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Research and Industry

IN his presidential address on September 2 to Section G (Engineering) of the British Association meeting at Nottingham, Sir Alexander Gibb took for his subject "Research and Engineering". He pointed out that engineering began as an art; at a later stage it developed into a somewhat scientific but purely empirical practice; and that it is now at the final stage of applied science. The same transformations may be noted in many other industries, though it must be admitted that there is still a great number of industries yet in the second stage of development, and some even in the first. Nevertheless, there is an increasing attention paid in industry generally—and not only in engineering—to the vital necessity of continuous research as being, to quote the words of Sir Alexander, "the only means of continuous progress in an increasingly competitive world".

Sir Alexander Gibb gave a necessarily brief historical survey of the rise and development of research, which is a plant of very recent growth. Apparently he regards the beginnings of the national recognition of the value of research as dating back to less than a century ago, when the Royal Commission was appointed to find uses for a surplus of £213,000, made by the Great Exhibition of 1851. The money was used to purchase land in Kensington Gore, on which were built museums and schools of art, and also to provide science scholarships. Government grants from 1850 onwards to the Royal Society and private donations or bequests went to aid research in mathematics, physics, astronomy, biology, chemistry and general purposes.

In Great Britain, throughout this early period, original research continued to be mainly the work of individual scientific workers and was carried on chiefly at their own expense. Industry lagged far behind in its recognition of the value of scientific research, and it may be said, indeed, that it is only within very recent times that industry generally has accepted the view that scientific and industrial research is an essential factor in our industrial and national existence. It is also true to add that it needed the lessons of the Great War to open fully the eyes of the Government to the paramount need of systematic scientific research in our industrial organization.

Perhaps nothing in the development of the research movement is more significant than the way in which the distinction between pure and applied science, which was originally as sharp as the distinction between 'Gentlemen' and 'Players' at Lord's, has gradually lost its sharpness and become vague and indefinite. It is not so very long ago that, in many quarters, research into the internal structure of the atom was regarded as a noble and elevating pursuit of pure science, and research on soap as a rather ignoble, if not degrading, investigation—as though an atom were inherently dignified and became disreputable only when it was associated with other atoms to form the molecules of a homely, if necessary, commodity. Indeed, the artificial division between pure and applied science has dissolved perhaps most rapidly in the very laboratories which may seem, at first sight, to have been designed to buttress and perpetuate it. In industrial research laboratories, both at home and abroad, there is abundant testimony to the importance of 'pure science' research—what it is now the fashion to call 'fundamental research'.

The same recognition is a remarkable feature of the experience of those industrial research associations which have been formed under the ægis of the Department of Scientific and Industrial Research. Almost with one voice they are crying out that the time and energies and the expenditure involved—necessarily and rightly involved—in solving *ad hoc* problems of great and immediate importance to the respective industries, leave them with too little time and energy and funds to be devoted to that fundamental research which they recognize as equally vital to the progress of industry. The solution, let it be said at once, demands not the curtailment of one to make possible the enlargement of the other, but adequate funds to enable both *ad hoc* and fundamental research to be pursued on a sufficient scale.

We may note here that Sir Alexander Gibb says: "There is what one may call true fundamental research—splitting the atom, or extreme low temperature investigation." Perhaps it is convenient to call such research fundamental. It is a little difficult, however, to see how "splitting the atom" is more "fundamental" than splitting the molecule in ordinary industrial cracking processes; or to understand why "extreme low temperature investigation", more than high temperature researches in, say, polymerization or hydrogenation, is "true fundamental research". However, the point is one of small importance. In all cases of so-called industrial research, the ultimate need is nothing less than the full available knowledge of all the factors involved, and these factors include as well those that may conveniently be regarded as 'pure' or 'fundamental' as those of immediate industrial importance. The real aim of industrial research, whether in engineering or in any other industry, should be to elucidate the scientific principles involved, to gain the scientific knowledge needed and to apply the knowledge, in so far as it can be applied, to industrial practice. To achieve these aims it may be necessary to undertake what is called pure or fundamental research, on one hand, and applied research, on the other. But, at bottom, these constitute essentially one research purpose.

Another feature noticed by Sir Alexander in his address is the degree to which, in later years particularly, co-ordination and co-operation in research have become recognized as essential. Sir Alexander quotes the remarks of Mr. Thomas Midgley on the occasion of the award to the latter this year of the Perkin Medal of the Society of Chemical Industry: "In any earlier age, wh science and industry were simply individualis processes, it is conceivable that some person, his efforts alone, could have advanced appli chemistry to have justified your Committee bestow upon him the Perkin Medal. To-day t is no longer so; to advance applied chemist even a little, requires the organized efforts many individuals." This is, of course, true a of industry and manufacture in general. The w undertaken by the various research boards the Department of Scientific and Industrial search, and the wide field of scientific and indust research covered by the activities of the indust Research Associations, all testify to the vital n to-day of co-ordination and co-operation in search. Scientific research is becoming less and an individual effort and more and more a mat of team work.

