanical centres.

Contributions from Agra include a series of papers by B. M. Johri on the embryology of the Alismataceæ as illustrated by species of *Limnophyton* and *Sagittaria*, with a review of previous work on the family: there is some variability in development in the embryo-sac and in endosperm formation. B. L. Gupta gives a comparative account of previous work on the embryology of the Potamogetonaceæ and contributes results of his own researches on pollen and ovule-development in *Potamogeton crispus* and *Wolffia arrhiza*. *Wolffia* shows several important differences in this respect from the allied genus *Lemna*. Similar work on the Centrospermales is found in studies by H. R. Bhargava on *Boerhaavia* (Nyctaginaceæ) and *Mollugo* and *Trianthema* (Aizoaceæ) and by V. Puri and B. Singh on *Digera* (Amarantaceæ). In a comparative review of embryological work on the

Centrospermales, Puri and Singh suggest the separation of the Portulacaceæ, Basellaceæ and Caryophyllaceæ as a distinct order. Species of *Neptunia* (Mimosaceæ), *Eclipta* (Compositæ) and *Cuscuta* have also been studied. In a paper on the gametophytes of *Berberis nepalensis*, Johri discusses the relationship between the families Ranunculaceæ and Berberidaceæ. The marked similarity in members of the two families in sporogenesis and gametogenesis suggests their close alliance in spite of differences in floral structure which have been used to separate them in distinct orders.

Dr. Maheshwari introduces a study of the life-history and anatomy of *Ephedra foliata* with an account of the development of the two gametophytes. With B. Singh he contributes an account of the morphology and anatomy of the fern, *Ophioglossum fibrosum*. In his general article referred to above, he stresses the importance of a study of the plants in their entirety in approaching a natural system of classification. He also refers to the serious difficulty arising from paucity of literature in India, and pleads for a more general exchange of reprints and journals.

## Experiments in Salmon Marking in Norway, 1935

A NOTABLE paper has just been published by Prof. Knut Dahl and Sven Sømme on this subject (*Statens Forsøksvirksomhet for Ferskvannsfiskeri, Oslo. I. Matem.-Naturwid. Klasse, 1935. No. 12*), and it is demonstrated that *Salmo salar* has a wider range in its migratory movements than was supposed, or at any rate than had been proved in Europe.

The Scottish coastal marking carried on for a number of years in the Moray Firth and east and north coasts of Sutherland certainly resulted in a

large number of recaptures and records published by the Fishery Board for Scotland—up to 38 per cent of the fish marked in one of the seasons—and shed a good deal of light on the movements of fish round the coast. Indications were collected also from the capture of salmon, at infrequent intervals, at far distant points, that the Atlantic salmon ranged widely. But the Norwegian results now published prove this to be the case.

The authors are of opinion that the high percentage of recaptures—reaching 48 per cent—is due really



to the fact that the marks used had the place of origin indicated upon them ("Zool. Museum, Oslo") as well as a distinguishing number, and that on this account the reporting of recaptures was more complete. In the Scottish operations we relied upon a wide circulation of the occurrence of the marking and the offer of rewards, but on one or two occasions it did happen that the report of a recapture was obtained only after the fish had made a railway journey to market. Also, the Norwegian marks were inserted not in the base of the dorsal fin, but were wired through the back just in front of the dorsal fin, where the mark was more conspicuous.

The greatest distance recorded from the Scottish marking was about 620 miles, being the shortest distance from the Spey round the north of Scotland to the Eden in Cumberland. On the Pacific coast of North America 'tagging' had shown greater distances than this, and operations at the Alaskan Peninsula had yielded not only long distances but also some interesting information about the pace of travel at different times of the year. Newspaper reports had even told of a salmon (*Onchorynchus*) from this set of operations that followed the line of the Aleutian Islands and had been captured in Kamchatka by Japanese fishermen. This journey is well over 1,000 miles. From the west of Vancouver Island also fish had gone south to the Columbia River, a distance of 800 miles.

The Norwegian records now give one example of a fish having travelled from Titran on an island off the Trondhjem Fiord, north to the Wyg River in the Gulf of Omega in the White Sea, a distance of 2,500 kilometres, which is approximately 1,500 miles. Lesser distances are 1,100 km., 800 km. and 700 km. It is interesting to notice also that one fish, marked at Rong not far from Bergen, had gone south-west across the North Sea to Montrose, the interval of time being 19 days and the distance 550 km., which is approximately 350 miles.

