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The Scientific Worker in State Service.

THE not wholly admirable human instinct for individual self-preservation has given to the technical expert in medicine and surgery an impressively high status in the community. A corresponding instinct for communal self-preservation has combined with still less admirable instincts to maintain a high status for the technical expert in the warlike arts. It is significant of the haphazard organisation of the human community that these emergency experts, concerned with the pathological processes of individual or political life, should hold a status not generally accorded to those technical experts who devote their not inferior knowledge and skill to the daily 'non-pathological processes' of a modern civilisation.

The British Science Guild has added to its considerable public services by publishing the report of a committee which has, since 1927, been inquiring into "the functions of the scientific and professional staffs in the Public Services and Industry from the point of view of efficient administration and national development".* The report is, perhaps necessarily, restricted to conditions in Great Britain, and to the special classes of scientific and professional staffs which might have been more closely described as physicist, chemist, and engineer classes. There is no reference to the biologist, whose claim to improved status has been conceded only in 'pathological emergency'—the entomologist, for example, has climbed to power by the ladder of fear which served the warrior and the medicine-man. The restriction of the field of survey to particular professional classes does little harm, but the most superficial knowledge of conditions in Germany and the United States suffices to suggest that the other restriction should be removed by extending the survey to these countries. "The Engineer who became a Bank Vice-President" is an American story, with a moral for the British reader, which might profitably be written by the Guild; it is far more significant than the better known story of the engineer who became Federal President. If no other assault on the British art of improvisation avails, the fear motive will eventually be effective in widening the sphere of influence opened to the technical expert. When pathological processes are sufficiently obviously established in the industrial organism, the 'industrial pathologist' will be given the wide powers which should have been his as a

* A Report on the Scientific and Professional Staffs in the Public Services and Industry. Prepared by the Committee on the Position of the Technical Expert in the Public Services and Industry. Pp. vi+62. (London: British Science Guild, 1931.) 1*s*.

directing physiologist, powers which are already accorded in the competing industries of other countries.

The committee indicates its awareness of this international contrast in a single sentence : " It can hardly be doubted that the contrast admittedly existing between the high *average* modernity of industrial plants in America, Germany, and France and the number of relatively obsolete plants in this country, is attributable in no small degree to the fact that British technicians in many undertakings have been denied the opportunity to influence policy to the same extent as in the countries mentioned ".

The report surveys the position of the scientific and professional worker in the local government service, the Civil Service, the forces of the Crown, and in industry, not from the point of view of conditions of service as affecting the individual, but from that of efficiency in the services and in industry. It is concluded that neither in industry nor in the public service are the requirements fulfilled, in every case, for close collaboration " on the part of the scientist or the technologist, the financial adviser, and the administrative chief ", nor for " the proper presentation of the various technical, financial, and other considerations involved in every problem, in such a manner that those ultimately responsible for making decisions may be put in a position to weigh the several considerations in their bearing upon questions of general policy ". The local government services are regarded by the committee as making better use of their scientific and professional staffs than do the other organisations considered ; the Civil Service, with few exceptions, is regarded as the least satisfactory part of the field surveyed.

This criticism of the national services is opportune. The provision for the very wide range of scientific and technical work now undertaken by the State has been subject to intense criticism and investigation throughout the last few years. A sub-committee of the Committee of Civil Research was appointed, in 1926, " to consider the co-ordination of research work carried on by or under the Government, to report whether any further measures should be taken to prevent overlapping, to increase economy and efficiency, and to promote the application of the results obtained ". In a report published in 1928 this ' Ormsby-Gore sub-committee ' discussed the scientific services of the Government from the point of view of function and organisation without including recommendations for their improvement. That recommendations were made, although not published, may be inferred from the report for the year 1928–29 of the Committee of the Privy Council for Scientific and Industrial Research (" In due course the sub-committee recommended, amongst other things, that . . .").

The recent Treasury committee on the staffs of Government scientific establishments had before it an outline, submitted by the Institution of Professional Civil Servants, for the radical reorganisation of scientific public services. That committee, however, stated in its report (1930) that " The respective functions of the establishments within our terms of reference have recently been set out in considerable detail in the Report of the Research Co-ordination Sub-Committee of the Committee of Civil Research . . . and we have assumed the first part of our terms of reference to be an instruction, not to criticise and report on those functions, but to take note of them as the basis of our investigation into the conditions of service of the staffs employed ". The Association of Scientific Workers submitted a generally similar scheme of reorganisation in its evidence to the Royal Commission on the Civil Service, now sitting. The Commission, in turn, has declared itself unwilling to add to its herculean labours by considering proposals involving substantial modifications of departmental structure.

The British Science Guild's Committee finds that " The evidence which has been obtained by us shows that, as a general rule, the position of the scientific and technical staffs in the Home Civil Service is most unsatisfactory, and that, in the interests of efficient administration and national development, drastic reforms are needed in the organisation of many of the civil departments of the Government. In order that the scientific and technical staffs should exercise their function properly it is imperative that the position occupied by the Minister of a civil department should be altered to accord with present-day requirements ; and, further, that the responsibilities of the scientific and technical staffs in relation to the Minister should be clearly and specifically prescribed. The heads of the scientific and technical departments should, it is submitted, be colleagues of, and be equal in status with, the permanent heads of departments, and not subordinates under a secretariat or similar body." The committee then proceeds to make suggestions for modernisation of the system.

It may be that this increasing body of constructive criticism is misdirected. It may be that Sir Holberry Mensforth's advice is of greater weight. It may be that " The thing to do with these men is to lock them up in a room and feed them through a pigeon-hole ; you must not let them loose in your

organisation". But sentence of solitary confinement should be passed only by a balanced, fully informed, and fully authoritative tribunal; the full-bottomed wig would certainly be, the black cap might be, more appropriate head-dress for the occasion than are the cap and bells donned by Sir Holberry Mensforth.

It is to be regretted that the Ormsby-Gore recommendations, on which the scientific services of the State must be assumed to operate at the moment, have not been communicated to the scientific world at large; also that a relatively large amount of attention has been given and is being given to merely subsidiary questions of the labels and rewards attached to the conduct of the scientific work of the State. Examination of these matters was urgently necessary, and the recommendations of the Carpenter Committee are valuable and most welcome contributions to economy and efficiency. So long, however, as the major issue is shirked, so long as those responsible for the organisation of scientific work for the State fail to take the scientific world into their confidence, so long as full inquiry into the best methods for ensuring the most economical and effective conduct of the technical work of the State—without undue tenderness about departmental structure—is delayed, just so long will improvisation, sometimes inspired, continue to bear its meagre fruit.

The Charm of the Alps.

The High Alps: a Natural History of Ice and Snow. By Dr. A. E. H. Tutton. Cheaper edition. Pp. xvi+319+48 plates. (London: Kegan Paul and Co., Ltd., 1931.) 10*s.* 6*d.* net.

DR. TUTTON'S book is written by a lover of mountains for those who desire to know more about the ice and snow which they meet on glacier expeditions, and about the nature and causes of the glaciers themselves. The first part of the book contains a good popular description of the physics and chemistry of water, snow, and ice. It leads naturally to a second part in which snow and ice are considered in the mass, as they occur upon high mountains. This second part includes an excellent, and not too long, account of the development of the theory of glacier movement (and interesting information concerning recent variations in mass of the glaciers); and a chapter on glacier phenomena—moraines, crevasses, and lakes—all treated in a simple manner. An account of scientific work upon Mont Blanc, and the story of the Mont Blanc observatories, which find place in the third part of the book, might perhaps have been more logically placed in the second part. The story of the Mont Blanc observatories is of particular interest, as it is abstracted from an account written for the author by M. Joseph Vallot himself shortly before his death. A topographical description of the chief mountain groups of the Alps might perhaps more logically have been placed in the third part of the book than in the second, which concludes with a brief historical sketch of the conquest of the great alpine summits.

Even if the reader had not already been warned by the profuse illustrations of mountain scenery (more than 150 in number, and to be criticised only on account of their small size—would that they had been larger!), he will find in the second part of the book that Dr. Tutton's real interest and enthusiasm lie in mountain expeditions and, particularly, in the views of the mountains which they afford. In this, Dr. Tutton carries on an illustrious tradition. It is curious how great has been the attraction of mountains for men of science both in Great Britain and abroad. H. B. de Saussure's encouragement of the first ascent of Mont Blanc in 1786, and his own ascent in the following year, are well known; but before that ascent he had spent many summers wandering in almost unknown alpine valleys. Of our own countrymen, Beaufoy (who climbed Mont Blanc a few days after Saussure) was a fellow of the Royal Society—as, of course, were Sir John Herschel (Breithorn, 1822) and J. D. Forbes. In later times, one in every twenty of the first three hundred members of the Alpine Club was, or was to become, a fellow of the Royal Society.

Forbes's "Travels in the Alps" is as much a record of mountain exploration as of his observations of glacier movement. It, and the "Tour of Mont Blanc" (1845), in which he republished the account of his expeditions, played a part in the development of mountaineering which is difficult to exaggerate. When Hudson and Kennedy and their companions made the 'guideless' ascent of Mont Blanc from St. Gervais, in 1855, they carried a map taken out of one or other of these books—and that ascent was the true commencement of modern mountaineering.

Modern climbing has developed a technique which would scarcely be recognised by the pioneers; but Dr. Tutton points out with truth the catholic nature of the attraction which mountains have for different men. If the great ice faces and steep ridges which are climbed to-day have their own strong attraction, that does not compete with

the equal attractions of a high glacier pass such as the Col du Géant, or of a walk along a valley path. Scenery is, and must remain, one of the chief motives of a mountain walk—whether that be a high or a low one; and the author is right where he says that the best mountain views are often to be obtained from the middle heights.

The third part of Dr. Tutton's book is of value and much interest. We have our Murrays and Baedekers on one hand and our climbing guide-books on the other, but here is something novel, and differing from both. In it Dr. Tutton gives us an account of some of his own expeditions framed as a sort of guide-book of glacier passes. The treatment is topographical, and he has so selected his material that all the expeditions are within the compass of a moderate walker, while none is dangerous. In particular, he is careful to mention good view-points, and to describe the views met in the course of the expeditions. What is better still, he illustrates these with his own camera. It is impossible not to understand and feel Dr. Tutton's own enthusiasm for mountain scenery when reading this last part of his book; and the book may be recommended not only to those who have walked in the Alps and would like to know more about the glaciers which they have crossed, but also to those who have never been there and would like to know wherein the attraction consists.

Those of us who have climbed in the Alps are often asked to do the impossible—to explain our motives. There is only one reply—"Go and see for yourself". But how is it to be done? This book may perhaps solve the problem for some. It is not difficult to select from it a series of expeditions which would comfortably fill a holiday and serve as an introduction to the regions above the snow line.

Genius-Hunting.

Genetic Studies of Genius. Vol. 3: *The Promise of Youth: Follow-up Studies of a Thousand Gifted Children.* By Barbara Stoddard Burks, Dortha Williams Jensen, Lewis M. Terman, assisted by Alice M. Leahy, Helen Marshall, Melita H. Oden. Pp. xiv + 508. (Stanford University, Cal.: Stanford University Press; London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1930.) 21*s.* net.

IF we allow one developed 'genius' to 100,000 children born (which is a liberal allowance), what is the chance that in the 250,000 Californian children, corresponding to 2·5 adult geniuses, one of these will have been picked out in the five or six hundred gifted children now remaining out of those selected in 1921–22 by the fact of their intelligence quotients (*I.Q.*'s) being 140 or above? Supposing one such should occur, shall we be able to differentiate him from the remaining 500 gifted children by the surprising record of facts concerning these children accumulated by Prof. Terman and his colleagues? We scarcely imagine that a Shakespeare, a Beethoven, or a Rembrandt would have been associated with a high intelligence quotient when six to eight years of age. It would seem to us that a more fitting title for this work would be "An investigation as to whether the promise of childhood is fulfilled in adolescence and (supposing the investigation can be still carried on) in adult life".

After all, intelligence tests are highly correlated with examination tests—even if we admit them to be an advance—but examination tests have not been very successful in bringing into the lime-light undoubted genius. The London County Council has to deal with something like a permanent stock of half-a-million children, and annually some 30,000 may be selected for secondary education; from these again, later on, a further selection is made for academic training. This has been in progress for thirty or more years, and a sample of 'gifted' children far larger than the Californian has been followed up and trained. Individuals of various degrees of real ability have been recorded and have obtained substantial positions in a number of professions. But will anyone venture to assert that a real genius has been netted by these tests? Yet if the tests have been cruder than the Californian—which we leave others to settle—they have dealt with incomparably greater numbers.

The age differences form one of the major difficulties of the whole of the present investigation. The same tests cannot be satisfactorily applied to children and to adolescents. This is well illustrated when our authors come to deal with the changes during six years in the intelligence quotient of the 'gifted' children. We find only 38 boys and 34 girls re-tested, and when these are divided into four age groups, we find four out of the total eight groups have only 5 to 6 children in them. Statistically such numbers are wholly inadequate if we desire to reach safe conclusions. Our authors themselves write:

"The age range of the subjects was so great that no test, whether of intelligence, achievement, or personality, was suitable to all. Moreover, because

of the limitations of time and funds it was not possible in the case of most of the tests to give them to all of the subjects to whom they were applicable. However, in each case, the number tested is large enough to give a fairly reliable sampling. To find out how a group of a thousand gifted subjects compares with a norm group, it is not necessary to test all of the thousand. By testing a random sample of one hundred to two hundred of the thousand, we learn almost exactly as much as if we had tested all " (p. 9).

When we remember that the children were originally selected as gifted on the basis of a single individual test series, the Stanford-Binet, the reasoning cited above seems somewhat obscure. If a thousand children agree in excess of intelligence by a particular test, it by no means follows that a sample of a hundred—and it is occasionally smaller—will fairly represent the thousand in a great variety of other characteristics of a markedly different nature.

In fact, the diversity of ages, the diversity of races, the diversity of tests, and the diversity of characters discussed render the results difficult to interpret, and make it hard for the reader to find his path through the many answers to the many questions propounded to children, teachers, and parents on a variety of ' blanks '.

It is, perhaps, idle when a vast task has been undertaken and is in part accomplished to suggest that it could have been better and more economically carried out otherwise, but it seems to the present reviewer that if 1200 children of the *same* age with *I.Q.*'s of 140 and upwards and the same number of children of the same age with *I.Q.*'s below 100 had been selected in 1921 and *both* series followed up, we should have known more eight years later than we actually do, when the control series has not been followed up. These numbers would have allowed for wastage, and a comparison of even 800 of both series by the *same* intelligence test would have been most profitable and far more reliable than a test repeated on only 72 of the gifted child series. Twenty years after the second testing, very little more than an examination of " Who's Who in America " would have indicated whether any of the ' gifted ' or of the mediocre children, as judged by public estimation, had reached marked distinction, to say nothing of attaining a claim to genius.

The authors of this massive series of volumes set out with the object of ascertaining whether a high intelligence quotient in childhood was an indication of a possible future adult genius, and they saw a double method of approaching the solution of the problem: (i) by following up ' gifted ' children, that is, those with a high *I.Q.*, and (ii) by studying the childhood of several thousand individuals considered to be geniuses, and allotting them *I.Q.*'s.

The method adopted in the latter investigation seems to us now, as it did when vol. 2 appeared, to be little short of perilous. The details of the childhood of the great are in some cases ample, in others sparse. But on the basis of these haphazardly recorded details, three judges (Prof. Terman, Miss M. A. Merrill, and Miss C. Cox, the extractor of the biographical data) have, on the basis of their knowledge of the characteristic doings and sayings of children of high *I.Q.*'s, attempted the converse problem and assessed the youthful intelligence quotients of the bearers of the earth's great names, and assigned to each of them an *I.Q.* which is on the average upwards of 140—that of their gifted Californian children.

" The most significant conclusion of the author [namely, Dr. Catherine Cox, the compiler of vol. 2] is that the extraordinary genius who achieves the highest eminence is also the gifted individual whom intelligence tests may discover in childhood. The converse of this proposition is yet to be proved " (p. 23).

This is the result of what we term the perilous process of assigning *I.Q.*'s to the childhood of the great. The actual position of the writers is well brought out in the following words :

" It seems *quite evident* * that while any person with an *I.Q.* as high as 140 [in childhood] may have the sheer intelligence requisite for exceptional achievement [in adult life], only a very small proportion are likely to possess the total complex of mental and personal traits that cause an individual to become eminent. If it were not that personality traits and other non-intellectual aspects of endowment wield an enormous power to enhance or inhibit the individual's use of his intelligence, we might expect in ten or fifteen years from our thousand California gifted children such a crop of geniuses as has never before graced the population of a single State " (p. 24).

There is no attempt in the present work to measure quantitatively these " personality traits and other non-intellectual aspects of endowment " which enhance or inhibit the use of intelligence. It is, perhaps, reasonable to assume such to exist, but it is pure hypothesis to assert that the youthful intelligence quotient is a measure of adult intellectual power, and that genius would be apparent but for these unmeasured and undetermined

* Italics the reviewer's.

'personality traits' and 'non-intellectual aspects of endowment'. If the object of 'following up' is to ascertain these inhibitions, then the wording should have refrained from dogma, until these traits had been discovered and measured.

While many readers will be most interested in the chapter entitled "Re-tests of Intelligence", and particularly in the "Summary" on pp. 61-62, a word of warning seems to be called for. While in the eight years the 'scores' of a number of children have changed considerably, sometimes up and sometimes down, we have no control series, and therefore no evidence of how in the far more extensive group of non-gifted children (as judged by their *I.Q.*'s) individuals may have risen. If one boy among 27 'gifted' children can rise 50 points in seven or eight years, is it not possible, nay, more than probable, that among the many thousands of 'non-gifted' children in California one or more may rise even double this amount; and if that State is to produce a genius at all in the next twenty years, may he not have been a child with an *I.Q.* far below 140 when the 'gifted' children were sorted out?

Notwithstanding our doubts as to whether the £12,000 which the three volumes of this investigation have cost have been spent to the best advantage, we readily admit the great interest which every social investigator must take in the present volume, especially in the later chapters. As a study of how far the promise of childhood will be fulfilled in adolescence there is a great deal to be learnt from the work, only we hold that it would have been wise to have kept the frequent discussions on genius out of it. To approach the problem of genius statistically we must deal with a far more numerous population, spread over a much wider field than those of a few thousand Californian children. If, against probability, a world genius, a da Vinci, a Goethe, or a Bach, appears among these Californian 'gifted' children, it will be more a startling chance than any contribution to an understanding of the origin of genius. This point seems to be almost admitted by the authors themselves (p. 469); but if this be so, why have they chosen "Genetic Studies of Genius" for the title of their researches? Why have they mixed up, in almost every chapter, the problem of the origin of genius with that of the future achievement of bright children?

Lastly, may we add a word of criticism which may help the writers in succeeding volumes of this encyclopædic work? The treatment is largely statistical, but their statistical technique is often defective. We may illustrate this by one example, that on pp. 28-30, where the writers endeavour to find from their *I.Q.* ratings in 1921–22 and 1927–28 (on the basis of 54 cases!) the correlation between *I.Q.*'s in *general* at a given interval of time. They have not published their correlation table, so that we ourselves cannot attempt to deal with it. But as they appear to have mixed boys and girls with marked sexually differentiated means, the correlation will, anyhow determined, be largely spurious.

In the next place, the authors state that it was impossible to use the product-moment method owing to the bizarre form of the correlation table arising from the truncating of the general population by the selection of 'gifted' children. Accordingly, they suggest three other methods: (i) The 'tetrachoric' method. Now, this is based on a normal distribution of the data, and could not possibly be applied to a truncated quadrant without replacing, which the authors have not done (but might have done), the three quadrants truncated. (ii) By a theory as to the regression. The means of the gifted children *alone* cannot possibly give, as the writers suppose, the correlation coefficient in the *unselected general* population. (iii) The deduction of the correlation from the standard deviation of the differences of the two ratings. This, if accurately applied, should give exactly the same result as the product-moment method which they have discarded at the outset. Clearly the authors are unfamiliar with the fundamental formulæ for measuring the influence of selection on correlation. We do not believe that much could be learnt by even treating the 27 boys and 27 girls independently, but if it is worth while attempting this, then surely it were better not to apply three erroneously adopted processes to heterogeneous material.

The title of this encyclopædic social inquiry suggests that the writers originally meant to deal with *hereditary* genius. There is little about inheritance in these volumes. But with the first conclusion of their summary we are in whole-hearted agreement, for it coincides with much observation of our own:

"Gifted children come predominantly from family stocks of decidedly superior intellectual endowment and slightly superior physical endowment" (p. 472).

Perhaps we may hope that a future volume may be devoted to the quantitative development of this special topic. We trust, if it be so, that the need for a control series will not be overlooked.

KARL PEARSON.

Photoelectric Cells.

Photocells and their Application. By Dr. V. K. Zworykin and Dr. E. D. Wilson. Pp. xi + 209. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) 12*s.* 6*d.* net.

UNTIL recently, there was a serious lack of really representative books dealing with the theory and practice of the photoelectric and selenium cells. Happily, this no longer exists, thanks to Dr. Campbell and Miss Ritchie—whose exhaustive book is already in its second edition—and to Mr. G. P. Barnard, whose recent treatise on the selenium cell, though perhaps not so critical a survey of the subject as it might have been, will certainly be regarded as a standard reference work.

It may be said at once that the book under review cannot be classed with these. Probably the authors did not intend that it should be, their claim being that the aim of the book is to introduce the general public to the modern 'electric eye', and to teach the layman its normal characteristics and its special idiosyncrasies.

In spite of the authors' belief that the book presents an understandable account "not too technical for the untrained man and not too shallow for the specialist", we would hesitate to say that it has achieved its object. There are, however, certain classes of workers to whom the book will prove of use: those interested in the construction of photoelectric cells, and more especially sound-film engineers and others concerned with the general problem of amplification of photoelectric currents and with any of the almost endless applications.

The first six chapters are devoted chiefly to the theory and construction of the gas-filled and vacuum cells, though the treatment is not so exhaustive as in Dr. Campbell and Miss Ritchie's book. A good deal of Chapter ii., on general theory, seems rather unnecessary. Does the reader really expect, or want, a chart of the entire spectrum of radiant energy, or a description of black body radiation extending over several pages, in a book of this kind?

Chapter vii. is an isolated one entitled "Photoconductive and Photovoltaic cells", and serves to illustrate the main criticism of the book, that in some chapters the treatment is not sufficiently thorough for the specialist. This chapter, for example, introduces us to the selenium cell (to which Mr. Barnard devoted 331 pages), the thalofide cell, and one or two photovoltaic cells, all in nine pages. There is scarcely any further reference to them throughout the book.

Two chapters (viii. and ix.) discuss various photocell circuits and the problem of amplification. There are short chapters on the use of cells in sound-film work, the electrical transmission of pictures, and in television. In a chapter on miscellaneous applications, some fifteen illustrations (again very condensed) are given of operations which the cell can perform. The last chapter discusses directions in which progress may be expected towards the discovery of the ideal cell. Several appendices are given at the end of the book. F. C. T.