Towards the conclusion of his address, Alexander Gibb directed attention to the fact th the greater the success of research, the m immediate and drastic is the effect on exist plant and equipment. He says: "Millions necessarily sunk in fixed assets, which may i year or two be made obsolete by the developm of new methods", and he declares that m valuable inventions have been bought up vested interests and suppressed, in order to s the greater loss that their exploitation wo involve to already operating plant. This partic allegation has been made so often that it is diffi to believe there is not a good deal of truth in The lack of data of specific instances of inventi being purchased only to be promptly strangled however, a great handicap to any assessment what the nation has lost and may lose by suc practice. Not many years ago, large commer combinations were regarded with deep suspic as being nothing but price rings. But the findi of a Government inquiry into the extension trade organizations and combinations did a g deal to allay public mistrust. The question ar whether a similar Government inquiry should made into this alleged practice of smothe valuable inventions at, or soon after, their bi It might turn out that the practice neither g so deep nor is so widespread as popular impres allows. On the other hand, if such an inq should reveal a grave public mischief, appropr measures could be taken. From every point view, however, it is desirable that precise infor tion should be available on this subject.

Cultural Basis of the History of Science

Famous American Men of Science

By J. G. Crowther. Pp. 414 + 12 plates. (London: Secker and Warburg, Ltd., 1937.) 15*s*. net.

SINCE the publication of Prof. Hessen's challenging discussion on the social background of Newtonian mechanics at the International Congress of 1931, there have been welcome indications of a new attitude which may do much to rescue the history of science from the disfavour or indifference of the majority of scientific workers. Prof. Wolf's book has made the famous woodcuts of Agricola's treatises on sixteenth century mining technology accessible to a wide circle of readers. The issue of Hooke's diaries and the reprint of the "Heads of Enquiries" have shed a new light on the early days of the Royal Society. Mr. Dickinson's admirable biography of Matthew Boulton has disclosed a mine of information about the scientific renaissance which accompanied the Industrial Revolution. Not least important of recent literature with this new orientation was J. G. Crowther's "British Scientists of the Nineteenth Century".

One of Mr. Crowther's reviewers compared the latter to Mr. Strachey's "Eminent Victorians". The comparison was a just one in so far as the faintly ironical flavour of the author's style placed it among the class of books which may be read painlessly. From another point of view it was less apt. Mr. Crowther is not a writer of footnotes or a biographer in the gentlemanly tradition. He has a vigorous and a unified point of view about the topics he handles. As Mr. James Branch Cabell used the romantic medium to satirize romanticism, Mr. Crowther uses the art of biography to put the individual in his place. That is not to say that he underrates the exceptional capabilities of the personalities he selects or discounts the magnitude of individual differences. What distinguishes Mr. Crowther's treatment from that of Prof. Lenard and a host of imitators who have raised the conventional cult of the scientific worthy to the status of a historical creed, is that he is pre-eminently interested in what circumstances of his situation enable a man of exceptional gifts to be trained in a particular way, how the conditions of his time canalize his curiosity into some specific and profitable channel and how his social circumstances provide him with instruments for solving the problems he tackles.

Great men do not come trailing clouds of glory from the abode where the eternals are. The human zygote—albeit well favoured with genes—does not attain the stature of international eminence in a social vacuum.

"From the perspective of the history of science," says Mr. Crowther, "the question of personal priority is of no importance. The significant feature of Henry's great paper of July, 1832, is that the phenomenon of electro-magnetic induction was discovered, or about to be discovered, independently at about the same time in Albany, U.S.A., and in London, England. These events show that the progress of science depends far less than is generally believed on the efforts of individual geniuses. . . . As Henry and Faraday made the discovery almost simultaneously, it could not have been of such a unique nature that it could occur only to one investigator of supreme genius."

Mr. Crowther might have made a more topical hit by substituting genes for God when he writes:

"The traditional explanation of why the laws of gravitation were discovered in the seventeenth century is that Newton happened to be born then. As Pope wrote:

'God said: let Newton be, and all was light.'

According to this view, the light of gravitation would have been seen in 1665 B.C. instead of A.D. 1665, if God had chosen to let Newton be twenty-three years of age on the former date."

Mr. Crowther's new book, no less noteworthy than its predecessor, follows the same plan and traverses a less familiar terrain. Its four hundred pages are devoted exclusively to four studies: Benjamin Franklin, Joseph Henry, J. Willard Gibbs and Thomas Edison. It deals, therefore, with a longer period of modern science than its predecessor, and the individual portraits are more detailed. Though it appeared first in its American edition, we may anticipate a wider audience in Britain than in the United States. It abounds in incidents of social history less familiar to men of science in Great Britain than to educated Americans. The selection of personalities, though closely involved in the dominant themes of British science, do not include any representatives of the biological sciences, such as genetics, to which the American contribution has been specially noteworthy. It would be interesting to read what Mr. Crowther would have made of the initial impetus which American biology received from the expansion of agricultural technology during the latter half of the nineteenth century. To regret that he

has not done so is a tribute to, rather than a criticism of, the book as a whole. The range of Mr. Crowther's knowledge and the discrimination with which he writes encourages us to ask for more.