This paper opens up a new vista of the range of *S. salar*, and some interesting particulars are given also about smolt marking carried out by Dr. Gunnar Alm in the Baltic, and showing wide movements.

W. L. CALDERWOOD.

## Educational Topics and Events

LONDON.—Mr. D. G. Catcheside, lecturer in botany in King's College, has been awarded a Rockefeller fellowship in cytological genetics. He is to spend a year in Dr. T. H. Morgan's laboratory at the California Institute of Technology, Pasadena, beginning in September 1936.

ST. ANDREWS.—The Senatus Academicus has resolved to confer the honorary degree of LL.D. on the following, among others, at the graduation ceremonial to be held in June: Mr. David Anderson, of the firm of Messrs. Mott, Hay and Anderson, consulting engineers, London; Prof. J. E. Littlewood, Rouse Ball professor of mathematics in the University of Cambridge; Major F. J. J. Ney, executive secretary, National Council of Education of Canada, Toronto, Canada; Prof. E. W. Reid, emeritus professor of physiology, University College, Dundee.

SHEFFIELD.—Lord Crewe, Chancellor of the University, will open the new University Students' Union building on Saturday, May 2. The building was made possible through the generosity of Alderman J. G. Graves, who gave £15,000, the cost of the building. Before opening the building, Lord Crewe will confer honorary degrees upon the following, among others: Sir Charles Grant Robertson, Vice-Chancellor of the University of Birmingham; Sir Harold Hartley, vice-president and director of scientific research of the L.M.S. Railway Company; Sir Frank Smith, secretary of the Department of Scientific and Industrial Research and secretary of the Royal Society; Sir Harold Carpenter, professor of metallurgy in the Royal School of Mines.

THE American National Research Council has administered during the past sixteen years a post-doctoral fellowship scheme, financed by the Rockefeller Foundation, involving the expenditure of nearly four million dollars. It seems that the Foundation, while continuing to take a keen interest in the post-doctoral fellowship principle, will not continue its support on the same scale and in the same way as in the past; and some anxiety has, in consequence, been aroused in university circles as to ways and means for ensuring the maximum of opportunity for minds capable of productive scholarship. At the thirty-seventh annual conference of the Association of American Universities held at Cornell University last November, this question was discussed in papers by Prof. F. R. Lillie of the National Research Council, Dr. K. T. Compton, president of the Massachusetts Institute of Technology and Dr. Ray Lyman Wilbur, president of Stanford University. The National Research fellowships are comparable in aim and scope with the fellowships instituted in Great Britain in 1891 by the Royal Commission for the Exhibition of 1851 and, like them, have this great advantage over fellowships awarded by universities, that the field of selection is enormously wider. Dr. Compton's paper outlined an ingenious plan, the essential features of which are: the offer by each of a group of associated universities of fellowships for research to be carried out within it, and the assumption of the task of selecting fellows by an independent board which receives applications from candidates throughout the country. A schedule of stipends uniform for all the universities would tend to prevent candidates' choice from being influenced by financial considerations. Such a scheme would, Dr. Compton believes, if subscribed to by a sufficient number of universities, be subsidised by the Rockefeller and other foundations.

HARVARD UNIVERSITY celebrates this year the three-hundredth anniversary of its foundation. The occasion is to be marked by inaugurating two schemes of high importance, the outcome of what is termed "a new appraisal of the University's place and function in the life of the nation". One of them is for the creation of 'university professorships' of a novel kind, affording to teachers and scholars of unusual scope and ability broader opportunities than have hitherto been available in American universities. The Harvard authorities are impressed by the realisation that all subjects which are intensively studied lead into other subjects, and the occupants of the new chairs, while not exactly "professors of things-in-general", will be limited by the scope of their own



interests rather than by the traditional division of subjects. It is hoped by this means to "fortify the university as a whole in contrast to its separate parts or departments". It is sought to obtain for each chair an endowment of half a million dollars to provide not only an adequate salary, but also an allowance for assistants, both for instruction and for investigations. In thus safeguarding itself against departmentalism—that insidious disease incidental to the growth of specialisation in universities—Harvard has given a lead that may prove to have very far-reaching results. It stands for a movement the very antithesis of the tendency, exemplified in Russia, to abandon the ideal of a great community of scholars working in all fields in the best environment in which to promote breadth of understanding, and to substitute that of separate schools or research institutes each concentrating upon its own field in isolation. The other scheme is for "national scholarships" intended to open the door of opportunity for study at a great endowed university to more of the most promising youth from every part of the country. They are to provide "as much as may be needed up to \$1000 in the first year and \$1200 thereafter" and will not carry an implication that all the recipients are poor.