Our Bookshelf.

A Manual of Practical Vertebrate Morphology. By J. T. Saunders and S. M. Manton. Pp. viii + 220. (Oxford: Clarendon Press; London: Oxford University Press, 1931.) 15*s.* net.

THIS text-book of practical work in vertebrate morphology covers the course for the first part of the Natural Sciences Tripos at Cambridge. Its contents are as follows. First, directions are given for the examination and dissection of the following types: The lamprey, the skate, the whiting, the auditory ossicles and swim-bladder of the roach, the salamander, the central and sympathetic nervous system of the frog, the lizard, the grass snake, the pigeon, and the brain of the sheep. The authors have not included an account of a general dissection of a mammal, "as many excellent accounts of the dissection of the rabbit are easily available".

The descriptions are good and the dissections are well planned. The authors have wisely refrained from inserting into these chapters discussions of the functions or evolutionary significance of the parts displayed, leaving such matters to the theoretical text-books that must be read in parallel with a practical course of this nature. But they append, after the chapters dealing with the dissections, a brief and highly compressed theoretical account of the vertebrate nervous system. In the reviewer's opinion, it would have been wiser to leave this also to the theoretical books, where it can be given more spacious treatment. Finally, there are four chapters dealing with the skeleton, in which the type system is abandoned and the different regions are taken one by one and examined in a great variety of animals.

The book is attractively illustrated and contains a number of useful and original features.

G. P. W.

Science and Religion: a Symposium. Pp. vii + 175. (London: Gerald Howe, Ltd., 1931.) 4*s.* 6*d.* net.

IF a series of popular broadcast talks on science and religion is to be commended at all, the publication of the talks in print is certainly to be commended, because the peculiar danger of this form of instruction is that there should be left upon the

mind of the listener a hazy impression, which he cannot clear up except by subsequent reading and thinking. We do not agree with people who write to the papers to the effect that these talks are unsettling to those who listen to them. 'The conflict between religion and science', to use the title of a nineteenth century presentation of the theme, has long been with us; but these talks exemplify the fact that there was never less real 'conflict' than there is at the present time. Religion, or rather theology, has more or less adapted itself to the view of the universe taken by modern science; and the tone of men of science is very different from what it inevitably was so long as theology adhered to demonstrably impossible positions.

The contributors to these twelve talks include five distinguished men of science, one philosopher, and six theologians—or, at any rate, churchmen. We think anyone would agree that these twelve chapters are more suitable for careful reading than for mere listening, and that, to the intelligent reader, they may convey a fairly clear idea of authoritative opinion on the problems discussed. He will gather also that when it comes to ultimate questions, there is divergence of opinion, not only between scientific workers and theologians, but also between, let us say, physicists and biologists; and he may be reminded of the proverbial query as to what is to be done when the doctors differ.

Aeronautical Meteorology. By W. R. Gregg, with the collaboration of C. G. Andrus, R. N. Covert, H. M. Hightman, V. E. Jakl, D. M. Little, F. W. Reichelderfer, J. A. Riley and R. H. Weightman. Second edition, revised and enlarged. Pp. xvi+405. (New York: The Ronald Press Co., 1930.) 4.50 dollars.

THIS revised edition supplies, in a convenient form, the kind of meteorological knowledge which is required by the airman. The author has since 1917 been in charge of the Aeronautical Division of the United States Weather Bureau, and is an acknowledged expert in upper air research. There are sections contributed by other experts on fog, 'coiling', and visibility, ice formation on aircraft, weather forecasting, instruments and methods of observations, airship meterology, and the Weather Bureau Airway Service.

There is a discussion of the relative advantages offered by prospective Atlantic air routes and an account given of the meteorological conditions attendant upon Lindbergh's trans-Atlantic flight. A natural feature of the book is a representation of the various meteorological dangers that beset airmen, like squalls, fog, and ice, and one gathers that thunderstorms, for several reasons, should be given a wide berth. As cloud scenery closely concerns the airman, the book is adorned by some handsome photographs of clouds. The book, in fact, notwithstanding the amount of technical information which it is its purpose to give, is anything but dull reading, and the author shows his artistic sense in some enthusiastic tributes to the magnificence of thunder clouds.

The Place Names of Galloway: their Origin and Meaning Considered. By the Right Hon. Sir Herbert Maxwell. Pp. xlvi+278. (Glasgow: Jackson, Wylie and Co., 1930.) 21*s.* net.

THE English Place-Name Society has introduced to a wider public the intense interest and value of a scientific study of place-names, especially in areas of racial contact. The locality with which Sir Herbert Maxwell deals is particularly instructive from this point of view. The great majority of the place-names were originally in the Erse or Gaelic dialect. No doubt they were perfectly intelligible until the introduction of Old Northern or Middle English. Although they then remained unchanged, the ideas which had suggested them were forgotten. Hence many of them can now be interpreted only through analogy with districts where Gaelic, Manx, or Welsh are still living languages. Some, however, must, in the nature of the case, remain unintelligible, perhaps for ever. Among the Galloway place-names are names of rivers which, it has been suggested, may belong to the language of the aboriginal long-headed, dark-haired population, and have affinities with Basque—an interesting suggestion, which unfortunately remains nothing more at present. The author has some interesting and pertinent observations to make on the difficulties in the way of adopting the latest views on the ethnological problem of Celtic settlement. The place-names of Galloway belong to the *q* Celts, while the neighbouring area of Dumfries is Brythonic.

Forged, Anonymous and Suspect Documents. By Capt. Arthur J. Quirke. Pp. xii+282. (London: George Routledge and Sons, Ltd., 1930.) 15*s.* net.

THE public taste for amateur detective literature was largely stimulated during the last quarter of the nineteenth century, and the one amusing factor was the unwarranted contempt poured upon the Criminal Investigation Department at Scotland Yard. In this book, however, Capt. Quirke (handwriting analyst to the Department of Justice, to the Attorney-General, and police headquarters, Irish Free State), whilst possibly somewhat patronising in his prefatory attitude to the police force, writes not as an amateur but as an official expert, mainly for the benefit of the legal profession and the police. From the individuality of handwriting he proceeds, by way of an extended consideration of analytical methods, to the details of materials and processes, arriving eventually at an illuminating exposition of the ultra-violet rays and the fluorescence test. The infallibility of this test in the detection of forgeries, as proclaimed by him, is supported by its practical adoption by the Bank of England. The author emphasises his views that not only are no two handwritings indistinguishably alike under test, but that this also applies to any two typewriters, even those of the same make and same age. The longest and perhaps the most abstruse chapter deals with a practical analysis of handwriting, a systematic study of which might prove to be beneficial to the public at large. P. L. M.

Letters to the Editor.

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

Propagation of Magnetic Disturbances along Wires.

IT is well known that the magnetisation of a ferromagnetic material changes in small steps (Barkhausen effect). We have shown [1] for a variety of materials that the sizes of these steps, or sudden changes in magnetisation, are independent of the sizes of the crystals of which the material is composed, and

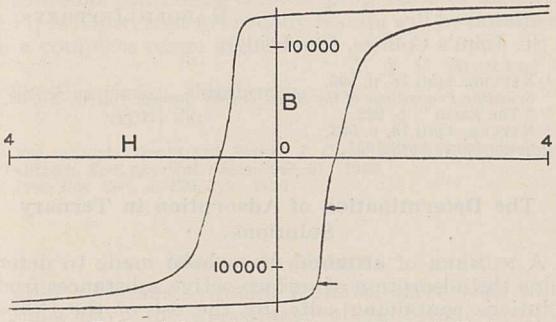

FIG. 1.—Hysteresis loop of Armco iron, maximum field strength 10 gauss.

correspond to the sudden reversal of the magnetic moment of a volume of material of the order of 10^{-8} or 10^{-9} cm.^{3}.

We now find that in many materials these small steps in magnetisation occur in groups of such size as to be detectable with a sensitive galvanometer. This effect for iron is illustrated in the accompanying figures. Fig. 1 shows a hysteresis loop of Armco iron recorded photographically with the fluxmeter recently described by Haworth.[2] No discontinuities are apparent here. Fig. 2 represents the portion of the loop lying between the arrows shown in Fig. 1, recorded more slowly with greater fluxmeter sensitivity, and shows the large steps under consideration. These steps appear only when the field is changed slowly; this is because it takes the magnetisation several tenths of a second to increase in any one step, and if during that time the field strength increased enough to set off the next change in magnetisation, the steps will not be separable. While taking Fig. 2 the field strength was changed 0·2 gauss per minute.

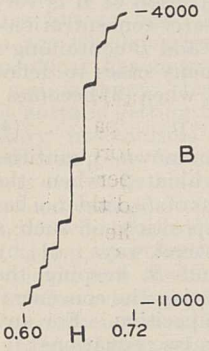

FIG. 2.—Portion of loop of Fig. 1, recorded slowly.

That each such step in magnetisation is composed of a great many separate smaller changes is shown in Fig. 3, where the whole record refers to the change in magnetisation occurring in one of the steps shown in Fig. 2. Each sharp point of the record indicates one of the small steps or discontinuities discovered by Barkhausen. The record was made with the usual arrangement [3] of search coil, amplifier, and oscillograph, used with a slowly and uniformly changing magnetic field strength.

Separate tests have shown us that the change in magnetisation corresponding to one of the single steps of Fig. 2 occurs throughout all sections of the sample, except near the ends, where the field is far from uniform. This fact suggested that the magnetic disturbance was transmitted from one part of the sample to another by mechanical vibrations produced by the sudden change in length accompanying the change in magnetisation (magnetostriction). The other way in which the disturbance might be propagated is by magnetic influence alone. According to the latter idea, the increase in magnetisation occurring at one point increases the field strength and consequently the magnetisation at nearby points. To distinguish between these two methods of propagation, an experiment was made as follows: The large step-like changes were made to occur over almost the whole length of the iron wire as before, but were prevented from occurring in a length of two centimetres in the middle by applying a field there in the opposite direction. The sudden changes in the two halves of the wire were then found to be completely independent of each other, or incoherent, whereas with no back field in the middle they were always coherent. Since elastic waves pass unhindered through the middle portion, and experiment showed that no change in magnetisation occurred here, it is concluded that purely magnetic processes are responsible for keeping the disturbance going once it is started.

We have examined similar disturbances in annealed iron wires so fine as 0·0017 cm. in diameter and found that the changes in magnetisation are in much larger steps, a single step accounting for almost the whole change from saturation in one direction to saturation in the other. These recall the results in hard drawn wires under tension and torsion described by Preisach [4] and by Sixtus and Tonks.[5] In our own experiments, when the diameter is less than about 0·01 cm., the separate small Barkhausen discontinuities cannot be detected even with an oscillograph recording frequencies up to 4000 cycles per second. The whole change occurs in one step and travels along the wire with a speed inversely proportional to the square of the diameter of the wire. This also suggests that the magnetic field strength controls the propagation, since the rate of decay of eddy-currents varies inversely as the square of the diameter.

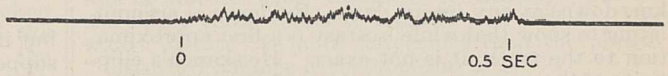

FIG. 3.—Oscillograph record of one of the single steps of Fig. 2, ordinates proportional to time rate of change of magnetisation.

R. M. BOZORTH.
J. F. DILLINGER.

Bell Telephone Laboratories, Inc.,
New York, N.Y.,
April 6.

[1] *Phys. Rev.* (2), **35**, 733-52; 1930.
[2] *Bell Sys. Tech. Jour.*, **10**, 20-32; 1931.
[3] Loc. cit. 1. The oscillograph was recently described by A. M. Curtis, *Bell Record*, **8**, 580; 1930.
[4] *Ann. der Phys.* (5), **3**, 737-99; 1929.
[5] *Phys. Rev.* (2), **35**, 144-1; 1930.

The Earth's Thermal History.

DR. J. H. J. POOLE has kindly pointed out to me that the reference to the adiabatic gradient of temperature in my previous letter [1] is capable of being understood to mean that he believes that the adiabatic gradient in a liquid heated below would not be maintained. This was not intended; the maintenance of the adiabatic gradient by convection currents (or rather, of one exceeding it by the trifling amount

needed to start and maintain convection currents) is essential both to his views and mine. My point was simply that excess heat would be carried up by convection currents, as in the formation of cumulus clouds on a summer day, while a passage in his letter had appeared to cast doubt on this.

My own views on the earth's thermal history have undergone some change since my original criticism of Prof. Joly's theory, and Dr. Poole's theory also differs from the original (he does not appeal to Prof. Joly's bodily revolution of the crust to ensure resolidification). An important change on both sides has been in the recognition of the importance of the fact that the melting point gradient in rocks is steeper than the liquid adiabatic. This was first noticed by Dr. L. H. Adams and rediscovered by Drs. J. H. J. and H. H. Poole. My present views are given in " The Earth ", second edition, pp. 138-148.

I have not yet had time to study Dr. Poole's paper [2] in detail, but it seems to me that its postulates differ from the geophysical problem in two respects. The earth is replaced by a deep vertical column, initially solid, with a non-conducting bottom. My view is that the earth was originally fluid throughout, and that it could never become solid throughout until such upward concentration of radioactive constituents had been achieved as to permit complete resolidification of the rocky shell. I think it improbable that the excess of the melting point gradient over the liquid adiabatic persists below a depth of a few hundred kilometres, so that the first solidification would be at an intermediate depth, and the condition at the lower boundary of the solid would be contact with a liquid in a convective state.

It seems to me that, apart from thermal considerations, there is a fatal defect in all theories requiring widespread weakness or fluidity in the lower layer of the earth's rocky shell (that is, between 30 km. and 3000 km. down) at any recent date. Evidence is accumulating to show that while isostasy is a first approximation to the truth, it is not exact. Heiskanen's ellipticity of the equator refers to the equipotential surface, not the solid surface. The corresponding difference between the mean and maximum radii of the equator of the solid, if the inequality is uncompensated, is about 0·7 km.; if compensated, it would have to be about 20 km., an entirely impossible amount.[3] The stresses involved in the support of this inequality must be distributed through a great depth, perhaps most of the thickness of the shell. There are several pieces of evidence tending in a similar direction, one of the most striking being the differences between the moon's moments of inertia, which must have persisted through most of the history of the earth. The recent work of the Indian Survey [4] and that of Dr. Vening Meinesz [5] constitute others. Now, if there had been any general fusion within a few hundred kilometres of the surface since these inequalities were formed, their pressure would certainly have displaced the liquid and restored the isostatic state.

I think we may go somewhat further than this. It is wildly unlikely that the material of the earth, at any depth, is a sufficiently pure substance to have a sharp melting point. For most geophysical purposes the melting point is the temperature at which the material acquires a sufficiently high viscosity to prevent convection currents; but the viscosity must vary continuously over a wide range of temperature. Now, in any theory of thermal cycles, after a solidification, heat transfer is by conduction and is a slow business. I think that in all such theories the variation of temperature in the solid between cycles is only a few degrees (except within, say, 50 km. of the surface). This applies to Prof. Joly's original theory, to Dr. Poole's modification, and to the various theories that Prof. Holmes has produced since he abandoned the theory of the earth's thermal history that he had done so much to establish, and which I still consider correct in essentials. To reconcile any theory of cycles with the observed imperfection of isostasy therefore requires that, in the lower layer, the strength of which supports the excess loads, a change of temperature of a few degrees corresponds to a change of mechanical properties, from sufficient softness to permit convection currents, to sufficient strength to support the stresses due to excess loads, normally of the order of 200 metres of material, and running up locally to some kilometres. It seems to me that the necessity of such a rapid change in strength with temperature in a substance without a sharp melting point is enough by itself to render any such theory untenable.

HAROLD JEFFREYS.

St. John's College, Cambridge.

[1] NATURE, April 18, p. 595.
[2] *Scientific Proceedings of the Royal Dublin Society*, vol. 19, No. 32.
[3] " The Earth ", p. 222.
[4] NATURE, April 18, p. 593.
[5] *Geog. Jour.*, April 1931.

The Determination of Adsorption in Ternary Solutions.

A NUMBER of attempts have been made to determine the adsorption of surface-active substances from solutions containing salts, by the use of the Gibbs' equation, in the form

$$d\rho/d\mu_B = -\Gamma_B, \quad . \quad . \quad . \quad (1)$$

where $d\rho$ is the variation of the surface tension caused by a change $d\mu_B (= RTd\log a_B)$ in the potential of the substance B.[1] The complete equation of Gibbs as applied to a ternary system A - B - S is

$$\Gamma_A d\mu_A + \Gamma_B d\mu_B + \Gamma_S d\mu_S + d\rho = 0, \quad . \quad . \quad (2)$$

but if the dividing surface up to which the solution is supposed to be perfectly homogeneous is defined so that $\Gamma_A = 0$, this becomes

$$\Gamma_B d\mu_B + \Gamma_S d\mu_S + d\rho = 0. \quad . \quad . \quad . \quad (3)$$

This equation reduces to (1) when the variation of μ_S is negligible in comparison with that of μ_B. This will be the case when the concentration of B is very small, but will cease to hold at greater concentrations.

In dealing with a solution of A and B containing a salt S, it is more convenient in many cases to define the dividing surface so that $\Gamma_S = 0$, when (2) becomes

$$\Gamma_A d\mu_A + \Gamma_B d\mu_B + d\rho = 0. \quad . \quad . \quad . \quad (4)$$

This equation contains two unknown quantities Γ_A and Γ_B, which cannot be evaluated when the variation of $d\rho$ for known variations of $d\mu_A$ and $d\mu_B$ has been determined. But the composition of such a solution can be varied in two distinct ways: (1) by varying the proportions of A and B, keeping the amount of S constant; (2) by varying the concentration of S in solvents of fixed composition. For any given solution we may thus obtain two equations:

$$\Gamma_A d\mu_A + \Gamma_B d\mu_B + d\rho = 0,$$
$$\Gamma_B d\mu_A' + \Gamma_B d\mu_B' + d\rho' = 0;$$

referring to variations of the two kinds mentioned, and these permit the evaluation of Γ_A and Γ_B.

In a binary solution of A and B, the surface *excess* Γ_B can only be identified with the actual amount of B present in the surface layer, when the concentration of B is small. In concentrated solutions, no method is available for determining unambiguously the composition of the surface layer.

It is evident that in the presence of a salt, which is

negatively adsorbed with respect to the other constituents, the method outlined may give a means of determining the actual composition of the surface layer.

The measurements of the partial vapour pressures of water and alcohol in solutions containing various concentrations of lithium chloride which have recently been made in this laboratory by Shaw and Butler [2] provide the data required in these equations. Mr. A. D. Lees has determined the surface tensions of some of these solutions in order to test the feasibility of this method, and has obtained provisionally the following ratios for $\Gamma_{(alc.)}/\Gamma_{(water)}$ in 1*m* lithium chloride solutions:

Molar fraction of alcohol	6·4	25	80
$\Gamma_{(alc.)}/\Gamma_{(water)}$ . . .	0·3	0·7	14

The vapour pressure measurements are being extended to solutions containing a lower proportion of alcohol, and it is hoped that eventually results will be obtained for a complete range of solutions.

J. A. V. BUTLER.

The University, Edinburgh,
April 29.

[1] For example, Goard and Rideal, *J. Chem. Soc.*, **127**, 1668, 1925; S. Palitzsch, *Zeit. physikal. Chem.*, **147**, 51; 1930.
[2] *Proc. Roy. Soc.*, A, **129**, 519; 1930.

Disease in Nature.

MOST naturalists would, I think, agree that wild animals have the appearance of exuberant health, and that it is quite unusual to meet with any obvious illness or disease. But it is a very optimistic inference that civilised man might achieve the same state.

So far as parasitic diseases are concerned, natural communities of animals, where there is no hygienic interference, seem to come into a state of equilibrium with their parasites which is rarely broken through into either the complete destruction of the parasite or the appearance of an epidemic in the host. Archdall Reid used to argue that human infections should be treated in the same way and left alone to do their worst.

A great number, however, probably the majority, of the bodily defects which give rise to the 'sub-health' of human communities are due not to parasites but to age. Man's body begins to decay at an age which varies widely in different individuals, but decay has generally definitely set in by the time a man is thirty: his lungs are losing their elasticity, his aorta is getting fibrous, his respiratory and circulatory mechanisms are relatively inefficient: few men can play first-class football above thirty. By forty-five even his brain is growing smaller. A large and increasing part of our population have, therefore, bodies which have deteriorated by the natural process of ageing, and there is no evidence that the enormous hygienic and medical advances of the last hundred years have done anything to postpone the effect of age. The expectation of life at birth has nearly doubled, but for old men it is no greater than it used to be.

In natural animal communities such age-deteriorated individuals are eliminated by the ordinary processes of selection. The same would presumably happen in man if survival depended on physical efficiency. Artificial breeding experiments (for example, with mollusca) indicate that the possible length of life is much more than that usually attained in the wild state. The wild populations are, therefore, healthy in a way which human populations can never hope to achieve. It does not seem likely that hygienists can do anything very effective in altering the tissues on which injurious agents work, though they can, of course, do much in protecting man from such agents. Whether the age at which the body begins to go downhill is a heritable quality I do not know: it probably is, for length of life is intensely inherited. The most likely eugenic procedure seems, therefore, to be to select for age at death.

A. E. BOYCOTT.

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Herts.

THE discussions in NATURE of April 25 and May 9, on the occurrence of disease among animals and plants living under natural conditions, are of importance from several points of view, both economic and scientific. While I do not admit the validity of the reviewer's distinction between internal predators and diseases, yet, for the sake of the argument, we can eliminate the huge death-roll of insects due to insect parasites and still leave a large death-roll due to diseases.

Bacterial diseases are common among insects, especially during the larval stage; the larvæ of Lamellicorn beetles living in the soil being very subject to attacks of bacteria. In the tropics many Lepidoptera larvæ suffer from such diseases. Fungal diseases among insects are common all over the world, but more noticeably in tropical rain forests, where they are sometimes the chief controlling factor in limiting the numbers of some insects. Economic entomologists are familiar with these facts.

Insects attacked by these diseases show all the signs of "disintegrative and deteriorative disturbances" shortly before death. By saying that these insects are 'diseased' I may be "influenced by human prejudices", as Mr. Maulik contends, but if we use the word in connexion with human beings, then it is also applicable to other animals. No one would ever talk of Nature being 'diseased' or 'healthy', but we can apply those terms to animals and plants. The word 'disease' is more convenient than the phrase "disturbed balance of metabolism".

Disease among insects leads to a speedy death, and the superficial observer only notes the active, healthy specimens. In spite of the great importance of a correct knowledge of the death factors of animals and their relative values as selective factors, in our understanding of natural selection, only superficial attention, so far, has been given to this subject. Among insects the greatest mortality falls upon the eggs and young, perhaps some eighty per cent, and the chief death factors are diseases (including parasitism). If we ignore this fact and base our statistics upon the idea that all, or the greater part, of the mortality falls upon the adult, and has selective value, we are likely to reach wrong conclusions. For this reason, if for no other, it is necessary to recognise diseases (including parasitism) among insects, and their overwhelming value as death factors.