The social background of science is so complex that two writers might well handle the same period with great detail and very little overlapping. Some of the main issues which confront the historian of science may be summed up in the triadic formula familiar to readers of crime fiction. The tempo of scientific progress receives new *motive* power from new problems which arise in the technique of navigation, mining, agriculture and other forms of production. New technical amenities, such as the manufacture of cheap and abundant glass of high transparency or the production of cheap amplifiers, provide the *means* for tackling problems which have defeated renewed efforts in the past. New social machinery for the recruitment of a new fund of social personnel—schools and academies, organized professions and scholarships—make *opportunities* for enlisting talent in the solution of new problems. One of the advantages of the biographical treatment which Mr. Crowther follows is that it does not commit him to concentrate on any one aspect of the social background of science to the exclusion of others. At one moment he dwells on the special climatic conditions which favoured Franklin's work on atmospheric electricity. At another he examines the influence of railroad extension on American contributions to electrical communications. Throughout the book he sustains a keen appreciation of the interplay of commercial and professional preoccupations in providing the means of livelihood for scientific workers.

The interest of Franklin for the student of scientific history extends far beyond the fact that he brought the first electrical invention into economic use. The Philadelphia Academy is a halfway house between the Invisible College and organizations such as the Edinburgh Society or the Lunar Society of Birmingham. Franklin, whose interest in electricity was inspired by the work of Hawksbee, Gray and Watson, had close personal contacts with Priestley, Boulton and other notables of the Edinburgh and Birmingham circles. Mr. Crowther insists that his political career and his scientific interests were different facets in the same social pattern. The further advancement of science was then contingent on the rising social influence of the entrepreneur, and drastic political changes were essential to establish it. There is much in the history of the time to show that this view was shared by many scientific men. Both the Lunar Society, among whom Priestley was elected a member of the National Convention and a delegate for the Department of Orne, and the Manchester Literary and Philosophical Society, when the elder Henry was one of its leading figures, sent official representatives to the Club of the Jacobins.

In the essay on Joseph Henry, first director of the Smithsonian Institution, Mr. Crowther's narrative puts the first beginnings of wireless communication in a new setting, and provides a useful corrective to reiterated emphasis on the cardinal incentive which Maxwell's theory is supposed to have supplied. Starting with Henry's experiments and Varley's lightning protector, the history of radio might well be rewritten from the record of workshop discoveries in connexion with microphone construction with much less reference to the parallel mathematical development of wave-theory.

Like Lytton Strachey, Mr. Crowther has the knack of selecting a situation which is ironical in its own right and needs no comment to embellish it. Such is the story of James Smithson, whose will provided for starting what Taft called "the incubator of American science". Such also are many of the well-authenticated incidents from Edison's history. The following is a sample:

"He made his first invention at Stratford when he was sixteen years old. Night operators were required to send hourly signals to show they were awake. He devised a clock which made the time signals automatically. This enabled him to sleep while on duty and preserve his energy for his own interests during the daytime."

When Edison started putting up telegraph lines between private business offices to exploit his alphabetical dial instrument, he himself says that they slung wires over the house-tops "without asking anyone's permission. Apparently they went to houses and stores which had already had wires supported by the roofs, and told the occupants they were the telegraph men and wanted to see the wires. They were always given permission to go up to them, and while there fastened up their own. This, apparently, is how it was possible for Edison, without any capital, to put up his own small centralised telegraph system in the center of a city. He did not pay rent for the wires slung over the property of others".

The importance of the new school to which Mr. Crowther belongs is that it gives the history of science a new cultural status. The future of scientific progress is not assured by its own momentum. In the past there have been Dark Ages. The recent exodus of scientific men from Germany shows that the prestige of science is more precarious than many would like to believe. In some small measure no doubt the choice between

progress and decay can be influenced by scientific workers as citizens equipped with understanding of agencies which decide the stability of a social culture. Only as an integral part of the story of man's social relationships can the history of science give them this understanding. As such Mr. Crowther's book has a wide appeal and claims a large audience. Among men of science it should arouse a new sense of social responsibility. Among those who have received a humanistic education it should stimulate a new interest in science.

L. T. H.

Science and the Modern Highway

Principles of Road Engineering

By Prof. H. John Collins and C. A. Hart. (The Roadmakers' Library, Vol. 6.) Pp. xvi + 628 + 21 plates. (London : Edward Arnold and Co., 1936.) 50*s*. net.

ALL branches of applied science have made rapid progress during the last quarter of a century, and not least that of the science of road building. During this time, we have seen the transformation of our roads from the dusty and pot-holed surfaces of the horse-driven carriage and early motor age to the smooth and clean highways of to-day, and with it the very face of England has also changed in a way that at one time would have been deemed impossible. Physics, chemistry and geology have all been pressed into the service of the highway branch of civil engineering, so that it has been transformed from empiricism to something approaching an exact science.