## Science News a Century Ago

### The British Museum

*The Times* of April 13, 1836, commenting on a return dealing with the British Museum issued in April 1836, said: "The receipts of the British Museum last year were £19,603 8s. 0½d., of which the public money voted by Parliament amounted to £19,076 4s. 6½d., leaving a balance of £527 3s. 6d. The estimated expenditure for the present year is £23,600. . . . There is in the present estimate a special item of £2,000 for the purchase of manuscripts, and another of £500 towards making moulds of the Elgin marbles. The principal item in which there is an increase this year is in salaries to the minor officers and servants . . . and to a provision for an increased number of copyists for the purpose of furnishing the public in the reading-rooms with a complete catalogue of the printed books within the current year. . . . The number of visitors to the general collection last year was 289,104."

### Airy's Lectures at Cambridge in 1836

WHEN Airy was appointed Astronomer Royal, he stipulated that he should be allowed to give a final course of lectures at Cambridge. Lord Auckland, the First Lord of the Admiralty, agreed to this, but his successor Lord Minto refused the necessary permission. When this was known in Cambridge, a petition was sent to Lord Minto, who then yielded. Referring to this in his "Autobiography", Airy wrote: "On April 18 I went to Cambridge with my wife, residing at the Bull Inn, and began Lectures on April 21st: they continued [apparently] to May 27th. My lecture room was crowded [the number of names was 110] and the lectures gave great satisfaction. I offered to the Admiralty to put all the profits in their hands, and transmitted a cheque to the Accountant General of the Navy: but the Admiralty declined to receive them."

### The Royal Society

At a meeting of the Royal Society held on April 21, 1836, Murchison being in the chair, a communication from Prof. J. F. Daniell was read entitled "Additional Observations on Voltaic Combinations". "The author," the report said, "has found that the constant battery, described in a former communication, might be rendered not only perfectly steady in its action, but also very powerful, as well as extremely efficacious and convenient for all the purposes to which the common voltaic battery is usually applied. With this view he places the cells which form the battery in two parallel rows, consisting of ten cells in each row, on a long table, with their siphon-tubes arranged opposite to each other and hanging over a small gutter, placed between the rows, in order to carry off the refuse solution when it is necessary to change the acid. Having observed that the uniformity of action may be completely maintained by the occasional addition of a small quantity of acid, he is able to dispense with the cumbersome addition of the dripping funnel; an arrangement which admits with facility of any combination of the plates which may be desired."

### Bichat's Theory of Life

"EVERYTHING around human beings, according to M. Bichat, tends constantly to their destruction, and to this influence they would necessarily yield, were they not gifted with some permanent principle of reaction. This principle is their life, and a living system is necessarily always engaged in the performance of functions, whose object it is to resist death. Life, according to Bichat, is the state of being produced by the possession and exercise of what he calls the vital properties; yet he does not always adhere with logical strictness to this definition; but rather uses the term sometimes to designate the vital properties collectively, and this is perhaps the best and most convenient sense. His essential doctrine, however, is that there is no one single individual presiding principle of vitality, that animates the body, but that it is a collection of matter gifted for a time with certain powers of action combined into organs, which are thus enabled to act, and the result is a series of functions, the connected performance of which constitutes a living being." (*Lancet*, April 22, 1836.)