F. MUIR.

Manoa, Warnham, Sussex,
May 11.

Vegetable Juices as Fixatives.

SINCE the article on "A Modified Gold Chloride Method for the Demonstration of Nerve Endings" was published by Mr. Fred W. Gairns, of Glasgow,[1] we have been experimenting with vegetable juices, other than lemon. This communication is intended only as a preliminary announcement of the uniformly satisfactory and constant results that we have obtained with them, and we hope to be able to publish an account of our investigations in greater detail soon in the *Mysore University Journal*. The following

juices have been employed, both for the purpose of demonstrating the nerve endings and for general histological investigations, with great success: Onion

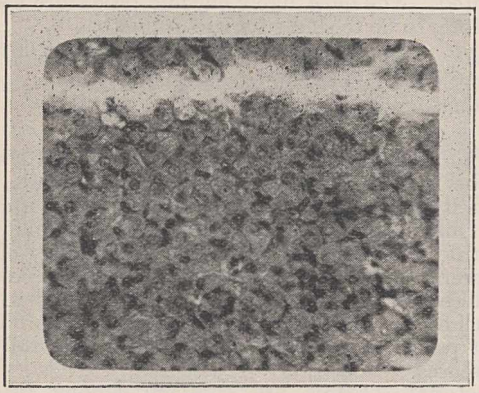

FIG. 1.—Corpus luteum of domestic rat, fixed in onion juice and stained with hæmatoxylin.

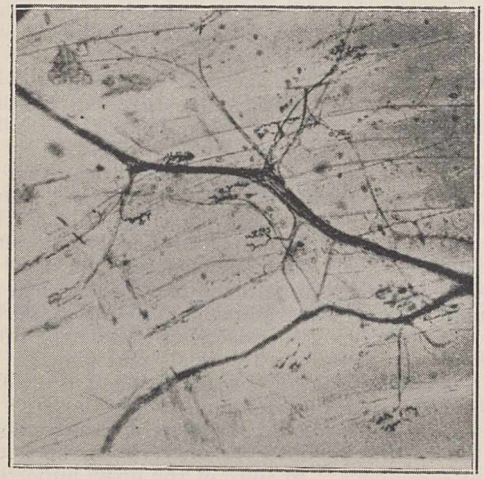

FIG. 2.—Nerve endings in the diaphragm of *Loris*; onion-formic-gold chloride.

FIG. 3.—Nerve endings in the intercostal muscles of *Loris*: citric-formic-gold chloride.

juice (*Allium cepa*); mango juice, green and unripe (*Mangifera indica*); tamarind juice, green and unripe (*Tamarindus indica*); gooseberry juice (*Phil-anthus emblica*); sour milk (whey).

Three photomicrographs are here reproduced (Figs. 1, 2, 3) to show the degree of accuracy and detail which may be obtained by these new methods.

In addition to the above juices, we have also used uric acid from the urine of the pigeon, and also cow's urine, besides citric and formic acids. We may only note here that vegetable juices with formic acid and 5 per cent formalin separately in certain proportions, which we shall announce soon, have also given very satisfactory results.

A. NARAYANA RAO.
L. S. RAMASWAMI.

Department of Zoology,
Central College, Bangalore,
April 9.

[1] *Q J.M.S.*, vol. 74, part 1, N.S. No. 293, Sept. 1930, p. 151.

Occurrence of *Protodrilus flavocapitatus* at Port Erin.

BRITISH Archiannelids are so few in number, and their habitats so little known, that any new observations on their occurrence are well worth recording.

One of the smaller members of the group, *Protodrilus*, was first taken in the adult condition on the south coast of England in 1913 [1] in a peculiar habitat, namely, just below H.W. neaps under stones embedded in fine gravel (pebbles 1-5 mm. with larger constituents) and in the gravel itself in localities where fresh water runs into the sea. It was later discovered in abundance in similar habitats—usually accompanied by the planarian *Procerodes ulvæ* (=*Gunda*), the isopod *Jaera marina*, and various Oligochæts and Gammarids—at numerous situations on the south and west coasts from Exmouth to Woolacombe, near Ilfracombe [2, 3]. In June 1929 and April 1930 a careful but unsuccessful search [4] was made for this animal (by one of us, J. H. O., and Miss M. K. Molyneux) in the locality of Port Erin, in the Isle of Man.

The search was continued this year and this interesting primitive worm found early in April in Port Erin Bay on Traie Vane and Spaldrick beaches, in habitats similar to those previously described.[2] At other localities near Port Erin, namely, at Fleshwick Bay, Port St. Mary (Mill Stream), and Perwick Bay, where streams run into the sea, *Procerodes*, *Jaera*, and the other normal associates of *Protodrilus* were again found,[4] sometimes in great numbers, but the Archiannelid itself was not seen. Comment on the apparent absence of *Protodrilus* from these localities is of little use at present, but a review of the habitats where the animal has been taken indicates that the following are important factors in determining the habitat: (1) stones lying on fine gravel or coarse sand at about to a few feet below the level of H.W. neaps in (2) situations remaining at least damp at low tide, (3) the proximity of fresh water, and (4) protection from direct wave action. In view of Pantin's recent work [5] on *Procerodes*, an additional factor is probably (5) the necessity for a certain concentration of calcium ions in the fresh-water stream.

The presence of shelving rocks below the H.W. neap zone undoubtedly affords the measure of protection from wave action conducive to a *Protodrilus* habitat; while in northern latitudes it is possible that beaches exposed to sunshine, as are those of Traie Vane and Spaldrick, are more suitable than others for a member of the genus *Protodrilus*, the centre of distribution of which is Lusitanian.

The seepage water in which *Protodrilus* was living on the exposed beach at Traie Vane was found to vary in temperature closely with the air, except just after the recession of the tide. A temperature so low as 7·5° C. was recorded, but much lower readings would be obtainable in winter; the salinity showed only slight variations, as the fresh-water stream was nearly

dry (about 29 to 33 per mille at *p*H 7·9 to 8·2 (corrected), as kindly determined by Mr. J. R. Bruce), but lower salinities would occur after heavy rains. On the south coast of England the animal has been taken in water which was almost fresh.[1]

It is possible, therefore, that *Protodrilus* may occur in suitable habitats as far north as Scotland.

The occurrence of 'red head', ventral eye-spots, bifurcate caudal appendages, segmental cilia, and the characteristic numerous epidermal glands figured by Pierantoni[6] define the species as *Protodrilus flavocapitatus*, Uljanin, which, however, attains a larger size (lengths of 20 mm. being common) than that recorded by Pierantoni.

J. H. ORTON.
H. B. MOORE.

Marine Biological Station, Port Erin,
April 16.

[1, 2] NATURE, **91**, pp. 85 and 348; 1913.
[3] NATURE, **110**, p. 574; 1922.
[4] 44th Ann. Rep., Mar. Biol. Stat., Port Erin; 1931.
[5] *Jour. of Exper. Biol.*, **8**, pp. 82-94; 1931.
[6] "Fauna and Flora, Neapel", 31, Berlin; 1908.

Wheat Surplus and its Cause.

THE comment made by Prof. Piaggio in NATURE of March 21, upon the address by Sir Arthur Eddington, cites the famous prophecy by Sir William Crookes, made near the end of the last century, as to the probable wheat supply in the future, say thirty years from the time of his address. The comment indicates that the present wheat surplus is due to the recent advances in fixing nitrogen and making new fertilisers. Sir William Crookes saw future controlled nitrogen fixation as the gleam of light amid the murky gloom of anticipated short wheat rations. While modern fertilisers may have had a slight influence in bringing about the present flood of wheat, their effect has certainly been a minor one.

The increase in the world's wheat production above what was anticipated is a complicated problem, but the utilisation of new types of machinery has certainly been a dominant factor. Sir William Crookes instances eight States of the U.S.A. located in a region "so arid as to be of infinitesimal value for food production relatively to the whole area" (with regard to tillable land). While he cites but 810,000 acres of this large area as devoted to wheat in 1897, we find that in 1929, thirty-two years later, the wheat land of this region had increased to 7,500,000 acres, with a production of 100,600,000 bushels. This nearly tenfold increase, in a region where further increase seemed impossible, has come about almost entirely because of the introduction of power machinery and the greatly increased utilisation of the combine harvester. Other regions would tell a similar story. Sir William Crookes's dictum was that the world's average yield per acre would have to be increased very materially to make up the impending shortage, and that such an increase would necessitate the comparatively abundant use of nitrogenous fertilisers. This has not proved true.

L. R. WALDRON.

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Origin of *Spartina Townsendii*.

FROM its characteristics and the circumstances of its origin, Stapf[1] and others have concluded that the cord or rice grass, *Spartina Townsendii* H. and J. Groves, must have originated on the foreshore of Southampton Water as a hybrid between *S. alterniflora* and *S. stricta*. The only objections to this have been raised on the ground that it is fertile and breeds true to type.

Cytological study has shown *S. Townsendii* to have 126 chromosomes in its root-tip cells—nearly double the highest number previously reported in the Gramineæ—and its putative parents have been found to have 70 and 56 respectively. These observations support the assumption that *S. Townsendii* is of hybrid origin and, further, they explain its fertility and its true-breeding behaviour. It is an allopolyploid similar to *Primula kewensis* and other recent experimentally produced plant species.

S. alterniflora is generally considered to be an introduced species from America, while *S. stricta* is native. The hybridisation and chromosome doubling which have given rise to *S. Townsendii* occurred in Nature, without human agency, but yet in such circumstances as almost to approximate experimental control. *S. Townsendii* has almost completely eliminated its parents wherever it has come into competition with them, and has spread very widely from its centre of origin. It emphasises the fact that one of the results of allopolyploidy is the maintenance of hybrid vigour, and is a striking example of the significance of hybridisation followed by polyploidy in plant evolution, as it seems to rise above the objections which have caused some authors to hesitate in their admittance of full specific rank to newly originated allopolyploids.

The economic significance of *S. Townsendii* has been widely discussed and need not be considered here.

A more complete account of the cytological observations is being published in *Genetica*.

C. LEONARD HUSKINS.

Dept. of Botany,
McGill University, Montreal,
Mar. 26.

[1] *Curtis's Bot. Mag.*, **152**, Tab. 9125; 1926.

The Altitude of Bird Migration.

IN NATURE of April 18, T. B. Blathwayt records a party of egrets observed (through a telescope) migrating at night, and about five thousand feet up; and he asks if there are other records of a similar nature.

In America some valuable material has been collected on the altitude of flight, by means of telescopic observations, but in Britain and elsewhere most of the scanty data have been obtained from aeroplanes. Chapman[1] collected altitude records for 262 birds crossing the face of the moon, all between 1500 ft. and 15,100 ft. Scott[2] noted large numbers of birds migrating between five and ten thousand feet, and Carpenter[3] recorded birds passing over by night between 1400 ft. and 5400 ft., while Winkendwerder[4] compiled a mass of information on migration by making telescopic observations.

Meinertzhagen,[5] in a review of the whole subject, gives thirty-six records of birds above 5000 feet (excluding the American work cited above). The greatest altitude for migratory flight known to me is that recorded at Dehra Dun, India, where a party of geese were accidentally included in a photograph of the sun; these birds were estimated to be flying at 29,000 feet.[6] Lammergeiers, godwits, curlews, and choughs have been observed above 20,000 feet on Everest, and a number of birds (perhaps cranes) were noted from an aeroplane at 15,000 feet during the War.[7]

There can be little doubt that the main bulk of migration (much of which passes by night) occurs at less

than 3000 feet. But our knowledge is still far from complete, and all who may obtain observations on this subject should follow Mr. Blathwayt's example by putting the occurrence on record (even if the species is not identified).

T. H. HARRISSON.

Pembroke College,
Cambridge.

[1] *Auk*, 1888, pp. 37-39.
[2] *Bull. Nuthall Orn. Club*, **6**, pp. 97-100.
[3] *Auk*, 1906, pp. 216-217.
[4] *Bull. Wisconsin N.H. Soc.*, **2**, pp. 97-107.
[5] *Ibis*, 1920, pp. 920-936.
[6] *Field*, Dec. 18, 1920, p. 876.
[7] *Ibis*, 1919, p. 321

Ultra-Violet Absorption and Raman Effect for Hydrazine.

THE ultra-violet absorption in hydrazine vapour, N_2H_4 (saturation pressure over the liquid at room temperature), consists of five or six nearly equidistant intensity maxima at about 2326, 2320, 2276, 2250, 2225 A., followed by continuous absorption, beginning at about 2200 A. and extending into the whole quartz region.[1] The band absorptions are entirely devoid of rotation structures at 5·4 A. per mm. dispersion.

To obtain some knowledge about the mechanism of dissociation shown at 2200 A., I have also photographed the Raman spectrum of the same substance using a column of liquid 1 cm. in diameter and 10 cm. in length, irradiated by a suitably filtered mercury arc so that only the radiations at 4047 A. and 4359 A. are effective (details of the experiment to be published in the *Scientific Papers* of this Institute).

Two sets of five sharp modified lines are observed under low dispersion, simply displaced by the separation of the two exciting lines, with the following frequency shifts from their respective lines of origin :

$\Delta\nu$ (cm.$^{-1}$) *a*, 900 (weak), 1120,
b, 3212, 3289, 3339.

The *b* lines are nearly of the same intensity and agree very well with the triplet observed in liquid ammonia (NH_3) by Daure[2] and others. They represent undoubtedly the *internal* vibration frequencies of the N-H or NH_2 group, the last one corresponding to the absorption centre of the 3μ band of ammonia (3337 cm.$^{-1}$).

Now, Dadieu and Kohlrausch[3] interpret Daure's line of lower frequency, 1070 cm.$^{-1}$ of ammonia, as due to the single bond vibration in the polymerised molecule H_3N-NH_3 with quadrivalent nitrogen supposed to exist in liquid ammonia. If this is true, my 1120 line is safely attributed to the N-H (single bond) vibration in the hydrazine molecule.

The hydrazine used was prepared from the hydrate $N_2H_4.H_2O$, and the weak line at 900 cm.$^{-1}$ is probably due to hydrazine hydrate molecules still remaining. This point I hope to verify with pure hydrate, but at the moment the substance is rather difficult to obtain.

It is not difficult to imagine that the N-N binding is very much loosened in an excited gaseous state, and the 500 cm.$^{-1}$ vibration frequency observed in ultra-violet absorption may arise from this. The dissociation of hydrazine vapour by 5·5 volt light absorption therefore seems to be effected by the breaking of the excited molecule in the middle. Considering the sharpness of the spectrum, the bands preceding may be regarded as a structureless predissociation spectrum.

S. IMANISHI.

Institute of Physical and
Chemical Research, Tokyo,
April 17.

[1] *Sci. Pap. Inst. Phys. Chem. Res.*, **15**, 166; 1931
[2] *C.R. Acad. Sci.*, **188**, 61; 1929.
[3] *Naturwiss.*, **18**, 154; 1930.

Crystal Structure of Chromium Trioxide.

SMALL thin red needles, heavily striated down the prism, were prepared by adding concentrated sulphuric acid to a cold concentrated solution of potassium dichromate. The crystals were sealed up separately in thin glass tubes to prevent deliquescence. Measurements on an ionisation spectrometer and from oscillation photographs gave the value of the cell size as $a = 8{\cdot}50$ A., $b = 4{\cdot}73$ A., $c = 5{\cdot}72$ A., the probable error being not greater than ± 1 per cent. The density given by Groth is 2·73–2·82 and there are therefore 4 molecules per cell. The axial ratios given by Nordenskjöld[1] are $a : b : c = 1 : 0{\cdot}69 : 0{\cdot}63$. The relation between his ratios and ours is $a : b : c$ (Wooster) = $a : \frac{3}{4}b : c$ (Nordenskjöld). The only face from which he could obtain the ratio $a : b$ should have been indexed (230) instead of (120). All the specimens which we have examined up to the present are mimetic twins on (110), closely simulating hexagonal symmetry.

Ionisation and photographic investigations show the following halvings:

(hkl) when $(h + k)$ is odd.
($0kl$) when l is odd.

These suggest the space-group Q_h^{17} – *Ccmm* and the co-ordinates of the chromiums are as follows, the centre of symmetry being taken as origin: u, 0, $\frac{1}{4}$; $\bar{u}$, 0, $\frac{1}{4}$; $\frac{1}{2}+u$, $\frac{1}{2}$, $\frac{1}{4}$; $\frac{1}{2}-u$, $\frac{1}{2}$, $\frac{1}{4}$. The value of u is doubtful, because the intensities are disturbed by the twinning, and fall off very rapidly, but u is probably about $\frac{1}{8}$. The observed halvings appear to require a structure consisting of tetrahedra of CrO_4 linked together in chains parallel to the c axis. This would explain the cleavages, which are very well marked parallel to this direction and tend to cause the crystal to break up into fine needles.

The work will shortly be continued at low temperatures and published in the *Zeitschrift für Kristallographie*.

W. A. WOOSTER.
N. WOOSTER.

Mineralogical Laboratory,
Cambridge,
May 6.

[1] A. E. Nordenskjöld, *Pogg. Ann. Phy. u. Chem.*, **114**, 622; 1861.

Deep Focus Earthquakes.

IN a letter published in NATURE of Mar. 28 (p. 486), Mr. F. J. Scrase, referring to an earthquake which was registered at Kew Observatory on Feb. 20, explained briefly how it was possible to recognise the abnormal depth of focus and to make an estimate of this depth. Confirmation of the deep focus of this earthquake has now appeared in a Seismological Bulletin issued by the Jesuit Seismological Association of America.

From the fact that the primary pulse (or *P* wave) reached Kew, Pasadena, and Riverview almost simultaneously, it is deduced that the epicentre of the earthquake was in latitude 44° N. and longitude 135° E., about 200 miles from Vladivostok. At every station for which the records have been examined, the interval between the times of arrival of the *P* and *S* waves was abnormally short for the distance from the epicentre. Moreover, the arrival time at La Paz of *P′* (the horizontal wave which passes through the earth's central core) is about one minute early, and, as La Paz is at an epicentral distance of about 150°, this early arrival strongly supports the other evidence for deep focus.

F. J. W. WHIPPLE.

Kew Observatory,
Richmond, Surrey,
April 30.

Applied Geophysics.

IN opening to the public a geophysical exhibition, and in publishing a handbook* which not only is descriptive of the exhibits but also constitutes an admirable historical résumé of and introduction to the study of applied geophysics, the Science Museum, South Kensington, has taken an important step in promoting the development of this branch of science; a step which is particularly appropriate at the present moment in view of the growing appreciation in Great Britain of the practical value of these relatively new methods of exploration. The exhibition is specially arranged to demonstrate the nature of geophysical prospecting operations, the various forms of instruments and field equipment employed, and the types of practical problems with which they are capable of dealing. Certainly, never before in Great Britain has there been a better opportunity for geologists and mining engineers to familiarise themselves with a subject which is rapidly becoming an important factor in the development of the world's mineral resources.

In the handbook, the four principal geophysical methods (magnetic, gravimetric, seismic, and electrical) are dealt with individually. In the first half of the book, an eminently readable and well-balanced historical account is given of these methods, with explanations in simple language of the general physical principles on which they are based. Although the literature of applied geophysics is extensive and in many languages, it is not readily accessible to the public, but in these pages there is ample evidence of an extensive research into the development of the various methods and regarding the most recent practice both in Great Britain and abroad. The sane outlook which is reflected will do much to dispel any misunderstandings which may have arisen in the minds of some in consequence of exaggerated claims or unduly sceptical opinions regarding geophysical methods of exploration that have occasionally appeared in print.

It is appropriate that an authoritative work on this subject should begin by dispelling the popular misapprehension that there is some connexion between geophysical exploration and the divining rod; an instrument which is aptly described on the second page as "an unscientific device depending on real or imaginary supernormal faculties possessed by certain individuals". This definition will be in accord with the opinions of most geophysicists and geologists. The persistence of the popular belief in the divining rod is truly remarkable, and it may be of interest to mention that in certain of the more remote parts of the British Empire the faith in this device for locating water is so ingrained that professional diviners are still employed upon the staffs of some government departments.

Although the full theory of the several geophysical methods requires a somewhat specialised study, the fundamental principles which underlie their applications to the search for mineral deposits and to the investigation of geological structures are relatively simple, and thus it will be readily appreciated that most minerals of economic importance possess some characteristic feature by which they may be distinguished from the barren rocks which enclose them. For example, some iron ores have distinctive magnetic properties, whilst most metalliferous minerals have a relatively high density. Amongst the latter there are many which are also good conductors of electricity; the sulphide ores of iron, copper, and lead being notable examples. In the non-metallic group of minerals there are not so many outstanding cases, but advantage may sometimes be taken of the low density of certain types of coal, and several important discoveries of oil are due to the fact that rock salt also has distinctive physical properties, namely, a low magnetic susceptibility, a relatively high density, and a high elasticity. In the coastal oilfields of Texas and Louisiana, the oil is characteristically associated with large plug-like masses of salt. Although the oil cannot be detected directly, it has been possible to locate these *salt domes* by geophysical methods, and thus to discover the oil-bearing ground. Magnetic, gravimetric, and seismic methods have all been used for this purpose; the success obtained by the latter being most remarkable.

The physical properties upon which the magnetic, gravimetric, seismic, and electrical methods are based are, therefore, those of magnetic susceptibility, density, elasticity,† and electrical conductivity. Whilst the magnetic and gravimetric methods are concerned entirely with naturally occurring phenomena (anomalies in the earth's normal magnetic and gravitational fields), it is apparent that the elastic and electrical properties of a concealed body are quite inert, except in response to an artificial applied stimulus. In the case of the seismic method, waves are propagated in the ground by means of explosive charges which are usually buried a few feet below the surface. The speeds with which these waves travel are measured with portable seismometers, and by plotting a series of time-distance graphs for each explosion, the structural features of an area may often be determined with a high degree of accuracy. In the electrical methods, current is applied to the ground, either conductively by means of earthed electrodes or inductively by insulated loops of wire which are connected to a source of alternating current. A search is then made with suitable

* Board of Education: Science Museum. "Applied Geophysics: a Brief Survey of the Development of Apparatus and Methods employed in the Investigation of Subterranean Structural Conditions and the Location of Mineral deposits." By Capt. H. Shaw, with the assistance of J. McG. Bruckshaw and S. T. Newing. Pp. 101+10 plates. (London: H.M. Stationery Office, 1931.) 2s. net.

† The velocity of propagation of a seismic wave through the ground is determined by the elastic constants and densities of the various geological formations that constitute its path. $V = \sqrt{\frac{\text{Elasticity}}{\text{Density}}}$ is the general expression of this relationship.

instruments (potentiometers, search coils, etc.) for departures from a normal current distribution or, in the inductive methods, for anomalies in the associated magnetic field. In favourable circumstances, it is possible in this way to locate the positions of conductive deposits lying several hundred feet beneath the surface.