Great Britain has so far lacked a treatise which deals clearly yet briefly with the principles of highway engineering ; the book produced by Prof. Collins and Mr. Hart, linking as it does the more specialized works which form the "Roadmakers' Library" in such an admirable manner, is therefore peculiarly welcome. Its merits are well considered with respect to the series of which it forms a part, since this is intended in course of time to cover the whole field of roadmaking and at the same time to make some reference to present policy in Great Britain regarding the development of our highway system. Thus the taking over of the thousands of miles of trunk roads by the Government —only a proposal when this book was published— is now an accomplished fact, and we may perhaps have yet more far-reaching changes in policy, since the Trunk Roads Act of 1936 was criticized from the Government benches as not going far enough.

For years past, the vexed question as to whether Great Britain should have an entirely new road system, as in the case of Germany and Italy, or whether her roads should be improved by the process of widening, bridge construction and the making of by-passes, has been hotly debated. The latter represents the official view, and it is greatly to the credit of the book under review that it is so designed as to be capable of use under either policy.

The book opens with a short, interesting history of the development of our present road system, rightly stressing the lack of foresight shown by those responsible. An account of the evolution of the various forms of surfacing follows, and the thorny subject of road accidents is dealt with in a very readable way, the necessary statistics being kept to a minimum. This part of the work leads naturally to a consideration of the factors affecting skidding, corrugation and noise, with an able treatment of economic considerations such as the relation between gradient, type of surfacing and running costs.

The principles of route location are illustrated by reference to the Ballachulish-Dochfour and the new Glencoe roads, the only important works of the kind which have been carried out in Great Britain since the Great War. The value of this part would perhaps have been increased if at least one foreign example of completely new location had been included, though the omission is understandable in view of our present policy of patching an old garment rather than investing in a new suit.

The geological section is clearly set out, the illustrations, here and in the other parts of the work, being most useful and well reproduced. It is unfortunate that the portion dealing with the use of local materials is quite inadequate. Great attention has been devoted to this matter in Canada and the United States, where geology has been applied to engineering problems in a way undreamt of in Great Britain, and a survey on these lines has been carried out in the case of the new Glencoe road, though not by official geologists.

Methods of carrying out preliminary, Parliamentary, location and construction surveys follow, and can be commended, though many readers will probably agree that Chapters ix and x, dealing with surveying proper, could with advantage have been omitted. It is to be supposed that all graduates in civil engineering will have covered the work given in these chapters in their university course, though this criticism may not apply to the matter dealing with aerial surveying. Surveying

for private streets is incompletely described, especially in view of the many legal and other difficulties which beset the paths of the local authorities responsible for the construction of many hundreds of miles of such roads yearly.

Horizontal and vertical curves, so important in view of the ever-increasing speeds of modern traffic, are covered in Chapters xi and xii, as is the subject of super-elevation, the variable super-elevations used in racing tracks being very properly condemned as being unsuitable for highways carrying mixed traffic. It is thought, however, that the two pages given to proving a formula used in work of this kind could well have been omitted and the space devoted to such common matters as the widening and improvement of highways, subjects which are not dealt with. The methods of lay-out of road junctions and crossings show the circular type of roundabout now favourably considered by the Ministry of Transport, though it is thought that one of the Y-junctions shown is capable of improvement. Earthworks, including the application of the valuable mass-haul curve, and drainage works, are well covered, though not all engineers will agree that the Ministry of Health formula for run-off gives satisfactory results, more particularly in the case of small areas of ground.

Road foundations and soil mechanics receive detailed attention, the work under the latter head comprising the results of researches not easily available to practising engineers. It is surprising to find no mention in this section of pitched or hard-core foundations, widely used in road construction generally, while the description of construction of concrete roads would probably have been more useful had diagrams and photographs showing arrangements of forms and other such details, been included. The debatable question of reinforcement in concrete roads is treated from a rational point of view, since this problem still awaits elucidation.

Chapter xviii is disappointing, important surfacings such as water-bound macadam, tarmac and sett paving each being dismissed in a page, footpaths—so much to the fore at present—in a few lines, and the data regarding surface dressing are similarly brief. On the other hand, four pages are devoted to a somewhat arid report of the Metropolitan Paving Committee. It is also questionable whether the nine pages of condensed highway law given in Chapter xix are of much value to the highway engineer, especially since the series of which the work forms a part contains an entire volume on the subject. One also looks in vain in either this treatise or the series as a whole for a really good account of highway administration, dismissed in a few pages in the first volume, which in this respect somewhat belies its title.

It would be invidious to over-stress points of this sort in considering a work dealing, as its title states, with the principles of highway engineering, and the authors are to be congratulated on having encompassed so vast a subject in so comprehensive, readable and authoritative a manner. Their treatise can be justly described as a real achievement and a marked contribution to scientific knowledge.

B. H. KNIGHT.

Indian Hydro-electric Technics

The Hydro-electric Practice in India

By Prof. Bhim Chandra Chatterjee. In 2 vols. Vol. 1. Pp. xi+576+vi. Vol. 2. Pp. v+577–1168+vii. (Benares City: Shiva Narayan Chatterjee, 1936.) 50 rupees.