### Scientific Lectures in Ealing

IN an interesting contribution to *The Times* of April 23, 1836, a correspondent said: "The beautiful village of Great Ealing, Middlesex, has been kept in a most pleasing state of excitement during the last week by the opening of an institution patronized by the principal of the nobility, clergy and gentry of the neighbourhood and entitled 'The Union for the Moral and Intellectual Improvement of the Industrious Classes of Great Ealing and its Vicinity.'" The opening of the institution took place in the Great Hall of Messrs. Nicholas's Ealing School on April 11, the Rev. Mr. Smith, the vicar, presiding. "Mr. Bird, lecturer at Eton College, Harrow School, Messrs. Nicholas's School, etc. was appointed to open the institution with a course of three lectures on astronomy, he having risen from the working class by his own exertion and perseverance to the high honour of lecturing before royalty. . . ."



## Societies and Academies

## PARIS

Academy of Sciences, March 9 (*C.R.*, 202, 785-884). LOUIS LAPICQUE: Notice on the late Ivan Petrovitch Pavlov. ALFRED LACROIX: The volcanic rocks of Pitcairn Island (Southern Pacific Ocean). JOSEPH MONTGOLFIER: An internal combustion motor. A sealed letter deposited in 1784. EDOUARD LE ROY: The formulæ of Lorentz. EMILE JOUGUET: Waves of shock and continuous waves of certain gases. RICHARD FOSSE and PAUL DE GRAEVE: The synthesis of cyanamide by the oxidation of formaldehyde and ammonia. By the oxidation of a solution of formaldehyde and ammonia with calcium permanganate, cyanamide was produced, in quantity about 2 per cent of the aldehyde oxidised. HYACINTHE VINCENT and FRANCOIS MOREL: The neutralising action *in vitro* of certain chemical bodies on the toxic power of curare. The substances found previously to exert a neutralising effect on certain toxins and alkaloids were found to exert a similar action on curare. CHARLES POISSON and ANDRÉ SAVORNIN: The magnetic anomalies at the summit of Rantoandro. Certain basalt peaks in Madagascar show intense magnetic anomalies, possibly sufficient to be dangerous to aeroplanes flying by compass. EDM. SERGENT, A. DONATIEN, L. PARROT and F. LESTOQUARD: The evolutive cycle of the sporezoan *Theileria dispar*, the agent of the bovine theileriosis of Mediterranean countries, in the ox and in a tick. JACQUES DE LAPPARENT was elected *Correspondant* for the Section of Mineralogy in succession to the late Georges Friedel. PAUL LÉVY: Observations on a note of M. Denjoy. LEONIDAS KANTOROVITCH: The properties of linear semi-ordinate spaces. F. LEJA: Certain functions of ensemble in any metric space. ARMAND RAUCH: The integral algebroids of  $\rho$  order admitting angles of divergence  $\pi/\rho$ . MICHEL LUNTZ and ANDRÉ JAPY: The dispersion of heat by turbulent convection and the measurement of the turbulence. PAUL SCHWARZ: The permanence of alternate eddies in a rectilinear canal. JEAN DELSARTE: A problem of diffraction. ALEXANDRE MARCEL MONNIER and JOSEPH BAZIN: A generator producing sinusoidal oscillations of constant amplitude over a very extended range of frequencies. ROMOLO DEAGLIO: The thermo-electric and voltaic properties of normal and abnormal metallic films. The normal film can be distinguished by opposing it to the massive metal in a cell, when no E.M.F. should develop. It is shown that two gold conductors, one thick and the other of green film thickness, are voltaically equivalent but thermo-electrically different. G. WATAGHIN: The interaction between protons and neutrons. MAURICE ROULLEAU: The influence of temperature on the sensibility of rapid photographic emulsions. The results of experiments on a dozen different emulsions are shown graphically, with density and temperature of the plate as variables. The sensibility was reduced as the temperature was lower. RENÉ DE MALLEMANN, PIERRE GABIANO and F. SUHNER: A new absolute determination of the magnetic rotatory power of water. With the apparatus used the rotations observed were of the order of  $55^\circ$ . For the green mercury line the Verdet constant at  $11.5^\circ\text{C}$ . was found to be  $1.543 \times 10^{-2} \pm 0.001$  minutes of arc. MARCEL LECOIN: The deviation of the  $\beta$ -rays on nitrogen nuclei. PIERRE PREISWERK and HANS VON HALBAN,