What has been said with regard to mineral deposits also applies in principle to certain rocks and geological structures, a detailed knowledge of which is sometimes required for special purposes, such as oilfield exploration and various types of engineering problems. Although the contrast in physical properties between contiguous geological formations may not be so marked as between mineral deposits and their enclosing rocks, this fact is often compensated by the difference in scale of the two classes of investigation. Structural problems of the type referred to are usually concerned with large scale geological features in which a relatively small but consistent difference in a physical property may afford a satisfactory basis for a geophysical survey. Thus, the axis of an anticline may sometimes be determined from the fact that the material which constitutes its core is commonly of a somewhat higher density than the formations forming its flanks. A fault displacement may also be revealed quite clearly by a comparatively small difference in the mean magnetic susceptibilities of the rocks lying on each side of it.

The second half of the handbook issued by the Science Museum is descriptive of the numerous exhibits which, until the end of June, will remain open for inspection there. Although the full benefit from these pages can scarcely be obtained without a visit to South Kensington, the descriptions of the instruments are so lucid and well-illustrated that there is much to learn from them alone. The historical range covered by the exhibition is very wide; in the case of the seismic method even dating back to a seismoscope made in China in A.D. 132, and in the magnetic method to an instrument made by William Gilbert in the year 1600. Of equal interest, however, and perhaps of greater importance from the point of view of the geophysicist of to-day, is a series of modern instruments, several of which are of so recent a design that they have not previously been seen in public.

Particular attention may be directed to certain of these modern instruments with which considerable experience has been gained by the Imperial Geophysical Experimental Survey during the past two years. This Survey, it will be remembered, has been conducted in Australia under the joint auspices of the British Empire Marketing Board and the Commonwealth Government, with the special object of testing the four principal geophysical methods under a variety of field conditions. The work of the Survey has now been completed, and a full report, under the title "The Principles and Practice of Geophysical Prospecting", will be available shortly.

In the magnetic section the Schmidt vertical variometer occupies an important position, since it is probably the best known and most extensively used of the more recent types of magnetic field instrument. It is intended for quick and accurate determinations of the relatively small anomalies in the earth's magnetic field that exist in the neighbourhood of certain types of mineral deposit and rock formation, and although well designed to withstand vigorous field conditions, it is certainly more portable and simple to use than any ordinary survey instrument, such as a theodolite or level. Experience in Australia with two of these magnetometers has shown that they are capable of detecting minimum variations in the vertical component of the order of 10γ (that is, 10^{-4} gauss), and that a careful and conscientious person is capable, after half an hour's instruction, of carrying out a complete series of field observations.

In general, it is found that the position of a hidden magnetic body or the details of a concealed geological structure are revealed most effectively by determining the variations in the vertical component of the earth's magnetic field at a series of points in the area in question, and by plotting the results of the survey in the form of lines (magnetic contours) joining all points at which the values of the anomaly are the same. In Australia the form lines of the Jurassic bedrock over a portion of the Victorian brown-coal field were studied in this way, and by a somewhat similar method it was possible to delineate a complex system of Tertiary basalt flows which lies beneath an alluvial sheet in one of the New South Wales goldfields. The magnetic method has so many applications, and the observations can be carried out so rapidly and cheaply, that it is surprising that its importance as an auxiliary to geological survey work has received so little attention until within the last few years.

Amongst the gravimetric instruments, the gravity gradiometer is one of the most interesting, since it is a comparatively new development specially designed to comply with the two principal needs of the working geophysicist, which are portability and speed of operation. Advantage has been taken of the fact that the *gradient of gravity* is the primary requirement in a gravimetric survey, and that in the majority of economic investigations the *curvature values* may be neglected without materially impairing the value of the results. By eliminating the effects of curvature, it has been possible to produce an instrument (the gradiometer) in which very substantial reductions in the overall dimensions and in the free period of the beam have been effected. Two of these small balances were used in Australia by the Imperial Geophysical Experimental Survey and it was found that the gradiometer principle has much to commend it. Although less sensitive than the normal type of torsion balance these instruments are adequate for many practical purposes, and the advantages gained from the ease with which they are transported to the site of work and moved from one station to another, and from their increased speed of operation, are so great as to render them preferable for most surveys where curvature values are not essential. If curvature effects and a higher degree of sensitivity are required, then recourse must

be had to the larger types of instrument that are represented in the Exhibition.

In Australia the principal use of the gradiometers was in determining the dispositions and boundaries of a concealed portion of the Victorian brown-coal deposits, and they proved quite effective for the purpose. One of the instruments used by the Survey is included in the Exhibition and may be compared with the most recent model which has been made by the Cambridge Instrument Company.

The display of electrical prospecting instruments certainly merits special attention, since this appears to be the first occasion on which geophysical equipment of this kind has been open to public inspection. In this connexion it is interesting to recall the following statement which appeared in 1927 in a report on geophysical surveying by a sub-committee of the Committee of Civil Research : " In particular, the electrical method has throughout been treated . . . as a jealously-guarded secret trade process. In the result, little information is available to the general scientific world regarding the methods employed . . . the apparatus required, the field operations, or the interpretations of results. We believe that . . . a full disclosure of the scientific facts would tend, more than anything else, to stimulate the natural development of this method of geophysical surveying, by placing it on a scientific footing, similar to that of the gravimetric method."

During the past few years, efforts have been made to remedy this position, and it is hoped that the forthcoming report of the Imperial Geophysical Experimental Survey will be found to assist in this direction to a substantial extent. Electrical methods were used in many parts of Australia, and several of the instruments which were developed and used by the Survey are to be seen at the Science Museum, with examples of the latest patterns which have resulted from the field experience gained during these investigations. Amongst these are the standard types of equipment used in the well-established equipotential line and spontaneous polarisation methods; and the Bieler-Watson double coil, with which inductive fields are investigated, and the ratiometer apparatus which was described in NATURE of Jan. 3, 1931, p. 37, are also to be seen. A further exhibit is the ' Megger ' earth tester, which is now being used extensively in connexion with earth resistivity surveys.

It is noteworthy that although the foundations of these four principal geophysical methods lie predominantly to the credit of pure research workers in Great Britain, the development of their practical applications is largely due to foreign enterprise, mostly on the Continent and within the last ten years in particular. Although we must admit a serious lag in this important phase of the work, considerable satisfaction is to be derived from the ample evidence afforded in the Science Museum of the fruitful activity now being displayed by British geophysicists and instrument manufacturers. It is also gratifying to know that this Exhibition is not the only step being taken in responsible quarters to ensure that the science of applied geophysics shall continue to be developed in Great Britain along progressive lines. A. BROUGHTON EDGE.

Ultra-Penetrating Rays.*

By Prof. H. GEIGER, Tübingen.

ABOUT twenty years ago we first noted the presence of a γ-type radiation of high penetrability, probably of cosmic origin, passing through the atmosphere. The first fundamental experiments carried out by Hess and improved on by Kolhörster, in which an air-tight electrometer registered the ionisation current at different altitudes, showed us that the current increased with the altitude; at not more than a few thousand metres the current was several times larger than at sea-level. These results indicated the presence of an extremely penetrating radiation, which seemed to be markedly absorbed by the atmosphere above us. Great difficulties were met with in studying the nature of this remarkable radiation, due principally to its extremely weak intensity, high penetrability, and lack of properties affected by external influences. Our knowledge progressed slowly, and only after many years of experimentation were we able to say that the penetrability is about ten times greater than the hard γ-rays of radium, and that the ionisation in air at sea-level is slightly more than 1 ion per second per cubic centimetre. We were able to add that in the explorable regions of the atmosphere the radiation was diffuse, and, further, there seemed to be no relation to the daily movement of the sun. Even at the present time, we cannot say with certainty that the variations observed in the intensity of the radiation are wholly of atmospheric origin or partly an intrinsic property.

The doubtful origin and nature of this radiation continued to occupy our attention. The old experimental methods had been exhausted and new ones had to be evolved to insure a better understanding of the problem. During the past few years, we have progressed in two directions, namely, along electrometric lines by the improvement of the registration and the application of high pressure chambers, and by the method of electron counting. In the pressure chamber the degree of ionisation produced in the gas by the ultra-radiation is measured, while in the tube electron counter the high velocity electrons coupled with the ultra-radiation are registered singly.

The results obtained with these methods, in so far as they promise to aid in solving the problem, are discussed below. Three experimental categories are apparent: absorption measurements and the determination from the absorption coefficient of the energy of the radiation quantum; further, the coincidence measurements from which range and other properties of such high energy electrons, which are associated, if not identical, with ultra-radiation,

* Opening paper of a discussion at the Royal Society on May 14.

can be studied ; the last, which on further development will probably give us the important data, embraces those effects taking place at the boundary of two adjacent media.

The principal aspect of the first of the above divisions is the hardest component of the complex ultra-radiation. Detailed knowledge is necessary here in order to analyse the complex absorption curve. With the aid of well-known formulæ, a knowledge of the coefficient of absorption enables us to determine the highest energy quantum. The extremely thick layers of material necessary to reduce the intensity of the hard component of radiation to a small fraction thereof are scarcely available, but we may well use the great depths of water in certain lakes. Regener has extended the noteworthy absorption experiment of Millikan and others by lowering his apparatus successively to depths of 236 m. in Lake Constance. The essentials of the apparatus are a pressure chamber with quartz fibre electrometer attached, where the deflections are photographically recorded every half-hour by the automatic illumination of the quartz fibre. At the greatest depths, where the ionisation was smallest, the successive half-hour records were close to one another and the registration could, therefore, be continued for days at a time ; but at the surface of the lake, the ionisation was so large that the quartz fibre completed its run in about five hours.

By another series of experiments, Regener replaced the ionisation chamber by an electron counting tube, the record in this case being made by a small adding machine. The sums registered were recorded every hour photographically on a slowly rotating plate. On the surface, such a counter registered about 8000 electrons an hour, but at the depth of 235 m. only 13 ; the residual effect of 500 particles per hour is, of course, subtracted from the above. Both methods gave the same absorption curve, and showed, especially for the hardest component, which practically alone is present at depths from 80 m. to 235 m., an absorption coefficient of 0·020 per metre water. In other words, a thickness of 35 m. water is necessary to absorb half of this radiation, which on the Klein-Nishina formula gives a wave-length of $0{\cdot}63 \times 10^{-13}$ cm.

A completely different view of the nature of ultra-radiation was the result of a second series of experiments, in which the coincidences of two neighbouring tube counters were observed. In this fundamental work of Bothe and Kolhörster, which was later extended by Rossi, two counters were mounted, one about 5 cm. above the other. Simultaneous photographic registration showed that quite a number of impulses occurred in both counters at the same time. It is difficult to explain this phenomenon other than by the presence of fast electrons which pass through both counters. In general, one would expect the presence of fast electrons associated with such penetrating radiation; however, the penetrating power of these electrons was of a very high order, practically as high as that of the ultra-radiation itself. This was observed by placing a block of gold 4 cm. thick between both counters ; in this block only about 25 per cent of the radiation was absorbed.

Regarding these experiments alone, one cannot help thinking that ultra-radiation is not of a wave nature, but consists rather of high velocity electrons. This, indeed, was the general conclusion arrived at by Bothe and Kolhörster.

Be that as it may, it is necessary to intensify all experimental methods to determine further the nature and properties of such ultra-electrons. Heidecke, in Tübingen, took steps in this direction ; he measured the scattering of these electrons occurring in their passage through matter. With the aid of two counting tubes (A and C), 21 cm. apart vertically, he observed the coincidences which indicated the passage of ultra-electrons through the spherical angle defined by both tube counters. If a third tube counter B were so placed that the horizontal axes of all three were parallel and all in the same vertical plane, one would expect the middle tube to count simultaneously with the coincidences of the outer tubes (triple coincidence). To a large extent this was observed. On moving the lowest tube C horizontally parallel to its original position, the expected reduction in the number of triple coincidences was observed. In certain positions of C, an increase rather than a reduction in the number of triple coincidences was observed when a 5 cm. lead plate was placed between B and C. This can be explained by the scattering of a number of electrons by the lead which were registered by the tube C in its new position ; this effect can scarcely be accounted for without scattering.

We can now discuss the third group of experiments, which deal with transition effects. Hoffmann, Steinke, Myssowsky, and others have found that by the passage of ultra-radiation from one medium into another, absorption peculiarities take place. For example, on passing from a less dense medium, such as aluminium, to a more dense medium, such as lead, the radiation is more highly absorbed in the first stages of transition in the second medium. One is led to believe that the passage of the ultra-radiation through the lighter element results in the emission of soft secondary radiation. Steinke, with an extremely sensitive compensation method, in which a Hoffman electrometer served as null instrument, could show that on placing an aluminium plate in the path of the rays the intensity of ionisation was increased instead of diminished.

In my laboratory, similar experiments were also carried out, but with tube counters. In one of these studies, a 5 cm. thickness of lead and an equal thickness of aluminium were so placed that the ultra-radiation passed first through the lead and then through the aluminium before entering the counter. After first determining the number of electrons in a given interval of time, the measurements were repeated with the plates reversed. By interchanging the plates the absorption should have been the same, and a possible secondary radiation would have been noticed if it did not accidentally occur with equal intensity in both metals. The

experiments, in fact, showed that with aluminium facing the tube counter, 5 per cent more electrons were recorded than in the reverse case. A portion at least of the secondary radiation thus consists of fast electrons. By varying the plate thickness as well as material, the penetrating power of such secondary electrons could be determined. In the three substances investigated the range was approximately inversely proportional to the density and amounted in aluminium to about 4 cm. These electrons, when compared with the ultra-electrons, are extremely weak, yet of greater energy than those inherent in radioactive processes.

It is not easy to interpret the origin of these observed electrons. To take them for Compton electrons is scarcely permissible, for then their low and limited energy content cannot be explained; furthermore, the slow electrons actually observed would then need to travel nearly perpendicularly to the direction of the ultra-radiation, which is contrary to experiment. On the other hand, should the nature of the ultra-radiation be electronic, we are led to explain the secondary radiation as due to ' branching ', that is, the collision of ultra-electrons with the electrons of the filter substance. The argument against the second view is similar to that given previously. In both cases, whether of wave nature or electronic, we should expect the presence of electrons the energy of which varies and reaches a maximum comparable to that of the ultra-particles themselves.

We might further conceive the secondary radiation to be of nuclear origin, but the principal difficulty therein is the experimental fact that the electrons emitted from paraffin, lead, and aluminium have approximately the same energy content; in addition, observations indicate that the electrons travel chiefly in the preliminary direction.

Only by regarding the ultra-radiation as made up of material particles such as protons with the energy of an ultra quantum, does it seem possible to interpret the secondary radiation experiments. The secondary radiation corresponds to the δ-rays liberated by α-rays. Following Rutherford, one can probably understand the energy of the accelerated electrons as corresponding to the observed range.

Obituary.

PROF. J. LORRAIN SMITH, F.R.S.

JAMES LORRAIN SMITH was born on Aug. 21, 1862, the son of the Rev. Walter Smith, of Halfmorton, Dumfriesshire. He died in Edinburgh on April 18. As an undergraduate in Edinburgh he achieved considerable distinction in philosophy, and this early training had its influence on all his subsequent work and behaviour. After he took to medicine and had qualified in 1889, he spent some years working at Oxford, Cambridge, Strasbourg, and Copenhagen, mostly on physiological problems and in association with J. S. Haldane. He then went to Belfast as lecturer and afterwards professor of pathology, in 1904 to Manchester, when the combined chair was split into pathology and bacteriology, and finally, in 1912, to Edinburgh as the first professor of pathology who had no duties as a clinical physician.

Lorrain Smith was an all-round pathologist and, with his own hands or through his assistants, he worked at a variety of problems. He will be remembered chiefly for two investigations. His early work with Haldane on hæmoglobin and its relation to carbon monoxide led to the first practicable method of determining in man the volume of the blood and the total quantity of circulating hæmoglobin. In Belfast he applied this to the investigation of human anæmias, and found that in chlorosis, then common among young women, the anæmia was due to the dilution of the blood with an excess of plasma without any real deficiency in the hæmoglobin; in pernicious anæmia, on the other hand, he showed that there was a substantial shortage of hæmoglobin whether the blood volume was normal or increased. This conception of the disease as a plethora was quite novel; indeed, the possibility of such a condition in man had come to be gravely doubted as the result of the failure of the attempts which had been made to establish it experimentally. Why the water in the body should be distributed in such an abnormal way has never been explained, and under modern conditions the disease is practically unknown.

In Manchester, Smith became interested in fats and lipoids, and, in conjunction with Mair, devised two histological methods which have been taken into general use—the Nile blue sulphate stain for neutral fats and fatty acids, and the improvement and adaptation of Weigert's bichromate-hæmatoxylin process to tissue lipoids, in which he collaborated fruitfully with his chemical colleague, J. F. Thorpe. He also did sound work on the supposed toxicity of expired air, oxygen poisoning, typhoid fever in Belfast, trench foot, and other topics.

Outside his laboratory, Smith was for thirty years one of the best known and best liked figures in British pathology. He took a prominent part in the foundation of the Pathological Society of Great Britain and Ireland in 1906 and of the Pathological and Bacteriological Laboratory Assistants' Association in 1912—two complementary organisations which have made a great difference to professional pathologists and their technical assistants. During a period of development in which pathology passed from being an appendage of clinical medicine to an independent status, his influence was always for the good.

Pathology occupies rather an awkward borderline between science and technology; some pathologists are at heart medical men, some are biologists. Smith was essentially a philosopher and a biologist and he continually aimed at finding a working compromise between his outlook and the practical requirements of a sound medical education. Many of us will gratefully recollect his kindly encouragement of young people and his constant friendly cheerfulness. A. E. B.

DR. T. V. BARKER.

THE death of Dr. T. V. Barker on April 15 after a short illness, at the early age of fifty years, is a serious loss to the study of crystallography in Great Britain. Born in 1881, at Lytham in Lancashire, he went up from Kirkham Grammar School to Exeter College, Oxford. While studying chemistry as an undergraduate, he came under the influence of Sir Henry Miers, then professor of mineralogy at Oxford, and acquired an enthusiastic love for crystals which inspired him throughout his life. He also studied in Munich under Prof. Groth. His election to a senior demyship at Magdalen in 1905 enabled him to devote himself to research, first in Oxford and afterwards in Russia.

Barker's earlier work was concerned with the regular growth, in parallel position, of crystals of numerous soluble salts upon minerals and upon one another, and with its bearing upon isomorphism and similarity of structure; and led to the recognition of the importance of molecular volume and of 'topic axes' in relation to such parallel growth. Many of these results have since been confirmed by the evidence of X-rays.

Later on, Barker worked for a time in St. Petersburg, as a pupil of Prof. Fedorov, with whom he collaborated in the publication of his monumental work, "Das Kristallreich", a dictionary of the forms of all the crystals so far described, by means of which any substance included in it might be recognised from the measurement of its crystals ('crystallochemical analysis'). The method was, however, complicated and required an amount of specialised knowledge which prevented its general use, and after his return to Oxford in 1909, Barker devoted his attention to devising a simpler method of classification. His book, "Systematic Crystallography", published last year, described the principles on which he proposed that a new dictionary of the crystal kingdom should be constructed, and it is much to be regretted that he did not live to supervise the execution of his project. In this connexion he also published, in 1922, a book on "Graphical and Tabular Methods in Crystallography", with the view of simplifying and shortening the operations of measuring and describing crystal forms.

At Oxford, Barker was successively demonstrator in mineralogy and University lecturer, and afterwards reader, in chemical crystallography, while he held a research fellowship at Brasenose College. His lectures and classes did much to encourage the study of crystals among undergraduates, and he also endeavoured, by vacation courses to schoolmasters, to awaken an interest in the subject in schools. During the last few years he had been led to take up administrative work, and since 1929 the increasing work of the University Chest, of which he had become secretary, had claimed his whole time. He will be greatly missed on many University boards, as well as by his many scientific friends and colleagues in Oxford and elsewhere. H. L. B.

WE regret to announce the following deaths:

Dr. Thomas Ashby, who was director of the British School at Rome from 1906 until 1925, and an authority on the archæology of Rome, aged fifty-seven years.

Prof. J. E. Edwards, principal and professor of mathematics and physics at Queen's College, London, author of well-known text-books on the calculus, on May 16, aged seventy-seven years.

Prof. T. R. Glynn, emeritus professor of medicine in the University of Liverpool, on May 12, aged ninety years.

Lieut.-Col. H. T. Morshead, Director of the Burma Circle, Survey of India, who was a member of the expeditions to Mount Everest in 1921 and 1922, on May 17, aged forty-eight years.

Mr. F. P. Sprent, assistant keeper of printed books in the British Museum and author of many works on cartography, on May 16, aged forty-six years.

News and Views.

THE Prime Minister's announcement in Parliament upon the future policy of airship development gave little cause for surprise, and must presumably be received in the spirit of half a loaf being better than none. The Government was faced with three courses of action: (1) To continue on a programme of new ships, carrying on the development as experience dictates; (2) to cease entirely, disposing of *R100*, turning the Cardington works to other uses, and terminating our responsibilities to the authorities who erected the various colonial mooring masts as best we can; (3) to recondition the existing airship, and find sufficient money to allow a limited experimentation to proceed along lines that the Simon inquiry and the Aeronautical Research Committee have suggested. The Government has chosen the last course, stating that it hopes that the use of the ship will serve to supplement the model experiments already made, will keep together a small nucleus of trained men, and will add its quota to the relieving of the local unemployment problem. It is estimated that sums of £120,000, £130,000, and £140,000 should be sufficient for this during the next three financial years. It is hoped that the various Governments concerned will agree to maintain their own airship stations where in existence.

So far as it goes, there can be no objection to this scheme, but it is obvious that neither in the Prime Minister's statement nor the subsequent debate is there any recognition of the fact that there is any necessity to ensure the continuation of scientific thought upon the broad problems of future development. That a select company of airship builders and operators will be maintained was stressed several times, but the fact that without a new building programme there will be no design staff kept together appears to have been entirely overlooked. It is an open secret that the designers of both of the ships have already been practically dispersed, owing to the lack

of continuity in the building programme, and this further three years' interval will certainly serve to set the seal upon this unfortunate state of affairs. Further, a suggestion that a scientific airship man should sit upon the Air Council in order to preserve contact with the experimenters at Cardington, and so keep the broader outlook of policy alive, was received by the Under-Secretary of State for Air with the remarkable statement that "It is rarely the case that a scientific expert is an efficient administrator". Mr. Montagu's opinion is singularly at variance with that of the rest of the aeronautical world. It is no mere polite phrase, but a literal fact, that admiration of the administration of aeronautical scientific research in Great Britain is world-wide. Mr. Montagu should make use of a press-cutting agency, or even maintain a closer personal touch with the scientific men in his own departments.