WRITTEN with an Indian purview by an Indian for Indian students, and produced from an Indian press, it is not altogether easy, nor perhaps quite fair, to judge these two substantial volumes by Western standards. The author is professor of electrical engineering at Benares Hindu University and he has had in mind the B.Sc. course for engineering students at that University, though his object has also been "to guide the engineers entrusted with the task of designing and constructing hydroelectric developments or reporting on their commercial success". He has illustrated the principles of his subject by reference to current practice in the most important hydro-electric schemes of India. At the same time, he indicates that he has drawn freely from all sources of information; and data and a few particulars are given of installations in Canada, the United States and Great Britain.

This being so, it is a little surprising that in a "Comparative Statement of Dams in the World" (p. 832), the only American example quoted is the New Croton Dam (which, by the by, appertains to a water-supply reservoir) and no reference is made to the outstanding examples of water-power dams at Grand Canyon (Boulder Dam) Grand Coulee, Bonneville and other recent American enterprises, or to the Chambon Dam in France and others elsewhere. Furthermore, the use of the term "unprecedented" from a report (dated 1910) in connexion with the Cauvery River

(Mettur) Dam might dispose the reader, in the absence of comment, to infer that a height of 200 ft. or so combined with a length of 5,300 ft. constitutes something unique, whereas the Grand Coulee Dam, though not quite so long (4,300 ft. crest length), has the much greater height of 550 ft. Recent instances of this kind relating to dams of great magnitude should scarcely be overlooked in an up-to-date treatise.

The author certainly deals with his subject in full and commendable detail. He commences with a good chapter on the conditions, financial and economical as well as physical, under which a hydro-electric development project may be considered feasible. Then he proceeds expertly to the theoretical aspect of the matter, surveying the field of hydrology and hydraulics, explaining the nature and purpose of structural features and plant equipment, winding up with a section of 500 pages (nearly half the contents of the whole work) on hydro-electrical installations in India, and a few notes on management. Among the installations described are the Tata, Cauvery, Kashmir, Mandi and Andhra.

There is, in fact, an immense amount of information comprised in the sixteen chapters of which the work is composed, a good deal of it quoted from various sources, with the limits of quotation not always clearly defined. The index is moderately good. The print is bold and readable, but a number of typographical errors are in evidence. The photographic illustrations might be clearer and some of the diagrammatic figures are blurred. The block on page 846 is upside down! In comparison with other publications of similar origin, the production is apparently up to Indian printing and book-binding standards, but there is certainly scope for improvement in these respects. Taken as a whole, the work should achieve its purpose as a serviceable manual for the Indian student, and, indeed, be of undoubted value for general reference. B. C.

Keeping Pace with Physics

The Physical Society

Reports on Progress in Physics, Vol. 3. General Editor: Allan Ferguson. Pp. iv+394. (London: Physical Society, 1937.) 20*s*. net.

THE annual output of papers in physics, including certain branches of electrical science, is at least six thousand. Few if any libraries contain all the original journals, and the time taken up by research, teaching and administration leaves far too little for the physicist to deal unaided with the bulk and diversity of published papers. Monthly classified abstracts are given in *Science Abstracts* and in *Physikalischen Berichte*. The subscriber to these journals receives each month about 480 fragments of physics in the making, from which he selects the few relevant to his own work and uses them as a guide to the original papers. Some kind of co-ordination of the results of the remainder of papers is needed by all who wish to keep pace with current physics.

The Physical Society's "Reports" are designed to cover most branches of physics at yearly intervals, and some special topics after longer periods. This third volume maintains the high standard of the two previous volumes without quite solving the two difficult problems of uniformity of treatment and freedom from overlapping. For example, sound is covered by an excellent 24-page article giving 78 references. The following article on the measurement of noise occupies 13 pages, gives no references, is written in the style of an advanced popular science lecture and overlaps the sixth section, technology, of the previous article. Each article is excellent of its kind, but the standard of previous knowledge needed to read the two is quite different. The overlapping is no mere repetition, but is wasted when the volume is used for reference, as there is no index. Contributors, unable to meet and discuss, cannot be held responsible for these two characteristics of the reports, but an editorial committee could perhaps help by issuing more detailed instructions formulated to guide the individuals.

Since the reports can be prepared only by experts, any avoidable overlapping is a waste of part of the world's science man-power. From this broader point of view overlapping with independent publications is also to be avoided. For many years the Chemical Society in its "Annual Reports" has issued excellent reports on crystallography. Why then has another group of workers been set the task of preparing for this volume another independent report in which the same subject is covered, as it happens, less adequately? The Chemical Society "Reports" deal also with radioactivity and sub-atomic phenomena. If it be urged that the reports are prepared from different points of view, it may equally well be urged that if physical aspects of phenomena are relevant to chemistry, then chemical aspects are relevant to physics.

At present, to keep pace with physics it is necessary to consult the "Reports" of the Physical

and Chemical Societies, the *Reviews of Modern Physics*, *Chemical Reviews* and *Die Physik*. With the persistence of the Government restrictions placed upon science, German periodicals will become less and less important. To avoid duplication it is therefore necessary to secure co-operation between only English-speaking societies.