JR.: The relative positions of the resonance levels for the capture of neutrons by silver and by iodine. MAURICE ENGELDINGER: Study of the formation, in dilute solution, of the colloidal resins obtained by the action of formaldehyde on resorcinol. CLÉMENT DUVAL: Ferric oxalate. From a study of the ion transport in absolute alcoholic solution the author concludes that this substance is not ferric oxalate,  $\text{Fe}_2(\text{C}_2\text{O}_4)_3 + 4\text{H}_2\text{O}$ , but behaves as ferritetrahydrin ferrioxalate,  $\text{Fe}(\text{C}_2\text{O}_4)_3 \cdot \text{Fe}(\text{H}_2\text{O})_4$ . LIOU OUI TAO and WANG SHIH MO: The equilibria between III chloro-pentamine cobalt sulphates and their sulphuric solutions. ARMAND MARIE DE FICQUELMONT: The physicochemical study of the neutralisation of aqueous solutions of the metaphosphimic and diimidotriphosphoric acids. PIERRE DONZELOT and MAURICE CHAIX: The Raman effect in organic sulphides. JEAN ETTORI: The colour reaction of titanium with ascorbic acid and other molecules containing the group  $-\text{C}(\text{OH})=\text{C}(\text{OH})$ . The formation of an orange yellow complex with titanium salts is a general property of the above group, named the orthodiol-ene group. RAYMOND PAUL: The synthesis of the Carlina oxide. This substance, extracted from the roots of *Carlina acaulis*, appears to be the only acetylene derivative occurring in Nature. A compound of the same composition has been prepared synthetically, resembling the natural product, but not quite identical, possibly on account of incomplete purification. JACQUES BOURCART: The marine Quaternary on the coast of Cap Saint-Vincent in the estuary of the Sado. ANDRÉ SAVORNIN: The possibilities of magnetic prospecting in Madagascar. An account of the difficulties encountered and suggestions for reducing errors. LOUIS EBLÉ: The values of the magnetic elements at the Val-Joyeux station (Seine-et-Oise) on January 1, 1936. FRANCIS ROGER SPENCER HENSON: The large Foraminifera of the Oligocene of Palestine. MME. FERNANDE FLOUS: The natural classification of the Pinaceæ. EMILE MICHEL-DURAND: The metabolism of the phosphorus compounds of the acorn in the course of germination in the light. HENRI MARCELET: The presence of hydrocarbons in the product removed by the deodorisation of olive oil. The examination of the substances removed by treatment of olive oil with superheated steam proved the presence of seven hydrocarbons. The original olive oil contained only 0.007 per cent of these hydrocarbons. G. and M. ARNAUD: Virus diseases of the Prunus group of Rosaceæ. PIERRE FEYEL: The influence of the renal secretion of urea on the working of the resorption apparatus of chlorides in mice. J. LEGENDRE: The continental penetration of the maritime mosquito. The mosquito *Aedes punctatus*, which normally breeds in salt water pools, can penetrate several kilometres inland, depending on the distance the sea-water reaches from the coast. PAUL BONNEVILLE: The ectodermic origin of certain parts of the royal adipose tissue of termites. MME. VÉRA DANTCHAKOFF: The capacity of an induced ovary of a bird to condition secondary sexual characters. GEORGES TANRET: The comparative velocities of hydrolysis of some glucosides under the influence of ultra-violet rays, acids and diastases.

## Moscow

Academy of Sciences (*C.R.*, 4, No. 6-7; 1935). A. MINJATOV: The interpolation problem with functions of several complex variables. A. A. ARTJUCHOV: A