A LECTURE upon a type of airship that does not need gasbags and fabric envelope was given by Mr. Carl Fritsche, president of the Aircraft Corporation of Detroit, before the Royal Aeronautical Society on May 14. This company has already built, and operated for two years, a small 'metal-clad' airship of 202,200 cubic feet capacity, which carried a useful load of 1300 lb., in addition to fuel, oil, ballast, etc., at 70 miles per hour top speed. It is filled with helium and has a remarkably low diffusion loss of only 12 lb. of lift for every twenty-four hours. This is principally due to the impermeability of the metal skin, the use of which is made possible by a special system of riveting the joints, which is really an ingenious adaptation of the principle of sewing with wire. This not only makes a gas-tight joint possible, but very considerably reduces the labour and time needed for erection. Compared with *R100*, using helium, a metal-clad ship could carry an estimated load of 10,000 lb. more, with 600 h.p. less in engine power. A part of the lecture was devoted to a detailed estimation of the costs of working an Atlantic service with these airships. Given a passenger fare of £180 and a mail subvention of £2 8*s*. per mile, it was suggested that an air line could be run at a profit of twenty per cent a year. This was provisional upon the ships being built and operated by an international company, with sufficient freedom from political restrictions to allow them to utilise their carrying capacity to the best advantage.

THE Annual Report of the Council of Management presented to the members of the British Science Guild at the general meeting on May 12 illustrates the unique place occupied by the Guild in the national life of Great Britain, and the valuable services it is rendering in promoting effective contact between science and the general life of the community. The value of the "Catalogue of British Scientific and Technical Books" prepared by the Guild is best attested by the publication of a third edition in September 1930. Its educational work is represented by the Norman Lockyer Lecture on "Science and Modern Industry", delivered by Sir William Pope, and the Alexander Pedler lecture on "Science Discipline", delivered by Lieut.-Col. Sir David Prain, both of which received wide notice in the press. Changes of officers during the year are recorded in the resignations of Lieut.-Col. W. A. J. O'Meara from the office of hon. secretary, and of Sir John Young from the chairmanship of the finance committee, and the appointment of Major A. G. Church as organising secretary.

A VALUABLE result of the non-political and national structure of the Guild is its ability to make authoritative representations on matters of public interest in which scientific considerations are involved. Two instances of such representations are referred to in the Report, the first being the Memorandum of Evidence submitted by the Guild in June 1930 to the Royal Commission on the Civil Service. The memorandum, which is printed in full in the Report, stresses the importance of the technical factor in many modern problems, and urges the necessity of remodelling the organisation of departments of State on the type adopted in progressive industrial concerns. The Guild considers that the time is ripe for a simplified structure of the technical services, and the memorandum enunciates the principles essential for efficient administration, and urges that the heads of the larger and more important professional, scientific, and technical departments should be given full administrative status. The chief defect in the organisation and structure of the Civil Service lies in the dominant influence of officers of the administrative and clerical groups. An appendix to the memorandum outlines the factors responsible for the present unsatisfactory position of the 'expert' group in the Civil Service. In January 1931, the Council of the Guild adopted an exhaustive report on the scientific and professional staffs in the public services and industry, which has been widely circulated and to which statement the non-political and representative character of the Guild lends great authority. The report is dealt with in our leading article this week.

IN his presidential address to members of the Guild at the annual meeting, the Right Hon. Sir Samuel Hoare, M.P., referred to the more ambitious programme upon which the Guild is anxious to embark. In additon to the contemplated investigation of the potentialities of existing industries and the effect of the proper application of science upon them, which would indicate how far reactionary influences, either of Government, employers, or trade unions, are impeding development, Sir Samuel Hoare urged the importance of a scientific study of the disarmament question. The main problem of disarmament, and by far the most difficult, is that of the new weapons of warfare and the method of their control. The relation of science and the attitude of scientific workers to gas warfare and other new forms of warfare require investigation by men of science as well as by politicians and the general staffs. Politicians in particular need a scientific opinion upon these subjects for the Geneva Conference in 1932. If during the next six months the Guild can produce a report upon such questions, it will be doing most useful work in educating public opinion and in investigating a critical aspect of the most prominent question in foreign politics in the immediate future.

THE philosophical faculty of the University of Berlin has conferred upon Prof. R. W. Wood, of the Johns Hopkins University, Baltimore, the degree of Doctor of Philosophy (*honoris causa*). This is the highest honour which the faculty has in its power to give, and is a recognition of Prof. Wood's contributions to physical optics. In announcing the award, Prof. Jaeger, the dean of the faculty, singled out as of particular importance Prof. Wood's researches on the resonance radiation of gases and vapours. These have certainly called for the exercise of the utmost experimental skill, and although initially conceived and carried out at a time when our knowledge of the structure of atoms and molecules was practically nothing by current standards, have contributed in no small degree, and continue to contribute, to our present ideas on "the exact nature of the piece of machinery which we call the molecule", to use Prof. Wood's own words. With the study of resonance radiation, however, one is tempted to associate Prof. Wood's allied work on magneto-optics, and to quote as an example of his ingenuity the separation of the *D* lines of sodium for work with intense beams of monochromatic light by the difference in their rotations. More recently, Prof. Wood has been interested in the Raman effect, where he has devised methods for reducing the time of exposure needed for recording the feeble spectra of modified radiation, and has also developed rapid methods for measuring up the Raman spectra. In addition to his many experimental contributions to physical optics, Prof. Wood is the author of two books on the subject, and has ruled gratings for other laboratories. His work, although, naturally, carried out on rather different lines, is in every sense worthy of being ranked with that of Rowland and of Michelson.

IN his second Rhodes Memorial Lecture, delivered at Oxford on May 16, Prof. A. Einstein discussed the application of the field equations of the theory of relativity to the problem of cosmogony. When the general theory of relativity was first formulated, the universe was assumed to be of a definite size, and in order to make the field equations compatible with this assumption an arbitrary term was introduced. Subsequent investigation has shown that even with this arbitrary term, the size of the universe could only remain constant under special assumptions—in general it would vary with the time. The work of Hubble on the radial motion of the extra-galactic nebulæ has shown that these systems of stars, distributed approximately uniformly throughout space, are all moving at very high speeds, which increase linearly with the distance. Prof. Einstein now omits the above-mentioned arbitrary term, and his original equations lead to a rate of expansion which is related by a simple formula to the mean density of matter in the space under consideration. The rate of recession observed by Hubble appears to agree approximately with the rate calculated from the formula if one assumes the density to be of the order of magnitude which appears to exist in the universe as we know it. The main difficulties are the small value of the world radius (one hundred million light-years), the comparatively short period of some ten thousand million years during which the space structure can have been expanding, and the conditions in the early stages before expansion had taken place. Prof. Einstein's next and final lecture on the latest developments of the theory will be given on May 23 at 12 noon, when the University will confer on him the honorary degree of D.Sc.

NEWS from the British Arctic Air Route Expedition, published in dispatches in the *Times*, shows that the main features of its work have been accomplished, happily without the loss of life that was at one time feared. Last August, a meteorological station was founded on the Greenland ice-sheet in lat. 67° 3′ N., long. 41° 48′ W., at an elevation of 8000 feet, about one hundred and forty miles north-west of the expedition's base on Sermelik Fjord near Angmagsalik. The station was merely a double canvas tent, since transport difficulties precluded a more substantial building. Two men occupied the station until Oct. 2, when they were relieved by two others. On Dec. 3 another relief party reached them, and it was then proposed to abandon the station, owing to the severity of the blizzards and the difficulty in sledging up sufficient food from the base. Mr. A. Courtauld, however, offered to remain alone, in order to continue the important observations throughout the winter. He was left with ample provisions to last until May. Efforts to relieve him in the early spring failed. Wireless messages to this effect reached Europe and caused anxiety and eventually alarm, which, however, was not felt at the expedition's base. The Swedish airman Capt. Ahrenberg made a fine flight from Europe to the rescue, and, reaching the station on the ice-cap, found it deserted. Mr. H. G. Watkins with a sledge party from the base had reached it on May 5, and found Mr. Courtauld safe and well, with ample food supplies. On May 13 they were back at Sermelik Fjord. The observations at the high-level station are the first complete winter records from the interior of Greenland and should prove of great value.

THE German Expedition to Greenland has sent to the *Times* a dispatch which seems to leave no doubt that its leader, Dr. A. Wegener, has perished on the ice-cap. This expedition, with its base near the Kamarujak glacier on the west coast, also placed a station in the interior. The German station was in lat. 71° 8′ N., long. 40° W., which is about the middle of Greenland, 275 miles north of the British station. It was set up last summer and inhabited by three men, Drs. Georgi, Sorge, and Loewe, who were found safe on relief reaching them on May 7. It was then learned that Dr. Wegener with one Greenlander had left the station on Nov. 1 in an attempt to return to the base, which, however, he never reached. The journey entailed a march of about three hundred miles, and though there appear to have been depots on the route, the risks entailed in winter darkness and blizzards were very considerable. The German expedition used motor sledges as well as dog teams in travelling over the ice-sheet, and while the mechanical transport proved satisfactory, reliance was placed

mainly on the dogs. This station will provide another set of most important meteorological observations.

THE subject of the Friday evening discourse at the Royal Institution by Prof. J. C. Philip, on May 15, was "Experimental Aspects of Hydrogen Ion Concentration". Prof. Philip pointed out that the contrast between solutions of strong and weak acids of the same total acidity is very marked. These differences are determined by the degree of ionisation mainly, and in the case of a weak acid like acetic acid a distinction must be drawn between 'total' and 'effective' acidity, the latter quantity being measured by the hydrogen ion concentration and expressed in terms of the *p*H value (Sørensen). Besides the standard electrometric methods of determining hydrogen ion concentration, now being developed in the direction of continuous record and automatic control, the colorimetric method is found valuable in many cases. The fact that for different indicators the colour changes occur at quite different *p*H values, and that the colour change in any particular case is not absolutely sharp but takes place gradually over a limited *p*H range, underlies the practical use of the colorimetric method. It is assumed that two solutions which exhibit a colour match (for the same amount of indicator) have the same *p*H value. In reality this principle is subject to some qualification. A significant point that emerges from the study of hydrogen ion concentration is the extent to which the *p*H value of a weak acid is altered by the addition of a neutral salt of the acid. Solutions which contain a weak acid in presence of its neutral salt have, moreover, a remarkably steady *p*H value, which is altered to a relatively slight extent by the addition of acid or alkali. Because of the resistance which they offer to change of acidity, mixtures of this kind are termed 'buffer' solutions. They play an important part in the accurate determination of *p*H values, and the 'buffer' effect is of prime significance in the regulation of the hydrogen ion concentration of the blood.

ON May 14 a discourse was given by Mr. Sydney Evershed before the Institution of Electrical Engineers to commemorate the centenary of the birth of David Hughes. The fame of Hughes rests on two works of creative genius: the invention of the synchronous type-printing telegraph and the discovery of the microphone. Hughes was the grandson of a bootmaker at Bala, in North Wales. He was born in London, but his family emigrated to the United States in 1838. He picked up some knowledge of electricity and at the age of twenty-four completed the development of his printing telegraph. It rapidly came into use in the United States and France, but England was almost the last civilised country to adopt it. The success of his invention brought Hughes a large fortune and in 1875 he returned to England and made London his home. Having leisure for research, he engaged in experiments which led to the discovery of the microphone. Graham Bell solved the problem of the transmission and reproduction of speech, but some kind of relay was needed for large telephone systems. This was found in the action of sound waves on the contact of electrical conductors. Having discovered the full scope of the phenomena, Hughes gave his knowledge freely to the world in a paper read to the Royal Society on May 8, 1878. In this paper, Hughes gave the name 'microphone' to any device in which sound waves acted on electrical contacts. From that day to this, every instrument employed as the transmitter for a telephone system has embodied some form of Hughes's microphone to serve as a relay. He was a fellow of the Royal Society and a president of the Institution of Electrical Engineers.

STANDARDISATION in the domain of chemical industry has moved a step forward with the inaugural meeting on May 7 of the provisional council for the chemical division of the proposed Standards Association of Great Britain. Negotiations, having in view an extension to other fields of the good work done by the British Engineering Standards Association, have been proceeding actively and harmoniously during the past year, with the result that agreement has been reached on a comprehensive scheme of organisation. The general council of the new body will be constituted by the election of nine members from each of the divisions and by the nomination of a representative each of the Board of Trade, the Department of Scientific and Industrial Research, the Federation of British Industries, the Association of British Chambers of Commerce, and the Institution of Civil Engineers. There will be four co-equal and largely autonomous main divisions, each controlled by a divisional council, for engineering, chemistry, building, and textiles. The engineering division will consist of the present B.E.S.A., with the exception of those elements which will now find a more appropriate place under one of the other divisions. The council of the chemical division will consist of not more than 40 members, not more than five places being reserved for the co-option of individuals whose services are likely to be of special assistance to the council. Agreement has been reached regarding the nominating bodies, each of which will nominate one member, with the exception of the Association of British Chemical Manufacturers, which will have five representatives. Dr. E. F. Armstrong has been elected chairman, and Mr. W. Rintoul vice-chairman. The council itself will not undertake the specification of standards, but will utilise existing organisations which are already engaged in that work. Where necessary, *ad hoc* technical committees representing the main interest affected will be constituted.

ON May 11, the Manchester and Altrincham Railway was changed over to all-electric operation, after eighty years of steam working. Although only twenty-eight miles of track, including sidings, are involved, it is of interest, as it is the first railway in Great Britain electrified on the standard 1500 volts direct current system adopted by the Ministry of Transport. Its power is obtained from the Stretford Electricity Board at 11,000 volts three-phase. The 11,000-volt cables are in duplicate and are carried on wooden stumps along the tracks. The district served is densely populated and so an accelerated service and more stations were

required. Transformers are used at the substations to step down the high pressure power to rotary converters which transform the alternating into direct current. By means of a pantograph, each set of two series-connected 750-volt direct current motors in the coaches is connected between the overhead wires and the return rails. To make the load more uniform and furnish a reserve of power, a battery of accumulators is installed at each substation. The machines and switchgear at the substations are kept free from dust and dirt by combined vacuum cleaning and blowing apparatus. There is one steel tank mercury arc rectifier for 1500-volt working at one of the substations. This type of rectifier will probably be widely used in the future. It was designed and manufactured by a British firm. It is a twelve-anode machine and so the ripple in the direct current voltage is very small. In order to prevent possible interference with telephone circuits, a smoothing circuit is provided. This consists of a reactance coil on the direct current side and four resonant shunt circuits connected across the direct current load. Experience with rotary converters has proved that this device is very efficient.

IT is announced by Science Service, Washington, D.C., that Dr. William Wallace Campbell, director of the Lick Observatory and formerly president of the University of California, has been elected president of the National Academy of Sciences, in succession to Dr. T. H. Morgan, of the California Institute of Technology, Pasadena. Dr. Campbell established his place in American science principally through his work in spectroscopic astronomy; he has also done notable work in solar eclipse problems. He was born in Ohio in 1862, and went to Mt. Hamilton as astronomer at Lick Observatory in 1891. In 1901 he was made director of the Observatory, and in 1923 president of the University of California. He retired from the latter post recently, in order to return to active astronomical work. Dr. David White, of the U.S. Geological Survey, formerly home secretary of National Academy, has been elected vice-president, and Dr. Fred E. Wright, of the Carnegie Institution of Washington, formerly vice-president, has become home secretary. Dr. Peter Debye, the distinguished physicist of the University of Leipzig, has been made a foreign associate of the Academy, and the following new members were elected: Henry Bryant Bigelow, Museum of Comparative Zoology, Cambridge, Mass. (oceanography); Edwin Broun Fred, University of Wisconsin, Madison, Wis. (bacteriology); Edwin Crawford Kemble, Harvard University, Cambridge, Mass. (physics); Adolph Knopf, Yale University, New Haven, Conn. (geology); Robert Harry Lowie, University of California, Berkeley, Calif. (anthropology); Joseph Haines Moore, Lick Observatory, Mt. Hamilton, Calif. (astronomy); Robert Lee Moore, Austin, Texas (mathematics); Hermann Joseph Muller, University of Texas, Austin, Texas (genetics); George Linius Streeter, Department of Embryology, Carnegie Institution, Baltimore, Md. (embryology); Margaret Floy Washburn, Vassar College, Poughkeepsie, N.Y. (psychology).

THE second general assembly of the International Union for the Scientific Investigation of Population Problems (chairman, Prof. Raymond Pearl) will be held in London on June 15–18, at the house of the Royal Society of Arts, John Street, Adelphi, Strand, W.C.2. Most of the European Powers and also the United States of America will be represented at the meeting. The first three morning sessions will be devoted to official business, and the afternoon sessions and the whole of June 18 to reports and papers relating to the work of the Union. Commission 1 (population and food supply) reports on the first afternoon, Commission 2 (differential fertility) on the second afternoon, and Commission 3 (vital statistics of primitive races) on the third afternoon. The papers also to be read on these afternoons and those for Thursday, June 18, include studies on differential fertility in Stockholm, the birth-rate and population of the United States, and vital aspects of a Chinese family population during six hundred years, more general papers on population theory and human biology, and experimental work on mice populations. Scientific workers are invited to attend the afternoon sessions and those on June 18. The organising committee for the meeting is the British Population Society, of which the chairman is Sir Bernard Mallet, and honorary secretary, Mr. Eldon Moore, Eliot Vale House, Blackheath, Kent, from whom tickets can be obtained.

A FEW months ago (Jan. 31, p. 176) we announced in these columns that arrangements were being made by the Society for Cultural Relations for a tour of British scientific workers to the U.S.S.R. Owing to the large demand for membership of the first party, the list for which closed on April 30, a second party will now leave London Bridge by Soviet ship for Leningrad on Aug. 8, returning to London about Sept. 2 in time for the British Association meeting. The return fare will be £18 0*s.* 0*d.* The party will spend a total of sixteen days in Russia, and the cost per day will be £1 0*s.* 0*d.* per head inclusive. Meetings are to be arranged which members of the party will be invited to address, and there will be excursions with guides to scientific institutions of interest to the members. The party will consist of twenty-five persons. If there is a large demand for places, the list might be extended. The latest date for receiving applications is June 15. Applications and all inquiries should be addressed to the Secretary, Society for Cultural Relations, 1 Montague St., London, W.C.1.

A CONFERENCE of agricultural and rural bodies met at the Ministry of Agriculture on May 13 to consider the damage caused by grey squirrels in Great Britain. Mr. A. D. Middleton, of the University Museums, Oxford, a summary of whose recent paper on the distribution and habits of the grey squirrel appeared in NATURE of April 4, p. 540, reported the results of his investigations, and Mr. L. W. Swainson, honorary secretary of the Anti-Grey Squirrel Campaign, described the activities of that body. The conference passed a resolution expressing the opinion that the grey squirrel is a pest which causes extensive damage

to agriculture and horticulture, that it is widespread and increasing in numbers, and that it is in the interests of agriculture and horticulture that all possible steps should be taken to bring to the public notice the damage caused by these animals and the importance of repressing them. The Ministry of Agriculture was asked to issue an educational pamphlet on the grey squirrel, describing its life-history and giving methods for its destruction, to be distributed to rural organisations with the view of encouraging the destruction of the pest.

THE Court of Common Council of the City of London has made a donation of two hundred and fifty guineas to the funds of the British Empire Cancer Campaign.

THE Honorary Gold Medal of the Royal College of Surgeons has been conferred on Mr. G. Buckston Browne, in recognition of his valuable contributions to the surgery of the genito-urinary system, and of his great liberality in the endowment of an institution for surgical research.

ON Feb. 10, Dr. Joaquim de Sampaio Ferraz resigned, for reasons of health, from his post as director of the Brazilian Meteorological Institute, which he initiated in 1921. Although he has retired from his official position, he intends to carry on his work in collaboration with M. Paul Pires Xavier, who has been appointed to succeed him.

THE portrait of Dr. G. Claridge Druce which was subscribed for by members of the Botanical Society and Exchange Club of the British Isles on the occasion of his eightieth birthday on May 23, 1930, has been painted at his residence, Yardley Lodge, Oxford, by Mr. P. A. de Laszlo. It will be formally presented to Dr. Druce at Mr. de Laszlo s residence in Fitzjohn's Avenue, London, next month.

AT the anniversary meeting of the Royal Society of South Africa, held on Mar. 18, a resolution was moved by Prof. Morrison and seconded by Prof. Newbery asking the Council to protest against the drastic reduction in the government grant to the Society for 1931. The following were elected as officers of the Society for the year 1931 : *President*, Dr. W. A. Jolly ; *Honorary Treasurer*, Dr. L. Crawford ; *Honorary General Secretary*, Dr. B. F. J. Schonland.

PROF. I. E. TAMM, of the Physics Research Institute and professor of physics in the First University of Moscow, will speak on "Higher Education in Soviet Russia", at a meeting of the Society for Cultural Relations between the People of the British Commonwealth and the U.S.S.R., to be held on May 28. Further information concerning the meeting can be obtained from the Secretary, S.C.R., 1 Montague Street, London, W.C.1.

THE council of the Institution of Electrical Engineers has made the following award of premiums for papers read during the session 1930–31, or accepted for publication : the Institution premium to Commendatore G. Bianchi, Ayrton premium to R. Grierson, John Hopkinson premium to J. W. Rissik and H. Rissik, Kelvin premium to B. L. Goodlet, F. S. Edwards and F. R. Perry, Paris premium to P. J. Ryle, and extra premiums to W. E. M. Ayres ; R. M. Charley ; H. S. Carnegie ; D. B. Hoseason ; Dr. J. J. Rudra and Prof. Miles Walker ; Prof. W. Cramp and A. P. Jarvis ; P. J. Higgs ; J. C. Prescott and E. W. Connon ; G. G. Smail, R. J. Brooksbank, and Prof. W. M. Thornton ; Prof. S. P. Smith ; and Prof. E. Wilson. In the Wireless Section, the Duddell premium has been awarded to T. Walmsley and extra premiums to C. E. Horton and C. E. Rickard. In the Meter and Instrument Section, the Silvanus Thompson premium has been awarded to Prof. W. M. Thornton, M. Waters, and W. G. Thompson, and an extra premium to E. W. Hill and G. F. Shotter.

THE Secretary of State for Scotland has appointed Dr. Birkett Wylam to be Chief Inspector for Scotland under the Alkali, etc., Works Regulation Act and Inspector under the Rivers Pollution Prevention Acts, in succession to Mr. J. W. Young, who is retiring. Dr. Wylam, who enters on his duties on June 1, is a graduate of the University of Durham. On graduation as B.Sc. he obtained the Freire Marreco medal for practical organic chemistry and was engaged on post-graduate research work for two years. Since 1928 he has been working as research chemist, and latterly also as process manager, in works connected with Scottish Dyes, Ltd.

WE learn from the recent issue of the *Taylor-Hobson Outlook* that the alteration in size or scale of the projected cinematograph image, seeing that the relative positions of the film, the projecting lens, and the screen are fixed, is effected by a change in the lens. To enlarge the image, the focal length of the lens must be reduced, and this is effected by making the front and back components movable axially and causing them to approach each other. To maintain the sharpness of the image, that is, to keep the film and the screen in focus during the change, the relative rates of movement have to be adjusted with great accuracy.