The Physical Society is already broadminded enough to adopt in its *Proceedings* an indexing system designed to help in the international co-ordination of knowledge. Is it too much to hope that the Society will also try to secure the co-operation necessary to present an annual report holding a unique position in journals published in English? Even the present "Reports" are indispensable in any science library, and readers are heavily indebted to the many individual contributors who have had to sacrifice some of their research effort to carry out the arduous task of digesting hundreds of research papers. W. H. GEORGE.

Light in the Service of Man

Allgemeine Photochemie:
ein Hand- und Lehrbuch für Studium und Forschung für Mediziner, Biologen, Agrikulturchemiker, Botaniker, usw. Von Prof. Dr. J. Plotnikow. Zweite, umgearbeitete und erweiterte Auflage. Pp. viii + 909. (Berlin und Leipzig: Walter de Gruyter und Co., 1936.) 28.50 gold marks.

PROF. J. PLOTNIKOW, who has considerable experience in theoretical and applied photochemical research, has dealt with different aspects of photochemistry satisfactorily in this treatise under notice. He has divided the subject-matter into four sections, namely: (1) sun and mankind; (2) interaction of matter and radiation energy; (3) statics and dynamics of light reactions; (4) different reactions caused by light.

In the first section, the characteristic properties of different radiations (for example, infra-red, visible, ultra-violet, etc.) and the problem of sight are described in detail. In the same section, the subject of nutrition in the future has been considered in an interesting manner from the point of view of the photochemist. A brief historical account of the development of photochemistry from ancient times appears at the end of this part.

In the second section, the laws of light absorption, reflection and scattering, the phenomena of fluorescence, phosphorescence, bioluminescence, etc., the laws and mechanism of photochemical reactions, temperature coefficient, quantum yield and allied problems, are discussed. It is interesting to note that the summary of quantum yields of different photochemical reactions recorded on pages 230–231 shows that the Einstein law of photochemical equivalence fails in the majority of reactions investigated so far. This fact has also been emphasized by the reviewer.

The mathematical aspect of photochemistry is considered in the third part of the book. The experimental technique of photochemical reactions, which has been considerably developed by Prof. Plotnikow and co-workers, is also discussed in this section. Cases of photochemical catalysis and equilibrium and the relation between the intensity of the incident radiation and the velocity of photochemical reactions have also been included.

In the fourth part, the author describes briefly numerous photochemical reactions involving inorganic and organic compounds. Most of the literature in photochemistry has been condensed in this section, which also contains a good account of the mechanism of photosynthesis in plants and the function of chlorophyll. Photolysis and photo-oxidations are also adequately considered. At the end, work on the sensitization of photographic plates and films to various parts of the spectrum is summarized: to the infra-red radiation by neocyanine, kryptocyanine, xenocyanine, etc.; to red by dicyanine; to orange red by pinacyanol, nigrosin, chlorophyll, etc.; to orange by pinachrome, cyanine, orthochrome-T, methyl violet, ethyl violet, etc.; to blue green by uranine, acridine yellow, etc.; to ultra-violet by sodium salicylate (alcoholic solution), 'Vaseline' (acetone solution) and other fluorescent substances. A brief account of the phenomenon of desensitization of photographic plates and films with phenosafranine and allied compounds discovered by Lüppo-Cramer has also been included.

As light is utilized in the production of food materials in plants, in nitrogen fixation and in other processes in the soil, in photography, in the production of vitamin, in the treatment of disease and in the preservation of health, in the large-scale sterilization of water and milk, in the detection and testing of different materials, etc., photochemistry is of necessity engaging the attention of numerous workers all over the world, and several important books on this topic have recently been published. The present comprehensive work by Prof. Plotnikow is a valuable contribution to knowledge and should be widely read by chemists, physicists, biologists, agriculturists, medical men and others interested in this subject, which has great possibilities. N. R. DHAR.

Soil Erosion and its Control

By Prof. Q. C. Ayres. (McGraw-Hill Publications in Agricultural Engineering.) Pp. xi+365. (New York and London: McGraw-Hill Book Co., Inc., 1936.) 21*s*.

ONE of the effects of the recent world depression has been to focus attention on problems of soil erosion. This has been the case particularly in the United States of America. The preceding years of high prices had led to a rapid expansion of mechanized farming, thereby reducing the man-power required to farm arable land. So long as prices ruled high, little notice was taken of the diminishing returns obtained from such expansive and continuous cropping, but as soon as the bottom fell out of the market, farmers discovered, almost overnight, that they could no longer carry on.

It was soon made clear that this was largely due to soil erosion and that the damage thus caused was increasing at an alarming rate. Whereas in 1910 it was estimated that ten million acres of farm land were ruined and abandoned, this figure had increased by 1935 to between thirty-five and fifty million acres. For years previously that "tireless little band of erosion technicians" to whom this book is dedicated, had been as a voice crying in the wilderness, and it required the effects of the depression forcibly to bring the position to the notice of the administration, which lost no time in forming this band of workers into the nucleus of a Soil Conservation Service. This Service, besides continuing research, was able to find employment for large numbers of farm workers and other unemployed in an endeavour to control soil erosion.