new evaluation of  $g(n)$  in Waring's problem. A. PLESSNER: Conjugated trigonometric series. A. S. BAKALIAJEV: The principle of radiation generalised in a stationary problem in the space of the elasticity theory. A. A. GRÜNBERG and D. I. RJABCHIKOV: Contribution to the problem of the strength of isomeric bases of the type  $[\text{Pt}(\text{NH}_3)_2(\text{OH})_2]$ . K. S. TOPCHILJEV: (1) Nitration method of 6-methoxy-8-nitroquinoline. (2) Cases of mobility of the nitro-group. Mobility of the nitro-group in 6-methoxy-5-8-dinitroquinoline. A. P. TERENTIEV, E. V. VINOGRADOVA and G. D. GALPERN: Diazotomeric determination method for carbohydrates. G. C. MOOR and B. N. ROZHKOV: Finding of bituminous rocks in the Cambrian deposits of north-west Yakutia (Anabar River). I. SEDLECKIJ and B. BRUNOWSKIJ: Structure of humic acid and its relation to lignin and to coals. N. N. MEDVEDEV: The contributive effect of cold to irradiation in the production of mutations. N. S. BUTARIN: The chromosome complex of the arkhar (*Ovis polii karelini*, Sev.), the kurdiuchny ram (*O. steatopyga*) and their  $F_1$ -hybrid. D. A. HENKEL and A. A. KUBYLIN: The drought-hardening of the potato before sowing. J. V. RAKITIN and N. N. SUVOROV: The effect of temporary anaerobiosis on the sprouting of young potato tubers. A. J. IVANOV: Notes on some birds of Tadzhikistan. A. M. POPOV: A new genus and species, *Lycozoarces hubbsi* (Pisces, Zoarcidæ), of the Okhotsk Sea.

## ROME

Royal National Academy of the Lincei (*Atti*, 22, 93-180; 1935). A. BEMPORAD: Increased precision in recent reductions of the Astrographic Catalogue. N. SPAMPINATO: Extension to the bicomplex field of two theorems of Levi-Civita and of Severi, through the homologous functions of two complex variables (2). G. PALOZZI: Projective applicability of plane lattices. U. BROGGI: Series development of Laguerre polynomials. G. SCORZA DRAGONI: Some theorems of means encountered in dynamics. U. BROGGI: System of infinite linear equations. A. TERRACINI: Projective lines of a surface. L. SONA: Translatory current which invests a bilateral lamina. M. PASTORI: Problem of Clebsch (1). C. M. MALDURA: Chemical researches on the Orbetello lagoon with regard to the biology (2). V. CAGLIOTTI: Structure of ferric phosphate.  $\text{FePO}_4$  prepared by the action of  $\text{Na}_2\text{HPO}_4$  on  $\text{FeCl}_3$  in presence of  $\text{CH}_3\text{COONa}$  crystallises in one phase isomorphous with quartz. C. NEUBERG and W. CAHILL: Total enzymatic hydrolysis of chondroitin-sulphuric and mucicoin-sulphuric acids into their components. G. SCAGLIARINI: Colour reaction between nitroprusside and sulphites (Bödeker's reaction). The formation of the complex ion  $[\text{Fe}(\text{CN})_5\text{NOSO}_3]^{4-}$  is demonstrated. P. PRATESI and A. ZANETTA: Reaction between pyrrole and isatin (pyrrole-blues) (3). Pyrrole blue A has been obtained in the pure crystalline state, but the structure is not yet certain. H. BREUIL and C. A. BLANC: Discovery *in situ* of a new skull of *Homo neanderthalensis* in the deposits of Saccopastore (Rome). E. SANERO: Presence of prehnite at Monte Loreto in Liguria. A mineral from this source is shown to be prehnite,  $\text{H}_2\text{Ca}_2\text{Al}_2(\text{SiO}_4)_3$ . G. AMANTEA: Method of estimating the antineuritic vitamin  $\text{B}_1$  using the conception of the beriberi quotient  $Q_b$ . G. AMANTEA: Action of some chemical substances on clonus due to atropinisation of the cortical sensory-motor centres.

## WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 22, 81-149, Feb. 15). JOHN M. IDE: Comparison of statically and dynamically determined Young's modulus of rocks. The specimen, in the form of a cylinder 20 cm. or 25 cm. long and 1.59 cm. or 5.08 cm. in diameter respectively, is placed upright on a thick steel disk, its lower end, to which is cemented a metal foil, being separated from the steel by a sheet of mica. Alternating voltage of variable frequency is applied to the foil and steel disk, and when its frequency resonates with the longitudinal frequency of the specimen, the latter vibrates with increased amplitude and radiates sound. From this frequency Young's modulus is computed. The values obtained agree well with those obtained by the seismic wave method. Generally, the dynamic values are 4-20 per cent higher than those determined statically for the same specimens, due probably to the presence of minute cracks and cavities. Variations in the same rock appear to be due to variations of density and of elastic properties. J. v. NEUMANN: (1) Continuous geometry. A continuation of recent work tending towards the elimination of the notions of points, lines and planes from geometry. (2) Examples of continuous geometries. JOSEPH MILLER THOMAS: Complete differential systems. EDUARD ČECH: On general manifolds. G. A. MILLER: General theorems applying to all the groups of order 32. M. R. HESTENES: Minimax principle for functions. E. B. WILSON and M. M. HILFERTY: On the explosiveness and destructiveness of the 1918 epidemic [of influenza in the United States]. A statistical discussion. CHESTER STOCK: Sespe Eocene Didelphids. The first record of these marsupials in the North American upper Eocene. JOHN H. LAWRENCE and ERNEST O. LAWRENCE: The biological action of neutron rays. Making certain assumptions about the amount of ionisation likely to be produced in the tissues of rats, a procedure was devised whereby two similar batches of rats were exposed for different periods to neutrons and X-rays estimated to produce equal amounts of ionisation. The blood picture and general health of the animals were observed. Per unit of ionisation in the rat, neutrons are possibly five times as effective biologically as X-rays. The results suggest that workers using neutron generators should have adequate protective screening, presumably by substances containing a high proportion of hydrogen and therefore good absorbers of neutrons. RAYMOND E. ZIRKLE and PAUL C. AEBERSOLD: Relative effectiveness of X-rays and fast neutrons in retarding growth. Wheat seedlings just showing the primary root were submitted to equivalent doses of neutron and X-ray radiation. Plotting retardation of growth against dosage, the experimental points cluster about the same smooth curve if the scale of X-ray dosage is twenty times that of the neutron dosage. Consideration of the mode of ionisation suggests that a unit of neutron irradiation produces twice as much ionisation in tissue as a unit of X-rays; hence one ion produced in tissue by neutrons is as effective as ten ions produced by X-rays. If this ratio (10 to 1), compared with that of the previous paper (5 to 1), indicates a real difference for different tissues, the therapeutic use of neutrons instead of X-rays, for example, in treating tumours, is indicated; but more detailed determinations on the rat or other biological object are required to support this suggestion. EDISON PETTIT: On the colour of Crater Lake water. This



lake in southern Oregon is in the crater of an extinct volcano, the walls of which mostly rise abruptly to 500–2,000 ft. The only known source of water supply is the precipitation within the crater; the average depth is 1,500 ft. The water of the lake is remarkably blue in appearance. It is comparatively pure and free from suspended sediment and dissolved matter. Laboratory tests of specimens suggest that the blue colour is due to scattering of light by water molecules. A. E. MIRSKY: The visual cycle and protein denaturation. Recent work on conjugated proteins suggests that visual purple is such a compound, a carotenoid-protein. Light denatures visual purple, forming a compound, visual yellow, in which the carotenoid group is loosely bound to the protein; in the dark, denaturation reverses. The function of retinene is to provide an increased absorption coefficient in the visible spectrum, to sensitise the protein.

## Forthcoming Events

### Monday, April 20

VICTORIA INSTITUTE, at 4.30 (at the Central Hall, Westminster).—G. R. Gair: "The Races and Peoples of the Early Hebrew World: a Study in Ethnology".

ROYAL SOCIETY OF ARTS, at 8.—Dr. R. E. Stradling: "Problems of Road Research" (Peter le Neve Foster Lectures. Succeeding lectures on April 27 and May 4).

### Tuesday, April 21

SOCIETY FOR STUDY OF INEBRIETY AND DRUG ADDICTION, at 4 (at 11 Chandos Street, London, W.1).—Dr. J. D. Rolleston: "On Snuff Taking".

INSTITUTE OF PATHOLOGY AND RESEARCH, St. Mary's Hospital, W.2, at 5.—Pathological Research in its Relation to Medicine. Sir Almroth Wright, F.R.S.: "Some Results of Recent Research".

### Thursday, April 23

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Dr. J. D. Cockcroft: "The Transmutations of Matter by High-Energy Particles and Radiations" (Twenty-seventh Kelvin Lecture).

FARADAY SOCIETY, April 20–22. General Discussion on "Disperse Systems in Gases: Dust, Smoke and Fog" to be held at the University of Leeds.