WE are glad to see that the Royal Photographic Society is giving rather more attention in its *Journal* to the scientific and technical side of photography than it has for the last few years. The April number of its journal has a 56-page supplement which consists of articles on the physical aspects of the latent image, the applications of physical chemistry to photography, recent progress in optics, photo-engraving, cinematography, colour photography, and commercial photography. This number also includes the eighth Hurter and Driffield memorial lecture by Sir William Bragg, on "X-rays and the New Range of Vision". In December, a special cinematograph number will be published, and other special numbers will be issued from time to time. The journal is published by the Fountain Press, 14 Clifford's Inn, at 2*s*. 6*d*. per copy.

THE latest issue of the Classified List of Publications of the Carnegie Institution of Washington (April 1931, 208 pages) contains a chronological list arranged under authors' names, a classified list, with summaries of the contents of papers, grouped under the appropriate branch of science, and an index of authors. Copies of the publications, sent gratuitously to a carefully

selected list of libraries throughout the world, may be consulted there, but books not otherwise disposed of are for sale at prices approximating to the cost of publication. Correspondents may obtain price-lists, or classified lists, as issued, by furnishing requisite addresses to the Secretary, Carnegie Institution of Washington. It is unnecessary to stress the value of the publications in the various branches of science and letters issued by the Institution.

Two books are nearly ready for publication by Messrs. George Allen and Unwin, Ltd., which should be of general scientific interest, namely, "The Universe in the Light of Modern Physics", by Prof. Max Planck, translated by W. H. Johnston, and "Human Heredity", by Profs. E. Bawe, E. Fischer, and F. Lenz, translated by Eden and Cedar Paul.

MESSRS. Dulau and Co., Ltd., 32 Old Bond Street, W.1, have just issued Catalogue No. 185—"Fungi, Plant Pathology, etc."—comprising a thousand works from the library of the late Dr. N. Patouillard. Among the volumes offered for sale are Saccardo's "Sylloge Fungorum", Saccardo's "Fungi Italici", Boudier's "Icones Mycologicae", Fries' "Icones Selectae Hymenomycetum", Paulet's "Iconographie des Champignons", and Lucand's "Suites a Bulliard". Messrs. Dulau have also circulated a list (No. 186) of upwards of 600 volumes, mainly on natural history, now on sale at very low prices.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—Two full-time tutors in the department of adult education of the University College of Hull—The Registrar, University College, Hull (May 26). An assistant lecturer in mathematics at Westfield College—The Principal, Westfield College, N.W.3 (May 27). A teacher of science and engineering at the Coleraine Technical School—The Principal, Technical School, Coleraine (May 28). A vice-principal of the Somerset Farm Institute, Cannington, near Bridgwater—The Clerk of the Somerset County Council, Ashcombe House, Weston-super-Mare (May 30). A chief cataloguer in the Library of the University of Aberdeen—The Secretary, University, Aberdeen (June 4). A resident assistant pathologist at the Royal Free Hospital and London (R.F.H.) School of Medicine for Women—The Secretary, Royal Free Hospital, W.C.1, or the Warden and Secretary, London (R.F.H.) School of Medicine for Women, W.C.1 (June 5). A secretary of the University Chest of the University of Oxford—The Acting-Secretary, University Chest Office, Oxford (June 6). An assistant lecturer in philosophy at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (June 6). A professor of mathematics at Raffles College, Singapore—The Director of Recruitment, Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1. A physics mistress at Westonbirt School, Tetbury—The Headmistress, Westonbirt School, Tetbury, Glos. A head of the mathematics department of the Borough Polytechnic—The Principal, Borough Polytechnic, Borough Road, S.E.1. A laboratory assistant at the County Mental Hospital, Lancaster—The Medical Superintendent, County Mental Hospital, Lancaster.

Our Astronomical Column.

The Date of the Crucifixion.—*Astr. Nach.* 5784 contains a paper on this subject by E. Dittrich. He makes use of data from the writings of the late C. Schoch, both published and unpublished. These include a discussion of the total eclipse of the sun of Nov. 24 in A.D. 29. Some ancient writers attempted to explain the darkness mentioned at the Crucifixion by this eclipse. The explanation is, of course, impossible, for the double reason that the Passover comes near the spring equinox and also near the full moon. Still, the statement has some value, for it would scarcely have been made unless the year of the eclipse agreed with that of the Crucifixion, or came very near it. The track of totality was investigated by Schoch, who found that it ran just north of Palestine ; the maximum phase at Jerusalem was $11\frac{1}{2}$ digits, and occurred 12 minutes before local noon. An argument is based on the incident of the corn being ripe enough to eat the ears at a time a little before the Crucifixion. The Passover must have been rather late, the preceding year having an intercalary month at the end of it. In summing up, the author observes that the discussions of the last hundred years have greatly narrowed the possible range of dates. The range was originally about ten years, but has now been reduced to two ; there is almost universal agreement that it was either A.D. 29 or 30.

Temperatures in Sunspots.—In the *Scientific American* for April, Prof. H. N. Russell gives an account of recent work on sunspot temperatures carried out at Mt. Wilson by Pettit and Nicholson with the aid of a delicate vacuum thermocouple. In violet radiations, the spot gave less than 30 per cent of the disc, but in the red the proportion was 40 per cent and in the extreme infra-red it reached 80 per cent. A mean was taken as 47 per cent, which was reduced to 40 per cent when the scattering of sunlight by the atmosphere was allowed for. This gave 4750° C. measured from the absolute zero, about 1200° cooler than the general surface temperature. The cooling is ascribed to the rapid expansion which the gas undergoes on ascending from a lower region of higher pressure. This implies that the portions of sunspots that are accessible to study are quite shallow ; but an explanation, due to Unsöld, is given, suggesting that the mechanism producing the spot is much deeper, about 1000 miles down ; the hydrogen atoms are there ionised, but as the column ascends, recombination of protons and electrons liberates enough heat to maintain the vertical current, which, as stated above, is cooled by expansion on reaching the surface.

Catalogue of Stellar Parallaxes.—*Publication* No. 4 of Merate Observatory is a general catalogue of 3975 stellar parallaxes compiled by Gino Cecchini. It includes trigonometrical parallaxes determined at all the leading observatories, also dynamical, hypothetical, group, and Cepheid parallaxes, distinguished by different symbols. The catalogue gives approximate R.A. and Decl. for 1900, magnitude, spectral type, parallax, probable error (each given to 0·001″), absolute magnitude, proper motion in polar co-ordinates, and references to Boss, Cincinnati, and Draper Catalogues. Proxima Centauri is entered as type *M*, parallax $0{\cdot}780'' \pm 0{\cdot}006''$, absolute magnitude 15, proper motion 3·76″ in P.A. 283°. Notes and references follow the catalogue, the whole making a useful work of reference.

Research Items.

Peking Man: Geological and Palæontological Evidence.—An account of the discovery of Peking man is contributed by P. Teilhard du Chardin to *L'Anthropologie*, t. 41, pts. 1-2, which deals in some detail with the geology and palæontology of the cave of Chou Kou Tien. It is evident that the cave was not an open fissure in which the remains were carried by torrential action, as was at one time thought, but a true cave which was gradually filled by a succession of deposits. The nature of these deposits points unquestionably to the fact that the cave was the habitation of carnivores, and presumably of man. It presents analogies with the caves of Europe, but the evidence of stratigraphy and palæontology points to the far greater antiquity of the levels in which human remains have been found. Hitherto only one pleistocene formation had been recognised in China, that of the yellow loess characterised by *Rhinoceros tichorhinus*, *Bos primigenius*, *Cervus elaphus*, *Hyæna crocuta*, etc., and worked quartzites of Mousterian and Aurignacian type. Now, however, it is evident that beneath the loess deposit of the Upper and Middle Pleistocene, and hitherto confused with it, is a series of sands, clays, and reddish loess representing a distinct formation with a characteristic fauna, *Rhinoceros cf. sinensis*, *Hyæna sinensis*, *H. machairodus*, etc. This formation begins at the end of the tertiary and the beginning of the lower quaternary. It is to this Early Pleistocene that the fossiliferous deposits of Chou Kou Tien belong. On this point the palæontological evidence is decisive. No fossil characteristic of the yellow loess has been found at Chou Kou Tien, the fauna of which corresponds with the pleistocene fauna of the Nihowan deposits, yet is lacking in those forms which assign the latter to the tertiary. In the rhinoceros, hyæna, horse, *Canis*, *sinensis*, *Machairodus*, there is exact correspondence.

A New Classification of Mammals.—In the course of arranging a large collection of mammal skins for cataloguing, storage, exhibition, and teaching, George Gaylord Simpson found it necessary to compile a workable synthesis of recent taxonomic studies of mammals. This classification of the living and extinct forms is now published for the use of workers faced with the same problems (*Bull. Amer. Mus. Nat. Hist.*, vol. 59, p. 259; 1931). The classification is conservative; it follows a middle course between the 'splitters' and the 'lumpers'; but, as it is, it summarises the progress of the last half-century. Where Gill's work of 1872 contained 138 families, of which 33 were extinct and 105 living, the present classification contains 242 families, 129 extinct and 113 living. It is clear that the progress of the intervening years as regards numbers of families has been due almost entirely to palæontological discovery, and that although many new species of living mammals have been described, their discovery has added little to the broader taxonomy of the class. So also with the changes in arrangement and classification: comparative anatomy of recent mammals has made its proper contributions, but the discovery of their extinct ancestors has added much more. The discrepancy between the two sets of contributions is likely to increase, for while outstanding new discoveries are extremely rare in the modern groups, the rate of palæontological discovery tends to increase rather than diminish.

Nutrition of Mosquitoes.—In the *Transactions of the Royal Society of Tropical Medicine and Hygiene*, vol. 24, pp. 465-472 (January 1931), Malcolm E. Macgregor describes some experiments dealing with the food requirements of mosquitoes with respect to ovulation. Two species were chiefly used in these experiments, namely, *Ædes ægypti* and *Culex pipiens*. The author points out that mosquitoes betray two methods of feeding. In the method usually known as 'biting' (or its equivalent, which can be attained by feeding from capillary tubes when the proboscis is 'unsheathed'), the insect is able to draw the ingested food directly into the stomach. In the other method, known as 'discontinuous suction', the ingested food collects first in the diverticula. The function of the diverticula as food reservoirs has long been recognised, and the author finds that the gas contained therein is air, and that these organs have a dual function. Besides acting as food-reservoirs, they serve as air-separators in which 'air-locks', between discontinuous sections of fluid food, are separated in order to preclude the entrance of air into the stomach. A selective and voluntary control is exercised by the insects in regard to the aspiration and destination of ingested foods, blood being generally dispatched to the stomach and sugary solutions to the diverticula. The outcome of the experiments described indicates that the essential requirements for ovulation in *A. ægypti* are not only the presence of sperms in the spermathecæ, but also the direct reception by the stomach of some essential food (blood). In the case of *C. pipiens* an additional factor, as yet undetermined, is necessary. If unfertilised females of *A. ægypti* take blood by interrupted feeds into the diverticula, ovulation never occurs. If, on the other hand, the blood enters the stomach, activation of the ovaries and oviposition usually take place. When a fertilised female of either species is fed through a capillary tube on blood containing a trace of honey, or other carbohydrate, the blood-honey mixture is diverted into the diverticula, and the food is rapidly digested without any activation of the ovaries.

Apple Scab.—Two papers dealing with work carried out at the Long Ashton Research Station upon this fungus disease of apples, *Venturia inæqualis*, appear in the March issue of the *Journal of Pomology and Horticultural Science* (vol. 9, No. 1). Dr. K. H. Johnstone analyses the varying resistance shown by different varieties of apple to the disease. The importance of an adequate water supply for spore germination of the parasite is emphasised, and it is pointed out that, in this connexion, varietal differences in the ease of wetting of the cuticle surface of the host may be important. Actual thickness of the cuticle presents no barrier to penetration, but in certain varieties an impenetrable quality appears to develop, so that the period of susceptibility is of short duration in these varieties. R. W. Marsh describes lime sulphur spraying experiments carried out on commercial plantations in Somerset, Worcestershire, and Herefordshire to test the conclusion, based on Long Ashton experience, that excellent control could be obtained by spray applications terminating before the time that the flower petals fall. The results were satisfactory on the whole, and, incidentally, observations on spore deposition carried out during these trials suggest that almost all the new infection in the early season comes from pustules from scabbed leaves, not from over-wintered leaves, as had been stated to be the American experience by Keitt and Jones (*Wisconsin Agric. Expt. Station Res. Bull.*, 73, 1926).

The Gold-Belt of Rhodesia.—"The Geology of the Country between Gatooma and Battlefields", in

Southern Rhodesia, is described by A. M. Macgregor in *Bull.* 17 of the Geological Survey of Southern Rhodesia, 1930, pp. 144 and maps. The area forms the central part of the principal gold-belt of Rhodesia and lies between the largest mines of the Colony, the Cam and Motor in the north, and the Globe and Phœnix and Gaika in the south. The most ancient rocks are greenstones with interbedded sediments that are older than the Rhodesdale Gneissic Granite. Next follows a belt of sedimentary rocks which in turn are cut by a series of 'younger' granites and alkali-syenites. All of these belong to the Basement Complex and are thought to be older than the Great Dyke and of Pre-Cambrian age. The mineral deposits are almost exclusively gold-bearing quartz-veins, of which about a hundred and sixty have been worked as small mines, producing gold valued at more than £2,750,000 up to the end of 1929. There was certainly one important period of ore-formation during the later stages of consolidation of the 'younger' granites, and there may also have been an earlier period. Several excellent and detailed analyses of the igneous rocks are presented. They disclose an important characteristic which deserves further attention: namely, the abnormal richness in strontia in the rocks of three successive igneous cycles. Baryta is rare in comparison, and thus the usual proportions of these oxides are reversed to an extent that is unknown elsewhere in the world.

Fossil *Metacheiromys*. — G. G. Simpson, in the *Bulletin* of the American Museum, vol. 59, 1931, has given a very full account of the genus *Metacheiromys*. The precise position among the mammalia of these animals, which occur in Middle Eocene deposits of the United States, has hitherto been rather uncertain. Their affinity to the Edentata has long been suggested, and Simpson now shows that this view is correct. Although aberrant in some respects, such as the peculiar and reduced dentition, in others they are very primitive and represent an early side branch of the Xenarthra. With regard to the origin of the edentates as a whole, Simpson considers that, with the exception of the Tubulidentates of South Africa, which are probably of proto-ungulate stock, the American forms and the Asiatic Manidæ came from some branch of the Insectivora during the Cretaceous period.

Active Earthquake-Faults in Tokyo.—A comparison of the levellings made in the Tokyo area in 1918 and November 1923 reveals a zone of marked depression of as much as 24·8 in. across the section of the city lying east of the river Sumida. As no other great earthquake occurred in this interval within 25 miles of Tokyo, the change was probably due mainly to the earthquake of Sept. 1, 1923. Since then, two new lines of levels have been carried across the area, in January 1926 and March 1930, the results of which have recently been examined by Prof. A. Imamura (*Tokyo Imp. Acad. Proc.*, vol. 7, pp. 1-4; 1931). During each interval, a similar depression occurred in the zone mentioned, which forms a block between two north-south faults about 4 miles apart. The maximum depression during the first interval was 7·0 in. and during the second, 22·0 in., the average secular depression of the district being less than 0·7 in. a year. During the first interval, no earthquake of any consequence occurred near Tokyo; but during the second, there was a semi-destructive earthquake on May 21, 1928, with its epicentre near the sea and close to the eastern of the two faults mentioned. Prof. Imamura suggests that the earlier of the two depressions was a harbinger, and the later a consequence, of the movement that caused this earthquake. As the earthquake that destroyed Yedo (Tokyo) in 1855 seems to have had its origin along the same fault, and as the two faults are not likely to remain inactive, he urges the desirability of keeping a close watch on the movements of the block.

Distribution of Ice in the North Atlantic.—The International Ice Observation and Ice Patrol Service in the North Atlantic has produced its report for 1930 (*Bulletin* 20, United States Coast Guard). Icebergs appeared off the Grand Banks of Newfoundland much earlier than usual. The cutter *Tampa* began its service about seven weeks earlier than in 1929 owing to the presence of much ice. A continuous patrol was maintained for 117 days, which was on the whole longer than usual, although the ice season ended so early as June 10. The conditions, however, were not so severe as in 1929, but the number of bergs was well above the average. Only six bergs drifted south of the forty-third parallel. This is attributed partly to the narrowness of the southward-flowing cold stream off the eastern edge of the Grand Banks. These six bergs were closely watched by the patrol vessels, and three of them crossed important west-bound shipping tracks. The usual extension of cold water to the westward round the Tail of the Bank was also absent. The report is illustrated by a number of charts showing the distribution of ice and surface temperature during the months of the patrol service.

Magnetisation in Strong Fields.—Prof. P. Kapitza's researches on the properties of bodies in very large magnetic fields, well beyond the range of ordinary electromagnets, are extended in new work described in the April number of the *Proceedings of the Royal Society* to the measurement of magnetisation. The experimental arrangements are typical of many used by Prof. Kapitza, being at once robust and very sensitive, and consist essentially of a magnetic balance with which the whole of the experiment is carried out in about one-hundredth of a second, and the results recorded permanently in this time. Typical ferromagnetic, paramagnetic, and diamagnetic bodies have been studied. With iron and nickel it has been shown that the state of saturation produced with relatively small fields persists, within the limit of experimental error (1 per cent) up to fields of 280 kilogauss, a result in accord with the Weiss theory. With the paramagnetic crystals of gadolinium sulphate—a substance studied exhaustively by Onnes at very low temperatures—an indication of incipient paramagnetic saturation was obtained at liquid nitrogen temperatures. Measurements have also been made upon monocrystalline bismuth. This work, extensive and important as it already is, is nevertheless only preliminary, and very interesting results are to be anticipated when the necessary equipment and facilities for using liquid hydrogen and liquid helium as refrigerants have been developed.

Pressure of Granular Material.—A large collection of data bearing on the properties of granular material, a subject of much technical importance, is contained in a communication from Prof. C. F. Jenkin in the April issue of the *Proceedings of the Royal Society*. The work arose from attempts to measure the effective coefficient of friction of sand, some phenomena encountered being immediately recognised as examples of what Osborne Reynolds termed "dilatancy". This suggested certain lines of experiment on pressures on walls built in various ways, and subject to the influence of small bodies packed under different conditions, and the paper deals largely with results so obtained. One result of immediate applicability is that the position of the centre of pressure on a wall is

indeterminate ; it may be much higher than one-third of the height of the wall, so that the distribution of pressure will often be different from the commonly accepted triangular distribution. The pattern of the packing of the grains is of fundamental importance, and as would thus be anticipated, ground and spherical preparations of a common material behave quite differently. Prof. Jenkin makes an interesting suggestion with regard to the variable nature of some results, which he assumes provisionally to be due to a variable adsorbed film of moisture on the grains.

Diffraction of Electrons in Polyatomic Vapours.—A recent paper by R. Wierl in the *Annalen der Physik* (vol. 8, p. 521) extends the use of electron waves to the study of the arrangement of atoms in polyatomic molecules. The principle of the method employed is that the nuclei of the atoms in each individual molecule are equivalent to a grating with a small number of diffracting elements, an analogous problem for X-rays having been solved by Debye. Electrons are, however, more rapidly absorbed than X-rays of the same range of wave-lengths which is useful for this purpose, so that the time of an experiment can be reduced to a fraction of a second. The apparatus consists essentially of a fine pencil of electrons from a discharge tube or thermionic source, which is made to traverse a beam of molecules passing through the same highly evacuated vessel, and to register its diffraction pattern photographically ; the diffraction rings are photometered afterwards. By comparing the observed distribution of intensity with that predicted for various molecular models, considerable information has already been obtained about the structure of a number of organic and inorganic bodies.

Dimensional Changes in Heat-treated Aluminium Alloys.—As a result of a report that heat-treated aluminium alloys were liable to serious secular changes of dimensions during storage, Grogan and Clayton have investigated the point for several such materials and found no appreciable change to occur, the variations which were observed being so small as to be negligible for all practical purposes. Their investigations were described in a paper read on Mar. 12 at the annual general meeting of the Institute of Metals. When the heat-treated alloy is machined, however, considerable changes in the dimensions may be found. These are greatest in the case of *Y* alloy and least in a copper-silicon alloy. Since the annealed bars do not give these effects, it is clear that it is to internal strains due to the heat-treatment that the variations are to be ascribed. In *Y* alloy and duralumin, the only alloys examined in this direction, quenching in cold oil reduces the dimensional changes which occur on machining as compared with those resulting from quenching the material in cold water. If the alloys are quenched in boiling water, which is shown to bring about quite satisfactory hardening, the distortion is reduced to relatively small proportions. Tempering subsequent to the hardening reduces the changes in '25 S' alloy, but increases them to a slight extent in the copper-silicon material.

Effect of Firedamp on Inflammation of Coal Dust.—For some time, the mining engineer has distributed stone dust underground as a means of stopping the propagation of coal dust explosions in mines, and rules have been drawn up for regulating the proportion of incombustible material in the mine dust necessary to ensure safety. It is an important question whether the presence of firedamp in the air underground would make the extinction of an explosion more difficult. In a recent paper, No. 64 (H.M. Stationery Office, 6*d*. net), issued by the Safety in Mines Research Board, experiments on "The Effect of the Presence of Firedamp on the Inflammation of Coal Dusts" are recorded. They showed that the presence of inflammable gas necessitated the use of an increased quantity of stone dust, the proportion depending on the nature of the coal. A coal dust the danger of which is neutralised by an equal quantity of stone dust, when no firedamp is present, would require about 5 per cent more stone dust for each 1 per cent of firedamp in the air.

Fuel Testing in Slow and High Speed Diesel Engines.—Data relating to oil fuel for internal combustion engines have a special interest for the engineer in view of the modern development of the heavy oil high compression engine in small power units both for stationary work and for traction. In a paper read before the Institution of Petroleum Technologists on Mar. 10, L. J. Le Mesurier and R. Stansfield attempted a survey of the behaviour of fourteen different types of fuel when used in slow and high speed engines of low power running under approximately standard conditions. The engines experimented with differ in three main particulars, namely, speed of running, design of combustion space, and arrangement of injection gear for the fuel, although all employ the solid injection system. The programme of work is very wide and includes the effect of leakage of fuel upon the running of the engine, fuel consumption, and the process of combustion. The authors also experimented with various dopes and have indicated the effects of these upon the fuels used. Many graphs and diagrams are published with the paper, among the most interesting being those dealing with the 'delay angle' for each fuel, and also those diagrams indicating the 'combustion line' for each fuel which are obtained from the different engines. The results presented by the authors should be of value to all those interested in the design and performance of the small-powered oil engine, and should be suggestive of further work in this direction.