Since the initiation of this Service, much has been published in the form of bulletins, leaflets, etc., on soil erosion and its control. The author of the present work has collected and arranged this information under suitable headings, and the diagrams, tables, charts and numerous illustrations add much to the value of the text. Though based entirely on American experience and American farming conditions, the book should prove of value to those in other lands where somewhat similar problems and circumstances prevail.

Revisiting my Pygmy Hosts

By Paul Schebesta. Translated from the German by Gerald Griffin. Pp. 288+31 plates. (London: Hutchinson and Co. (Publishers), Ltd., 1936.) 18*s*. net.

AFTER two visits to the pygmies of the Congo in 1929 and 1930, Dr. Schebesta found himself constrained to pay them a third visit to obtain supplementary data. On this occasion his objective was in the area of Lake Albert and his hosts the Bambuti, as they call themselves. He has thus completed the tour of both the eastern and the western pygmies.

In this story of his sojourn among the little people of the forest, the author has purposely omitted any formal account of organization and culture where it does not differ from that described in his earlier work. Here again negroes and pygmies live in a relation in which each supplies something lacking in the economy of the other. The negroes need meat and the pygmy hunter supplies it: in turn, the pygmy needs bananas and vegetable produce, which is obtained from the negro gardens lacking in the pygmy culture.

Dr. Schebesta's lively picture of his relations with his pygmy people affords his readers an opportunity of appreciating their mentality. He has also taken full advantage of his informal method of description to demonstrate the actual working of their social and cultural organization and their magico-religious beliefs. The author is more than ever convinced that the culture of the pygmy is of purely forest origin, and that they are its aboriginal inhabitants.

Exercices d'analyse

Par Prof. Gaston Julia. Rédigés par Dr. Georges Bourion. Tome 4: Équations aux dérivées partielles du premier ordre. Pp. v+230. (Paris: Gauthier-Villars, 1935.) 60 francs.

THIS is the author's fourth volume of exercises in analysis. It is devoted mainly to partial differential equations of the first order, and consists of a discussion of some 55 problems taken from examination papers set at the Sorbonne for the Certificate in Calculus and from Part II of Édouard Goursat's "Course in Mathematical Analysis". The questions selected range from total differential equations to be solved by Bertrand's method, to simultaneous systems and problems in geometry involving partial equations. The solutions are not only complete, but also are characterized by their clarity and elegance. In nine cases, alternative methods, geometrical and analytical, are considered, whilst problem 53 is provided with three solutions. Relevant extensions, particular cases and applications are also indicated wherever possible.

To teachers and students of differential equations, this book should be extremely valuable.

F. G. W. B.

A Marriage Manual:

a Practical Guide-Book to Sex and Marriage. By Dr. Hannah M. Stone and Dr. Abraham Stone. English edition edited, and with an Introduction by, Michael Fielding. Pp. 352. (London: Victor Gollancz, Ltd., in conjunction with John Lane, The Bodley Head, Ltd., 1936.) 7*s*. 6*d*.

THE admirable little work by Dr. Hannah M. Stone, medical director of the Birth Control Clinical Research Bureau of New York and Marriage Consultation Centre, and Dr. Abraham Stone, surgeon to the Sydenham Hospital and director of the Marriage Consultation Centre, is written in the form of imaginary conversations between a physician and a young couple about to be married. The subjects on which the pair seek enlightenment are fitness for marriage from the psychological, sexual and eugenic points of view, the anatomy and physiology of the sexual organs, fertility and sterility, prevention of conception, venereal diseases, the art of marriage including the technique of coitus, psychical and somatic incompatibilities and health in marriage. A bibliography of recent English and American literature is appended.

Noise and the Nation*

By Dr. G. W. C. Kaye, O.B.E.

SIMULTANEOUSLY with the remarkable growth of applied acoustics, there has gradually developed in Great Britain a public consciousness of the insidious growth of the social evil of needless noise—a pernicious by-product attributable in great part to an increasingly mechanized civilization. With this growing realization, the nation is beginning to demand and to receive protection against the nuisance of outrageous noise whether generated by private or public bodies. It is looking for ways and means of mitigating excessive transport noises, particularly on the road and in the air, and it is seeking to know why in modern houses or flats it should not be accorded adequate privacy against the natural, though sometimes unreasonable, noises of neighbours.

The Measurement of Noise

It is common knowledge that most noises are complex in character, containing a variety of components which may be distributed over the entire auditory ranges of frequency and intensity. Such a physical constitution lends itself to objective measurement and analysis, but apart from the psychological aspects, there are subjective factors of prime importance to the listener, namely, pitch, timbre and loudness, and these sensations are not readily appraisable. Experience indicates, however, that while the composition of a noise is not to be ignored, sheer loudness is the determining factor in most cases of annoyance caused by noise, so that the problem largely resolves itself into the correlation of the sensation of noisiness (as assessed by the ear) with the associated energy, which can be quantitatively measured by physical instruments.