## Official Publications Received

### Great Britain and Ireland

Technical Publications of the International Tin Research and Development Council. Series A, No. 31: The Constitution of the Tin-Rich Antimony-Tin Alloys. By Prof. D. Hanson and W. T. Pell-Walpole. Pp. 12. Free. Series A, No. 32: Influence of Surface Cuprous Oxide Inclusions on the Porosity of Hot-Tinned Coatings on Copper. By Dr. W. D. Jones. Pp. 8. Free. Series A, No. 33: The Hot-Tinning of Copper; the Attack on the Basis Metal and its Effects. By E. J. Daniels. Pp. 10. Free. (London: International Tin Research and Development Council.) [233]  
Engineers' Study Group on Economics. Interim Report on the Design of a Family Budget with Special Reference to Food. Pp. 20 (London: Engineers' Study Group on Economics.) 6d. [243]  
Proceedings of the Royal Society of Edinburgh, Session 1935–1936. Vol. 56, Part 1, No. 1: The Lunar Atmospheric Tide at Glasgow. By Prof. S. Chapman. Pp. 5. 6d. Vol. 56, Part 1, No. 2: The Effect of Present Trends in Fertility and Mortality upon the Future Population of Scotland and upon its Age Composition. By Dr. Enid Charles. Pp. 6–12. 6d. (Edinburgh: Robert Grant and Son, Ltd.; London: Williams and Norgate, Ltd.) [243]

### Other Countries

Reprint and Circular Series of the National Research Council. No. 107: Industrial Prospecting. By C. F. Kettering. Pp. 3. (Washington, D.C.: National Research Council.) 25 cents. [233]

U.S. Department of the Interior: Geological Survey. Bulletin 853: Zinc and Lead Deposits of Northern Arkansas. By Edwin T. McKnight. Pp. vi+311+11 plates. 1 dollar. Bulletin 868-A: Mineral Industry of Alaska in 1934. By Phillip S. Smith. Pp. ii+91+13a. 10 cents. Water-Supply Paper 759: Surface Water Supply of the United States, 1934. Part 4: St. Lawrence River Basin. Pp. vi+159. 20 cents. Water-Supply Paper 762: Surface Water Supply of the United States, 1934. Part 7: Lower Mississippi River Basin. Pp. v+129. 20 cents. Water-Supply Paper 769: Surface Water Supply of the United States, 1934. Part 12: North Pacific Slope Basins. C: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. vi+165. 20 cents. Water-Supply Paper 771: Floods in the United States: Magnitude and Frequency. By Clarence S. Jarvis and others. Pp. 497+3 plates. 1 dollar. Water-Supply Paper 772: Studies of Relations of Rainfall and Run-Off in the United States. By W. G. Hoyt and others. Pp. 301. 25 cents. (Washington, D.C.: Government Printing Office.) [273]

U.S. Department of Agriculture. Circular No. 376: New Equipment for obtaining Host Material for the Mass Production of *Trichogramma minutum*, an Egg Parasite of various Insect Pests. By Herbert Spencer, Luther Brown, Arthur M. Phillips. Pp. 18. (Washington, D.C.: Government Printing Office.) 5 cents. [303]

Bulletin of the Vanderbilt Marine Museum. Vol. 6: Scientific Results of the World Cruise of the Yacht *Alca*, 1931, William K. Vanderbilt Commanding. Crustacea: Anomura, Macrura, Euphausiacea, Isopoda, Amphipoda and Echinodermata; Asteroidea and Echinoidea. By Lee Boone. Pp. 264+96 plates. (Huntington, L.I., N.Y.: Vanderbilt Marine Museum.) [303]

Records of the Botanical Survey of India. Vol. 8, No. 6: Flora Arabica. By the Rev. E. Blatter. Part 5: Gnetaceae—Gramineae. Pp. ii+451-519+lix. (Delhi: Manager of Publications.) 2 rupees; 3s. 6d. [303]

British Honduras. Report of the Forest Trust for the Period 1st April 1933 to 31st December 1934. Pp. 21. (Belize: Forest Department.) [303]

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106a: Ergebnisse Aerologischer Beobachtungen. 23, 1934. Pp. iv+42. 1.50 fl. No. 108: Seismische Registrierungen in De Bilt. 21, 1933. Pp. viii+49. 0.70 fl. (-s-Gravenhage: Rijksuitgeverij.) [303]

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