An Improved Metallographic Microscope.—Many improvements tending to secure a high degree of rigidity and ease of manipulation have been embodied in the redesigned Leitz metallographic microscope. The improved optical system gives a very flat field and is provided with a new type of illuminator giving conical illumination, that is, oblique in all azimuths, thus permitting wide angles to be used without the introduction of glare. Another illuminator, consisting of a glass plate and a small lens, can easily be inserted when photographic objectives of short focal length are being used. The mechanical design is such as to minimise so far as possible the necessary movements of the operator in manipulating the apparatus. The transition from visual observation to photographic work is made by rotating the viewing eyepiece. The observer can view the image to be photographed through an opening in the side of the camera without changing his position by the ocular. In addition, a mirror fitted to the camera stand can be used for purposes of demonstration or observation of the image on the ground-glass screen. The arc lamp, which has a steady crater, is interchangeable with a filament lamp for use when a less intense source of light is desired. A noteworthy feature of the outfit is the vibration-absorbing device on which the prismatic optical bench carrying the saddle-stands is suspended. By its use the difficulty of obtaining photomicrographs in rooms subjected to vibration is obviated. Full particulars of the apparatus and accessories may be obtained on application to Messrs. E. Leitz, 20 Mortimer Street, London, W.1.

Optical Experiments with Electrons.*

IT is now seven years since L. de Broglie brought forward the view of the duality between waves and particles which is now almost universally accepted under the name of wave mechanics, and represents one of the greatest advances in physics of this or any other century. The original treatment was a development of the theory of relativity, but this side of his theory can no longer be kept in its original form. It appears, in fact, that the requirements of relativity are closely connected with the magnetic properties of the electron which gave rise on the older theory to the idea of a 'spinning electron' and were not considered by de Broglie. I do not propose to deal with these, and shall give the theory in the approximate form, which is sufficient to explain the experiments I propose to describe.

The basis of the whole is a duality between waves and particles which is common both to matter and radiation. Maxwell made optics a branch of electricity; if de Broglie has not reversed the relation, he has at least shown both as different cases of a common principle, which is more like old-fashioned optics than old-fashioned electricity. The duality takes this form: any observable atomic event is representable as the arrival or departure of a particle at or from a small region of space, but the laws which govern this event involve a quantity which is best thought of as the amplitude of a wave (possibly in multidimensional space). In the case of light, this quantity is indeed the electric or magnetic vector of the Maxwell wave (it is indifferent which).

In the case of electrons, it is the more elusive ψ which obeys also an equation of the type known to mathematicians as a wave equation. In general, ψ is complex, for the equation is complex, so no direct physical meaning can be assigned to it. Its modulus $|\psi|$ is real, and de Broglie gives as his 'principle of interference' the statement that the chance of the presence of an electron at a given place and time is proportional to $|\psi|^2$. The analogous statement in optics is that the chance of a quantum of light appearing at a given place and time is proportional to the square of the amplitude of the Maxwell wave.

According to de Broglie's theory, the wave-length associated with a free electron is $\lambda = h/mv$ where h is Planck's constant and mv the momentum. He enunciates, therefore, a 'law of spectral distribution', according to which the chance of the presence of an electron with a given momentum is proportional to the square of the modulus of the Fourier component of the wave, the wave-length of which corresponds to the given momentum. In optics, the chance of the appearance of a quantum of energy W is proportional to the square of the Fourier component of the Maxwell wave of wave-length hc/W.

This simple correspondence between electron and quantum—ψ wave and Maxwell wave—in the case of the free electron, prepares us for a close experimental analogy. In fact, we can repeat many optical experiments with electrons and get strikingly similar results. The chief differences are due to the smaller wave-length, which is usually less than that of X-rays, and the much smaller penetrating power. Davisson and Germer made experiments with electrons which are analogous to the diffraction of X-rays by a single crystal, as in the Bragg method.

Other experiments have reproduced with cathode rays the diffraction of X-rays by a crystalline powder, and have verified de Broglie's law of wave-length with considerable accuracy. Some recent work with cathode rays and single crystals of copper and silver provides the electron analogy to the optical experiment in which two transmission diffraction gratings

FIG. 1.—Diffraction pattern of cathode rays incident on a cube face of a single crystal of silver.

are superposed with their rulings inclined to each other (Fig. 1). The etched surface of the single crystal is apparently covered with a number of small lumps, probably the material left between etching pits. The cathode rays strike the crystal at a small glancing angle to the main surface, and pass through the lumps, being diffracted by the atoms in them. If the thickness of the lump, in the direction in which the rays traverse it, is less than a certain amount, which for the angles of diffraction and electronic wave-lengths used is of the order 10^{-6} cm., the thickness has no influence on the pattern. The diffracting system is then equivalent to an arrangement of atoms in the plane normal to the rays, and this two-dimensional array is mathematically equivalent to the crossed gratings of the optical experiment, giving rise to an array of spectra which is reciprocally connected with the atomic array producing it.

The spectra, when received on a fluorescent screen, are bright enough to be shown to a small audience.

* From a lecture delivered by Prof. G. P. Thomson, F.R.S., before the Optical Society on May 14.

Indian Fossil Plants.

IN 1928, Prof. Sahni produced the first part of an important work on Indian fossil plants. It dealt with the fossil coniferous plant remains found in the form of impressions and incrustations in rocks of the Gondwana System in India. The majority of the fossils described were of Mesozoic age, but there were also a few Palæozoic species of a doubtful nature.

In the second part of the work, which has recently been published,* Prof. Sahni extends his researches to petrified coniferous plants, providing descriptions of much that is new and interesting, as well as revising earlier work on this subject. The material with which

* Memoirs of the Geological Survey of India. *Palæontologia Indica*, New Series, vol. 11: "Revision of Indian Fossil Plants". Part 2: Coniferales (b. Petrifactions), by Dr. B. Sahni. Pp. 47-124+plates 7-15. (Calcutta: Government of India Central Publication Branch, 1931.) 7.6 rupees; 12*s*.

he deals has been accumulating for many years in the collections of the Geological Survey of India, and some of the specimens are preserved in the British Museum. As Prof. Sahni remarks, it is unfortunate that the localities and horizons of so many of the specimens are not known with certainty. In spite of this serious disadvantage, Prof. Sahni adds very considerably to our knowledge of the Coniferales.

Most of the petrifactions are of secondary wood and belong to either the Jurassic or Cretaceous age. They include the following form genera: *Mesembrioxylon*, *Cupressinoxylon*, and *Dadoxylon* (*Araucarioxylon*). It is curious that there is no mention of *Dadoxylon indicum* or *Dadoxylon bengalense* Holden, two palæozoic fossil woods which are certainly gymnospermous, while the latter is as likely to be coniferous, in view of its structure, as any of the Mesozoic species of *Dadoxylon* described by Prof. Sahni. These two Indian fossil woods are particularly interesting, since they resemble, in certain important characters, species described from the Karroo formation in South Africa. Prof. Sahni cites this work by Holden in part 1, but does not mention either of these two species.

A new genus of cone, *Indostrobus*, is described. It bears bract and ovuliferous scales as in the living pine, but differs in the ovuliferous scale being forked at its distal end. The seeds are placed on the ovuliferous scale at some distance from the cone axis. Prof. Sahni recognises features reminiscent of the podocarps in the structure of this cone; but at the same time is clear that it is most closely related to the Pinaceæ. He also produces clear evidence of the existence of araucarian conifers in the Jurassic of the Gondwana system. The podocarps, if one may judge not only from the various types of fruits and foliage but also from the numerous examples of secondary wood, were abundant and had a wide geographical distribution in India in the Jurassic and Cretaceous.

The contrast between the present and past distribution of conifers in India is stressed by Prof. Sahni. There is only one native conifer in peninsular India at the present day. There is no native living conifer in Ceylon. The living conifers are restricted, in greater India, to the Himalayas with their connected ranges and to Assam and Burma. In the Tertiary Period there is apparently an almost complete absence of conifers in the India floras so far investigated, and the Indian Tertiary floras would appear to have been almost exclusively angiospermous. There is only one record of Indian Tertiary coniferous wood and that is from Southern India. In the Cretaceous Period the traces of conifers are fairly numerous, but the group appears to have enjoyed its maximum development in the Jurassic. It is a remarkable fact that no fossil conifers are recorded from extra-peninsular India.

On the strength of these facts, Prof. Sahni concludes that the conifers were confined in Mesozoic times to peninsular India. Later they gradually approached extinction, and when the Himalayas were brought into existence in the Tertiary Period the conditions for coniferous growth were reintroduced and an invasion of the modern coniferous flora took place from the landward borders.

From a consideration of their respective floras, Prof. Sahni considers that the Parsora Stage of Dr. Cotter's 1917 classification of the Indian Gondwana System is of Triassic age, and that the Maleri Stage must be referred to the Upper Gondwanas and not, as has been done previously, to the Lower; for the flora suggests an age at least as late as the Rhætic. He considers that while it is clear that Ceylon and the Madras region formed part of the same palæobotanical province in Upper Gondwana times, it is possible that the flora of the Mesozoic plant-beds of the Southern Shan States had a closer connexion with the contemporaneous floras in China than with the Indian Upper Gondwana floras.

Valuable synoptic charts and distribution maps are given. One of the many outstanding good qualities of these memoirs is the excellence of the illustrations, and by means of these the evidence is put before the reader in a manner which leaves little to be desired. All palæobotanists and those geologists who are interested in the stratigraphy of the Indian Gondwana System will look forward to the extension of Prof. Sahni's researches to the other groups of Indian fossil plants.

Physics in Relation to the Internal Combustion Engine.*

THE development of all internal combustion engines using gas or oil as a fuel and for all duties, whether stationary on land or for transport, road, marine, or in the air, owes more to the guidance of physics than any other prime mover.

In the first period, when the engine was nearly always a gas engine, the investigation of the processes which governed its action and the limitation of its cycle of working were carried out by physicists like Sir Dugald Clerk, Prof. Hopkinson, and others. The results assisted and accelerated development, making possible the extended use of the engine for all industrial purposes that followed.

Perhaps the outstanding feature during this time was the growth of the engine in size, until ultimately engines using the waste gases from blast furnaces were built, or are building, for powers so large as 10,000 h.p. per engine. These large-size engines are found usually abroad, operating in the most efficient iron and steel works. As regards the smaller sizes in Great Britain, they would have been used more widely if the gas industry had foreseen the possibilities of a country-wide gas supply with interconnecting trunk mains, as has been done since by the electrical industry.

The War period followed, and led to an intensive and rapid development in the engine for transport, in particular in the air, where special materials and increased accuracy of workmanship were called for. The extraordinary progress made was largely due to the number of highly trained physicists and engineers who concentrated upon every problem and solved it as it arose.

Since the War, development has been in the use of oil, and the wide adoption of the engine for marine propulsion has been due to the high economy of the Diesel motor. The high economic possibilities of this engine were thoroughly discussed in a paper by Diesel before the engine was actually built, and though it took many years to bring this into practice the results have justified all that he had proposed. At the present time, development is being concentrated upon the high-speed oil motor using relatively cheap fuel, with the added advantage of reducing the risk of fire, for road transport and for the air, and very good progress is being made.

The first 'safety first' engines to fly regularly were those supplied to the airship *R101*. Since then one has flown in the United States and one in Germany, and these will shortly be followed by another type in Great Britain.

On the road, extraordinary progress has taken place in the application of the small engine to motor lorries,

* From a lecture delivered by Alan E. L. Chorlton before the Institute of Physics on May 19.

etc., the economy with cheaper fuel and using less of it has been so marked. This class of engine has called for the most intensive investigation and research that has ever been carried out in the internal combustion engine world. Much valuable laboratory work has been carried out in the United States by the National Advisory Committee for Aeronautics in connexion with their air work, and elsewhere.

This reveals the intensity of effort which will before long ensure that not only will the oil engine become predominant for road work of heavier nature, but also for the air, where its great safety from the fire risk, coupled with its economy, makes it so highly suitable. The use of coal dust in the engine progresses very slowly for a country like England, the industrial supremacy of which is founded on coal. This is to be regretted, and we should conduct special work with this object.

In all the development of the engine, the steady improvement of the material has been the measure of the progress made. To-day we have new steels practically unwearable—allowing high speeds and long life, and also of such strength that motors like the Schneider Cup engine weigh less than 1 lb. per h.p.—and a degree of excellence of workmanship not excelled, if equalled, in all the world.

University and Educational Intelligence.

BIRMINGHAM.—At the annual degree congregation on July 4, the honorary degree of M.Sc. is to be conferred on the following: R. A. Chattock, formerly chief electrical engineer to the City of Birmingham; W. Wickham King, known for his work on the Permian breccia; J. H. Reynolds, who has made a special study of the nebulæ; and J. J. Shaw, known for his seismological work.

Prof. J. C. Brash is resigning his posts as professor of anatomy and dean of the Faculty of Medicine on being appointed to the chair of anatomy in the University of Edinburgh.

CAMBRIDGE.—A meeting of the electors to the Sadleirian professorship of pure mathematics will be held on June 12. The stipend of the professor is £1200 a year or, if he holds a fellowship with dividend, £1000 a year. Candidates are requested to communicate with the Vice-Chancellor on or before June 2.

A University lectureship in the faculty of mathematics is vacant. An appointment to it will be made in the current term, to take effect from Oct. 1. Candidates are requested to send their names, with any evidence of qualifications which they may desire to submit, to Mr. W. J. Harrison, Secretary of the Faculty Board of Mathematics, Clare College, Cambridge, on or before May 30.

The General Board recommends that an additional University demonstratorship be established in the Department of Zoology.

Prof. G. Elliot Smith, professor of anatomy in University College, London, has been elected an honorary fellow of St. John's College.

LONDON.—At a meeting of the Court of the University held on May 13, the Principal, Dr. Edwin Deller, read his annual report of the work of the University for the year 1930–31. The statistics for that year have brought out some striking facts concerning the number of students. For example, the number of matriculations has almost quadrupled since just before the War. A great increase has taken place in all branches of study. For the year 1913, the numbers of matriculations, first degrees, and higher degrees were 6638, 1636, and 171 respectively. The corresponding numbers for 1929 were 23,832, 3436, and 510, and for 1930, 25,544, 3543, and 548. The total number of degrees, diplomas, and certificates awarded for those three years were 11,937, 36,633, and 39,323. During the last decade, the inspection and examination of secondary schools have received much attention, and the growth of the school examinations has been specially noteworthy.

The Goldsmiths' Company has offered the University a sum not exceeding £50,000 towards the cost of erecting and equipping the library building on the Bloomsbury site. The University library, at present housed in the Imperial Institute, South Kensington, contains a total of some 260,000 volumes and pamphlets, and includes, with other special collections, the Goldsmiths' Library of Economic Literature.

APPLICATIONS for grants from the Research Fund of the Chemical Society must reach the Assistant Secretary of the Society, Burlington House, W.1, by June 1, and be made upon special forms obtainable upon application.

APPLICATIONS are invited by the London County Council for two Robert Blair fellowships in applied science and technology, each of the value of £450 and for one year. The fellowships will be tenable in the Dominions, the U.S.A. or other foreign countries, and are open only to British subjects of not less than twenty-one years of age. Particulars and application forms can be had from the Education Officer (T.3), The County Hall, S.E.1. The latest date for the return of forms of application is June 18.

A NUMBER of post-graduate scholarships in agriculture and agricultural science and in veterinary science respectively will shortly be awarded by the Colonial Office. The scholarships, which will each be of the annual value of £250, plus £12 for books, have been instituted with the view of ensuring a supply of adequately trained men for future service in the Colonial Agricultural and Veterinary Services. Requests for particulars of the scholarships and for the necessary forms of application should be addressed to the Director of Recruitment (Colonial Service), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1. The latest date for the return of completed forms is June 15.

THE twenty-second annual Conference of the Association of Teachers in Technical Institutions will be held at Manchester on May 22–26, under the presidency of Mr. H. Ade Clark. The Conference will be held at the College of Technology. In connexion with the Conference an exhibition of machines, scientific apparatus, and books will be opened on May 25. Among the resolutions for public sessions is the motion that a representative of technical education should be appointed to the Consultative Committee of the Board of Education. The teaching of biology, too, will receive consideration. A considerable amount of biology is taught in many technical schools and colleges; but this is chiefly of a purely technical character for the benefit of pharmaceutical chemists. The resolution to be placed before the Conference, however, will be of a wider nature. It is considered that a knowledge of biology is an essential part of a sound general education, and that more experts in the subject are required for the advancement of agriculture and industry. The Conference is to ask for the teaching of elementary biology in all State-aided schools and an increase in the facilities for higher education in biological subjects. The latter is scarcely necessary. The facilities are there; but the former really needs attention. A better groundwork in the younger pupils is certainly desirable. Much has already been suggested concerning it; but little, so far, has been done.

Birthdays and Research Centres.

May 24, 1855.—Dr. A. C. HADDON, F.R.S., formerly reader in ethnology in the University of Cambridge.

At present I am engaged in compiling published and unpublished information concerning the sea canoes of Melanesia, New Guinea, and North Queensland. The original craft are, in many areas, fast disappearing or becoming modified, and in some places have quite disappeared. Not only do these canoes often exhibit remarkable technical skill and adaptability to local circumstances, but also considerable diversity. The distribution of the various types and details of construction of these vessels is worth recording, since these were the means by which the various migrations and culture-drifts have spread over western Oceania. The names for canoes and their various parts are significant in this connexion. Very little has been recorded about the traditional relation between definite types of canoes and culture-heroes or culture-drifts. It is hoped that a foundation will be provided upon which other ethnologists may build.

May 24, 1860.—Prof. A. SMITHELLS, F.R.S., director of the Salters' Institute of Industrial Chemistry and emeritus professor of chemistry in the University of Leeds.

So far as research work is concerned, I continue with the study of some flame problems and, with a long-standing connexion in the gas industry, with scientific investigations relating to the carbonisation of coal and the use of gaseous fuel. The advances that are being made by this branch of our fuel industries in the application of science to its technical problems, and the results which have accrued from industrial research conducted by the gas industry and the benzol industry in association with the University of Leeds, are, I think, notable. The national importance of directing research to fuel problems on every side scarcely needs emphasising in the columns of NATURE.

May 25, 1858.—Sir HENRY MIERS, F.R.S., honorary professor of crystallography and lately vice-chancellor of the University of Manchester.

The splendid results of X-ray methods will not, I hope, distract attention from two promising lines of research in mineralogy and crystallography. (1) Experimental mineralogy: that is, the artificial production of minerals, both rock-forming and others, and the study of their origin and transformations. The lack of a geophysical laboratory in Great Britain has long been deplored. (2) Crystal growth: that is, the study of the conditions which prevail in and upon the surface of the growing crystal; these determine its actual form; perhaps also its external symmetry, as some believe.

May 25, 1865.—Prof. P. ZEEMAN, For.Mem.R.S., professor of experimental physics in the University of Amsterdam.

My co-workers and I are at present most interested in the experimental study of the influence of magnetic fields on the hyperfine structure of spectrum lines. Values of the mechanical moment of the atomic nucleus obtained from such magneto-optical resolutions are among the most important data for the further development of the quantum theory. A second line of work, concerning the more detailed analysis of the light given out by positive rays, which, as Stark and Lunelund have shown, is partially polarised, is in the charge of Miss W. Lub. An extensive study, made in my laboratory, of the magnetic resolutions of the spectra of the ionised noble gases, will soon be published by Mr. Bakker.

Constant progress is being made in the analysis of different spectra, especially by Dr. de Bruin.

May 28, 1861.—Dr. H. R. MILL, vice-president and formerly librarian of Royal Geographical Society and president of Section E (Geography) of the British Association in 1901, past-president of Royal Meteorological Society and Director of British Rainfall Organization.

I worked long at researches preliminary to the construction of an accurate map of the normal annual rainfall of the British Isles, and I hope that the work will be continued and completed by better equipped and more fortunate investigators.

The practical problem present to my mind is to draw isohyets of the average annual precipitation from air currents impinging horizontally on land slopes. Such a map would express exactly the control of a mobile distribution by crustal configuration, undisturbed by the sporadic precipitation produced by ascending air-currents of purely aerological origin occurring in cyclones, squalls, and thunderstorms. Centuries of observations would be required to produce a map of total rainfall in which such sporadic splashes would be smoothed out; but I believe that a method of eliminating these irregularities in shorter periods might be deduced from the study of very detailed maps of individual showers together with equally detailed synchronous maps of atmospheric pressure.

May 29, 1882.—Prof. H. BATEMAN, F.R.S., professor of mathematics, physics, and aeronautics in the California Institute of Technology, Pasadena, California.

My chief investigation now in progress is on reflection at an absorbing wall of the sound from a point source.

Societies and Academies.

LONDON.

Royal Society, May 7.—M. D. Waller: (1.) The measurement of actinic erythema produced by ultra-violet radiation with special reference to the latent time. Consistent results regarding the biological action of ultra-violet radiation, as measured by the resulting skin erythema, can be obtained provided certain precautions are taken. The latent time of erythema, which may vary from about one to seven hours, according to the length of exposure, provides the most accurate and simple way of estimating the effect of ultra-violet radiation on the skin, and it is easily measured. When it is desired to get the maximum contrasts due to differing conditions of radiation, exposures should be chosen which will lie on the steep part of the curve, corresponding to rapid variations of the latent time with exposure and to slight erythemas which will differ even visually one from another more than will deep erythemas.—(2.) The relation between energy doses of ultra-violet radiation and actinic erythema produced. Particular attention was paid to the question of how the intensity of the radiation decreases with the distance from the source. The intensities were varied over wide limits (200 : 1) corresponding to distances varying from 40 cm. to 5·5 m. The effect of a given dose of the weak intensity is just as great as that of the most powerful intensity used, and it is concluded that the production of erythema follows the Bunsen-Roscoe law for a

photo-chemical action, that is, the time factor is unity. —J. W. Tudor Thomas: On the return of sensitiveness in corneal grafts in rabbits. In a series of experiments on corneal grafting, some of the grafts became sensitive and others did not. The results of 29 experiments are analysed. Some of the grafts were central in position in the cornea, others marginal. Some remained or became clear; others became more or less opaque, while one exhibited a central clear area. The establishment of an afferent nerve supply to a corneal graft depends upon a precedent or concurrent growth of blood vessels in that graft. It does not seem to be necessary that the blood vessels should accompany or take the same path as the afferent nerves that grow in from the surrounding tissue.—G. E. Briggs and A. H. K. Petrie: Respiration as a factor in the ionic equilibria between plant tissues and external solutions. The conductivity of water containing slices of tissue from carrot root rises at first and then falls to a steady value, which is maintained as long as the tissue is alive. The rate of evolution of carbon dioxide by the system follows a similar course to that of the conductivity. Theoretical consideration shows that variations in the rate of production of carbon dioxide by the tissue will be accompanied by similar changes in the concentration of hydrogen ions in the tissue. This will result in changes in the degree of ionisation of indiffusible substances, such as proteins, with consequent changes in the distribution of diffusible ions, such as K and Cl, between the tissue and the external solution. The final result of this chain of events will be a parallelism between rate of production of carbon dioxide and conductivity of external solution.—McKeen Cattell, T. P. Feng, W. Hartree, A. V. Hill, and J. L. Parkinson: Recovery heat in muscular contraction without lactic acid formation. Muscles poisoned with iodo-acetic acid contract without producing lactic acid. Functional recovery in oxygen after stimulation can be demonstrated under certain conditions in such muscles. The persistence of this 'recovery' heat suggests that one effect of iodo-acetic acid is to interfere with the mechanism by which energy released in oxidation can be employed in driving the endothermic reactions necessary for functional recovery; it does not interfere with oxidation as such. Normal muscles stimulated to extreme exhaustion have a 'recovery' heat only about one quarter of its usual value in relation to the initial heat. Possibly in normal muscles pushed to extreme exhaustion, as in muscles poisoned with iodo-acetic acid, one reason of incomplete recovery is that phosphate set free by the breakdown of creatine-phosphoric acid is 'side-tracked' as hexose phosphoric ester and so cannot be recombined with creatine. A. G. R. Whitehouse: Further investigation of sweating and sweat. For a given rise in body temperature, sweating is facilitated by the performance of muscular work when compared with sweating produced by the same rise in body temperature with the subject at rest. Some product of muscular metabolism is responsible for this, though the connexion may be a less direct one. The performance of a moderate amount of work would seem to be accompanied by little rise in the chlorine concentration of the sweat, although a marked increase with time, indicative of fatigue of the sweat-glands, is evident when the subject is at rest and the sweating is simply due to the wet-bulb temperature of the surrounding air. A progressive decrease in the proportion of organic matter to ash is observed as the sweating continues. The chlorine concentration, and also the ratio of chlorine to potassium in the sweat, is found to vary for different individuals.—R. Snow: Experiments on growth and inhibition (2). In decapitated pea seedlings, which have produced two equal shoots springing from the axils of the cotyledons, if one of the shoots is deprived of its leaves until only those of 1 mm. or less remain, it is rapidly arrested in growth and finally killed. This effect must be due to inhibition coming from the other shoot. The influence coming from developing leaves kills (directly or indirectly) those shoots or parts of shoots that are not in the line between developing leaves and roots and in which it travels towards the apex, and this fact also suggests that it is of a polar nature.

Geological Society, April 22.—H. H. Thomas and W. Campbell Smith: Xenoliths of igneous origin in the Trégastel-Ploumanac'h granite, Côtes-du-Nord, France. In the neighbourhood of Trégastel, a red porphyritic biotite-granite crops out along the coast and forms the rising ground for several miles inland. In parts, this granite is remarkable for the abundance of xenoliths which it contains. Some of these are of sedimentary origin, but the majority are of the kind usually referred to as 'basic segregations'. The occasional presence of large felspars in the xenoliths is discussed, and the authors are of opinion that these are xenocrysts and have not grown in place. Evidence is produced to show that the basic mass from which the xenoliths were derived was most probably part of the roof of the granite.—C. I. Gardiner and S. H. Reynolds: The Loch Doon 'granite' area, Galloway. The plutonic rocks are almost everywhere surrounded by high hills composed of metamorphosed Ordovician sediments. Analyses were prepared by Mr. E. G. Radley of each of the three rock-types. The most interesting problem concerning the plutonic mass is to determine the mutual relations of the rocks and to ascertain whether their different varieties may be considered to have arisen by differentiation subsequent to intrusion, or whether the facts point to each of the three rock-types being a separate intrusion. The authors believe the latter to be the true explanation. No evidence was found of contamination of the igneous magma by the incorporation of sedimentary material.

PARIS.

Academy of Sciences, April 7.—Charles Camichel and Léopold Escande: An experiment of Joule concerning the mechanical equivalent of heat.—A. Gelfond: The order of $D(\lambda)$.—G. A. Boutry: Cycles and lag in photoelectric cells with a gaseous atmosphere.—J. Barbaudy and A. Petit: Study of the buffer effect in nickel-plating baths.—E. Herzog and G. Chaudron: The protection of iron plunged into aerated saline solutions and the realisation of an Evans battery.—L. Meunier and M. Lesbre: The action of electrolytes upon substantive colouring matters.—H. Forestier: The ferrites: the relation between their crystalline structures and their magnetic properties. The magnetic properties of the ferrites have been shown previously to fall into different groups. The X-ray study of the crystalline structure of these compounds proves a direct relation between the crystalline structure and the magnetic properties.—Maurice Marie Janot: Sclareol and its derivatives. The formula $C_{17}H_{30}O_2$, provisionally given to the solid alcohol obtained from *Salvia sclarea*, is now found to be $C_{20}H_{36}O_2$. This results from a purer product and is confirmed by the preparation and analysis of a dihydrosclareol.—Louis Lecoq: The complex salts of gold and sodium derived from camphodithiocarboxylic acid.—Acolat: Physiological researches relating to the separation of the venous blood and arterial blood in the frog's heart. The peculiarities of the structure of the frog's heart described in an earlier paper

(*C.R.*, **192**, p. 767) suggested that the separation of the two bloods in the ventricle is nearly complete. Confirmatory evidence is now given, based on the use of a coloured Ringer-Locke physiological liquid. —**R. Fabre** and **H. Simonnet**: Researches on beer yeast. The experimental conditions of its action on cystine.—**A. Boutroux**: The influence of lipoids on the separation of the proteins by neutral salts.—**Paul Durand**: *Rhipicephalus sanguineus* and the virus of the pustular fever of Tunis. In Tunis, as in the Midi (France), apart from any connexion with human cases, *Rhipicephalus sanguineus* can harbour the virus of pustular fever and keep it intact for several weeks.—**P. Delanoë**: The merion (*Meriones Shawi*) as a reservoir of the Moroccan spirochæte *Sp. hispanicum*, var. *marocanum*. Out of twenty-one merions, two were found to be infected, or about 10 per cent, but the exact proportion of infected merions can only be settled by further work. It is, however, certain that this rodent can be spontaneously infected by the Moroccan spirochæte.

GENEVA.

Society of Physical and Natural History, Dec. 20.—**L. A. Deshusses** and **J. Deshusses**: Estimation of the active principles of pyrethrum. The authors have studied pyrethrums of Swiss, French, Spanish, and Dalmatian origin, estimating the two active pyrethrins, which give a direct measure of the efficiency of pyrethrum insecticides. All these products contain about the same proportions of the active principles, the maximum having been furnished by French pyrethrum cultivated at Bossey (Haute-Savoie) and at Montpellier. For each of these products, the fully opened flower always gives a much higher percentage than the half opened flower, and the latter more than the closed flower.—**E. Cherbuliez, F. Neumeier**, and **H. Lozeron**: Some synthetic substituted ephedrins. The authors give results of a pharmacological study of some synthetic derivatives of ephedrin, showing how the specific action of this alkaloid is profoundly modified by slight changes of constitution.—**E. Cherbuliez** and **M. Schneider**: The non-homogeneity of casein. Casein, hitherto considered as a homogeneous substance, has been separated by physical methods into at least two constituents. This necessitates a modification of the current views on the physiological formation of this important substance and on the phenomena of its precipitation by rennet.—**E. Cherbuliez**: The behaviour of two antipodes in an unsymmetrical solvent. The author has examined the behaviour of two antipodes in a solvent, constituted for the two antipodes dissolved by the same active substance. A difference between the properties of the two antipodes is not shown by the solubilities, but, on the other hand, racemisation in presence of the active solvent appears to lead to an active body, and this proves a difference in the reaction of the two antipodes in solution, in spite of the absence of chemical combinations in the ordinary sense of the word.—**R. Wavre**: A measure of the deformation of a fluid. By an analysis based on the functional calculus, the author expresses more exactly the ideas of the deformation of a fluid, in order to obtain more rigid definitions of the stability of the states of a system depending on an infinity of parameters. The object of this is to study the changes of form that the earth may have undergone in the course of ages, influenced as it is by the solar-lunar attraction.—**W. H. Schopfer**: An active substance found with maltose. Its physiological action. The author shows that along with maltose there occurs a nitrogenous impurity, probably a vitamin: it accelerates the development of fungi.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society of Edinburgh, Session 1930-1931. Vol. 51, Part 1, No. 3: On some Problems involving the Persymmetric Determinants. By J. Geronimus. Pp. 14-18. 6*d*. Vol. 51, Part 1, No. 4: A Note on the Secular Changes of Rock Temperature on the Calton Hill. By Dr. F. J. W. Whipple. Pp. 19-24. 6*d*. Vol. 51, Part 1, No. 5: Secular Changes of Rock Temperature—Note on Dr. Whipple's Paper. By R. W. Wrigley. Pp. 25-26. 3*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Transactions of the Entomological Society of London. Vol. 79, Part 1, April 24. Pp. 247. (London.) 21*s*.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1930. Edited by Prof. Alexander Meek. (New Series 19.) Pp. 68. (Newcastle-on-Tyne: Armstrong College.) 5*s*.

Government of India: Department of Industries and Labour (Public Works Branch). Irrigation in India: Review for 1928-29. Pp. 37. (Calcutta: Government of India Central Publication Branch.) 1.2 rupees; 2*s*.

India: Meteorological Department. Scientific Notes. Vol. 1, No. 8: Monthly Normal Isobars and Wind-Roses at 0·5, 1, 2 and 3 km. above Sea-level over India and Neighbourhood. Pp. 109-112+48 plates. 4 rupees; 6*s*. 9*d*. Vol. 3, No. 20: Correlation between Rainfall in N.W. India and Height of Indus River at Bukkur. By Rao Saheb Mukund V. Unakar. Pp. 15-20+2 plates. 6 annas; 8*d*. Vol. 3, No. 21: Upper Air Circulation over India and its neighbourhood up to the Cirrus Level during the Winter and the Monsoon. By H. C. Banerjee and Dr. K. R. Ramanathan. Pp. 21-27+13 plates. 2 rupees; 3*s*. 6*d*. (Calcutta: Government of India Central Publication Branch.)

Report of the Haffkine Institute for the Year 1929. By Major L. A. P. Anderson. Pp. 69. (Bombay: Government Printing and Stationery Office; London: High Commissioner for India.) 4 annas; 5*d*.

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 4 (New Series), No. 3, March. Abstracts Nos. 397-584. Pp. 71-105. (London: H.M. Stationery Office.) 9*d*. net.

University College of Wales, Aberystwyth. Leaflet Series S. No. 2: New Varieties and Strains from the Welsh Plant Breeding Station. No. 2: Pure Line Strains of Ceirch Llwyd (*Avena Strigosa*) and Ceirch-du-bach (*A. sativa*). By E. T. Jones. Pp. 26. (Aberystwyth.) 1*s*.

The National Physical Laboratory. Report for the Year 1930. Pp. vi+295+16 plates. (London: H.M. Stationery Office.) 12*s*. 6*d*. net.

Commonwealth of Australia. Fourth Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June 1930. Pp. 51. (Canberra: H. J. Green.)

Report of the Twentieth Meeting of the Australian and New Zealand Association for the Advancement of Science, formerly known as the Australasian Association for the Advancement of Science. Brisbane Meeting, May-June 1930. Edited by Dr. D. A. Herbert. Pp. xlviii+596. (Sydney, N.S.W.: Australian and New Zealand Association for the Advancement of Science.)

The University of Leeds: Department of Coal Gas and Fuel Industries. Report of the Livesey Professor (J. W. Cobb) for the Sessions 1928-29 and 1929-30. Pp. 15. (Leeds.)

A 21 Years' Chronology of Textiles, 1910-1931. Pp. 67+51 plates. (Manchester: The Textile Institute.) 5*s*.

The Empire Forestry Handbook, 1931. Edited by Fraser Story. Pp. 189. (London: Empire Forestry Association.) 3*s*. 6*d*.

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1930; with Report and Notes of the Director, Rev. E. D. O'Connor. Pp. xxv+49. (Blackburn.)

McGill University Economic Studies: National Problems of Canada. No. 15: The Alberta Coal Problem. By Herbert Leighton Draper. Pp. 65+viii. 75 cents. No. 16: The Negro in Canada. By Ida Greaves. Pp. 79. 75 cents. (Orillia, Ont.: The Packet-Times Press, Ltd.)

Commonwealth Bureau of Census and Statistics, Canberra. Official Year Book of the Commonwealth of Australia. No. 23, 1930. Prepared under instructions from the Minister of State for Home Affairs by Chas. H. Wickens. Editor: John Stonham. Pp. xxxii+806. (Melbourne: H. J. Green.) 5*s*.

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Forestry Society. Vol. 45, Part 1, March. Pp. xvi+121+26. (Edinburgh: Douglas and Foulis.) 7*s*. 6*d*.

Royal Astronomical Society. List of Fellows and Associates, 1931. March. Pp. 54. (London.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1364 (Ae. 492—T. 3030): The 5-ft. Open Jet Wind Tunnel, R.A.E. By F. B. Bradfield. Pp. 11+11 plates. (London: H.M. Stationery Office.) 1*s*. net.

Ministry of Transport. Report of the Committee on Main Line Railway Electrification, 1931. Pp. 57. (London: H.M. Stationery Office.) 3*s*. net.

FOREIGN.

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 135: Chestnut Blight in Michigan. By D. V. Baxter and F. C. Strong. Pp. 18. Special Bulletin No. 207: Public Health and Educational Services in Michigan. By C. R. Hoffer. Pp. 34. Special Bulletin No. 208: Services of Institutions and Organizations in Town-Country Communities. By C. R. Hoffer and Margaret Cawood. Pp. 37. Special Bulletin No. 209: Consumer Demand for Apples in Michigan. By H. P. Gaston. Pp. 50. Special Bulletin No. 210: Corn Growing in Michigan. By H. C. Rather and J. R. Duncan. Pp. 35. Special Bulletin No. 212: School Financing in Michigan; a Plan to Equalise the Burden. By F. M. Thrun. Pp. 79. Special Bulletin No. 213: Investigations with Oat Varieties and Diseases in the Upper Peninsula. By B. R. Churchill. Pp. 15. Technical Bulletin No. 110: A Contribution to the Bacteriology and Pathology of the Bovine Udder. By L. B. Sholl and J. P. Torrey. Pp. 31. (East Lansing, Mich.)

Carnegie Institution of Washington. Classified List of Publications. Pp. 208. (Washington, D.C.: Smithsonian Institution.)

Smithsonian Institution: United States National Museum. Bulletin 82: A Monograph of the Existing Crinoids. By Austin Hobart Clark. Vol. 1: The Comatulids. Part 3: Superfamily Comasterida. Pp. vii+816+82 plates. (Washington, D.C.: Government Printing Office.) 2 dollars.

Bulletin of the American Museum of Natural History. Vol. 61, Art. 5: Dolichopidæ of the Canal Zone. By M. C. Van Duzee. Pp. 161-205. Vol. 61, Art. 6: New North and South American Ascidians. By Willard G. Van Name. Pp. 207-225. (New York City.)

Japanese Journal of Astronomy and Geophysics. Transactions and Abstracts, Vol. 8, No. 2. Pp. ii+39-65+5-10+plates 3-17. (Tokyo: National Research Council of Japan.)

The Egyptian University: the Faculty of Medicine. Publication No. : The Bibliography of Schistosomiasis (Bilharziasis), Zoological, Clinical and Prophylactic. By Dr. Mohamed Bey Khalil. Pp. x+506. (Cairo.) 30 P.T.; 6s. net.

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 294-296: On the Absorption Spectra of Salt-Solutions—Appendix: The Absorption Spectra of Metallic Ions, by Seichi Kato; The Near Infra-Red Arc Spectrum of Iodine, by Tatsuro Iwama; Note on the Ultra-Violet Absorption Spectrum of Hydrazine Vapour, by Sunao Imanishi. Pp. 161-167+plates 7-9. (Tōkyō: Iwanami Shoten.) 30 sen.

U.S. Department of Agriculture. Technical Bulletin No. 230: *Macrocentrus gifuensis* Ashmead, a Polyembryonic Braconid Parasite in the European Corn Borer. By H. L. Parker. Pp. 63. (Washington, D.C.: Government Printing Office.) 15 cents.

The Science Reports of the Tōhoku Imperial University, Sendai, Japan. Fourth Series (Biology), Vol. 6, No. 1. Pp. 162. (Tokyo and Sendai: Maruzen Co., Ltd.)

Bulletin of Yale University. Supplement: Report of the Director of Peabody Museum for the Academic Year 1929-1930. Pp. 23. (New Haven, Conn.)

The Peabody Museum of Natural History, Yale University. Special Guide No. 1: The Evolution of the Horse Family. By Richard Swann Lull. Revised edition. Pp. 31. 15 cents. Special Guide No. 2: The Evolution of the Elephants and Mastodons. By Richard Swann Lull. Revised edition. Pp. 40. 15 cents. (New Haven, Conn.)

Annales de l'Institut Henri Poincaré. Vol. 1, Fascicule 2. Pp. 77-203. (Paris: Les Presses universitaires de France.) 35 francs.

Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. 29, Part 3: The Ascigerous Forms of some Graminicolous Species of Helminthosporium in Japan. By Seiya Ito and Kazue Kuribayashi. Pp. 85-125+plates 7-9. Vol. 31, Part 1: Beitrag zur Kenntnis der Pickelwirkung. Von Satoshi Sawayama. Pp. 17. (Tokyo: Maruzen Co., Ltd.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Supplement to Bulletin No. 100: Developments of the Existing System for Seed Supply of Cotton in Egypt. By Dr. W. Lawrence Balls. Pp. 17. (Cairo: Government Press.) 1 P.T.

Smithsonian Miscellaneous Collections. Vol. 85, No. 2: The Avifauna of the Pleistocene in Florida. By Alexander Wetmore. (Publication 3115.) Pp. 41+6 plates. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 78, Art. 20: A new Parasitic Fly of the Genus Chaetophlepsis. By R. T. Webber. (No. 2863.) Pp. 4. Vol. 79, Art. 7: Descriptions of New Genera and Species of Siamese Fishes. By Hugh M. Smith. (No. 2873.) Pp. 48. Vol. 79, Art. 8: A new Shipworm from Venezuela. By Paul Bartsch. (No. 2874.) Pp. 3+1 plate. (Washington, D.C.: Government Printing Office.)

U.S. Department of the Interior: Office of Education. Bulletin, 1931, No. 20: Biennial Survey of Education in the United States, 1928-1930. Chapter 10: Hygiene and Physical Education. By Marie M. Ready and Dr. James Frederick Rogers. Pp. 27. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 78, Art. 4: Cambrian Bivalved Crustacea of the Order Conchostraca. By E. O. Ulrich and R. S. Bassler. (No. 2847.) Pp. 130+10 plates. Vol. 78, Art. 16: Report on the South American Sea Stars collected by Waldo L. Schmitt. By W. K. Fisher. (No. 2859.) Pp. 10+8 plates. (Washington, D.C.: Government Printing Office.)

Catalogues.

The Bureau of Information on Nickel. Air, Oil and Water Coolers: the Influence of Design and Materials upon Service. By H. E. Upton. (Nickel, R5.) Pp. 7. (London: The Mond Nickel Co., Ltd.)

List of Cheap Books in many branches of Science and Natural History. (No. 186.) Pp. 16. (London: Dulau and Co., Ltd.)

B.D.H. Ureamometer Outfit. Pp. 4. Gaster Siccata B.D.H. (Desiccated Stomach.) Pp. 8. (London: The British Drug Houses, Ltd.)

Annotated and Classified Catalogue of Ancient and Modern Books on Exact and Applied Science. Part 1: Including Periodical Publications, General and Collected Works, Mathematics. (Sotheran's Price Current of Literature, No. 825.) Pp. 152. (London: Henry Sotheran, Ltd.)

A New Refractometer for examining Sugar Solutions, Jams, Butters, Oils and Fats. Pp. 8. Refractometers for Industry and Research. Pp. 12. (London: Bellingham and Stanley, Ltd.)

Diary of Societies.

FRIDAY, MAY 22.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 6.15.—Exhibition of a Cinematograph Film: The Story of Bakelite Resinoid.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Dr. J. T. Dunn: Chairman's Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William Bragg: X-Ray Investigations of the Structure of Liquids.

TUESDAY, MAY 26.

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

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.—Gossip Meeting.

WEDNESDAY, MAY 27.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College), at 5.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—Annual General Meeting.

SOCIETY OF SWEDISH ENGINEERS IN GREAT BRITAIN (at Swedish Chamber of Commerce, 14 Trinity Square, E.C.3), at 8.—A. F. Enstrom: Research in Industry and Rationalisation.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London), at 8.30.—Dr. R. Money Kyrle: The Remote Consequences of Psycho-Analysis on Individual, Social, and Instinctive Behaviour.

[*THURSDAY*, MAY 28.

ROYAL SOCIETY OF MEDICINE (Urology Section) (Annual General Meeting), at 8.30.—A. R. Thompson: Further Considerations Relative to Congenital Deformities of the Lower Urinary Tract.

FRIDAY, MAY 29.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Sir William Hamer: The Crux of Epidemiology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Very Rev. Dean Inge: The Future of the Human Race.

SATURDAY, MAY 30.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (Annual General Meeting) (at Cambridge).

PUBLIC LECTURES.

FRIDAY, MAY 22.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Prof. E. L. Collis: Industrial Hygiene: Respiratory Diseases.

BIRKBECK COLLEGE, at 5.30.—Sir Henry Hadow: The Philosophy of Lord Haldane (Haldane Memorial Lecture).

TUESDAY, MAY 26.

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Col. S. P. James: The New Method of Studying Malaria and Some of its Results.

WEDNESDAY, MAY 27.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. R. H. Crowley: Child Guidance.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Prof. A. O. Lovejoy: Knowing and its Place in Nature. (Succeeding Lectures on May 28 and 29.)

KING'S COLLEGE, LONDON, at 5.30.—Dr. W. Rosenhain: Some Impurities in Metals and the Production of Metals of High Purity (Armourers and Brasiers' Company Lectures). (Succeeding Lectures on June 3 and 10.)

THURSDAY, MAY 28.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. F. C. Shrubsall: Mental Deficiency from the Social, Legal, and Educational Aspects.

FRIDAY, MAY 29.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—N. Howard-Mummery: An Industrial Welfare Scheme.

SATURDAY, MAY 30.

UNIVERSITY COLLEGE, LONDON, at 2.30.—Sir Flinders Petrie: The City of the Shepherd Kings. (*To be repeated on June 2 at* 5.30.)

CONFERENCES.

MAY 22 TO 26.

ASSOCIATION OF TEACHERS IN TECHNICAL INSTITUTIONS (at Manchester).

Monday, May 25 (at College of Technology), at 10.30 A.M.—Induction of President (H. Ade Clark).—Presidential Address.

MAY 25 TO 28.

DEUTSCHE BUNSEN-GESELLSCHAFT (at Vienna).—Subjects for discussion: Metallography, Crystal Structure, Thermodynamics, Spectroscopy, Adsorption, and Free Radicals.

MAY 27 TO 29.

CONFERENCE ON MENTAL HEALTH (at Central Hall, Westminster).

Wednesday, May 27, at 8.15.—The Human Factor in International Problems.

Thursday, May 28, at 3.—The Human Factor in Crime.
At 8.15.—The Human Factor in Industry.

Friday, May 29, at 3.—The Human Factor in the Social Services.
At 8.15.—The Human Factor in Education.

MAY 28 TO 30.

VEREIN DEUTSCHER CHEMIKER (at Vienna).—Symposium: The Separation of Liquids and Solids.