Let us first consider the measurement of acoustical energy. For the purpose, we need an intensity meter, this commonly consisting of a microphone and amplifier together with a suitable rectifier and indicator. Moving-coil or ribbon microphones are sometimes employed, though for fundamental work the condenser or the crystal microphone is preferred despite the lower sensitivity. Whatever the microphone used, it is usually calibrated by direct interchange comparison under appropriate conditions with a standard (pressure) microphone of the condenser type, which in turn has been fundamentally calibrated in absolute units by means of either the Rayleigh disk or the piston-phone.

The Rayleigh disk depends for its operation on the tendency of a small thin glass disk suspended from its edge by a fine fibre to set itself at right angles to a sound field. The torsional constants of the system and the degree of deflection of the disk afford the sound particle velocity, the corresponding sound pressure being calculable from the known relations in the field. The measurements are made either in a stationary-wave pipe or in a room with highly absorbent walls.

The piston-phone, which measures sound pressures directly, consists essentially of a small cavity, one face of which is closed by the diaphragm of the standard microphone, the opposite face consisting of a small piston connected to the moving coil of a loudspeaker unit. The amplitude of motion of the piston, when it is set in vibration, is measured optically and enables the corresponding sound pressures in the cavity to be calculated.

So much for intensity measurements. As regards the associated loudness levels, we turn to auditory diagrams of the ear, such as those of Fletcher and Munson. The various loudness contours for pure tones of different frequencies show that while loudness and energy are manifestly related, the two do not normally keep in step, particularly for notes of very high and very low frequencies. At feeble intensities, the ear exercises pronounced selective preference for notes of medium frequency, and it is only at high intensities that equal increments of energy produce even approximately equal increments of loudness. Furthermore, the thresholds of hearing are much higher for high and low frequencies, so that the corresponding ranges of intensity with which the ear can deal are more restricted than for notes of medium frequency. The situation is worsened in the case of complex sounds or noises since the loudness is affected by their character, there being in general no simple relation between the loudness of a noise and the energy-loudness characteristics of its several components. It is evident that an energy meter, such as a microphone system, cannot unreservedly be used as a direct measurer of loudness.

* From the presidential address to Section A (Mathematical and Physical Sciences) of the British Association, delivered at Nottingham on September 2.

The Decibel and the Phon

The next step in the measurement of noise is to equip ourselves with units and standards of loudness. In this connexion, we have to cater for the enormous intensity range of the ear, particularly for notes of medium frequency, where the greatest intensity that can be tolerated (the threshold of pain) is some 10 million million (10^{13}) times that corresponding to the threshold of hearing. In such circumstances, we turn, as always, to a geometrical rather than an arithmetical scale, and the unit adopted for the purpose is the *bel*, which is a ratio signifying a 10-fold increase in intensity, power or energy. Two bels signify a 100-fold increase, three bells a 1000-fold increase, and so on.

Equipped with such seven-league boots, and starting at a zero approximating to the threshold of hearing, we can traverse the entire auditory intensity range for a medium-frequency note in as few as thirteen geometrically progressive steps. But the steps are too big for practical convenience and so it is usual to speak of a range of 130 *decibels*, which provides a serviceable energy scale. Arithmetically, a decibel (db.) denotes approximately a 5/4 energy increase (that is, antilog 1/10), two decibels a $(5/4)^2$ increase, three decibels a $(5/4)^3$ = a 2-fold increase, . . . 10 decibels a $(5/4)^{10}$ = a 10-fold increase, that is, a bel. More generally, two similar sounds of intensities I and I_0 and corresponding acoustical pressures p and p_0 are said to differ in intensity by n decibels when

$$n = 10 \log_{10} (I/I_0)$$
$$\text{or } n = 20 \log_{10} (p/p_0)$$

If I_0 or p_0 corresponds to some selected zero, then n becomes the number of decibels above that zero level.

Thus provided with an acoustical intensity scale, we can proceed to set up a loudness scale which is based on the accepted ability of the average individual to compare and match loudness. To this end (just as in photometry we make use of a standard candle) we need a standard sound ; and for the purpose a pure reference tone is chosen which, on the British Standard Scale, has a frequency of 1000 cycles per second. We also require a zero of loudness at or near the threshold of hearing, and this is arbitrarily adopted as corresponding to a pressure of 0·0002 dyne per sq. cm. If now we operate the reference tone by successively increasing decibel steps of energy, the associated changes of loudness are expressed in numerically identical steps on a scale of *phons*. That is, if the reference tone is excited by an intensity of n decibels above the zero, the loudness is n phons. The equivalent loudness of any other sound or noise is evaluated by matching it by ear under specified conditions against the suitably adjusted reference tone, the numerical value of the latter in phons then giving the equivalent loudness of the sound to be measured. Thus by this procedure we have set up a subjective scale of equivalent loudness, the unit being the phon.

It happens that a phon corresponds roughly to the smallest difference of loudness which can be detected by alternate listening, in the case of a sound of medium frequency and moderate loudness. Experience shows, too, that for many loud noises of common occurrence the loudness level in phons is approximately equal to the intensity level in decibels—a convenient relation for many purposes.

A number of different zeros of loudness have unfortunately been employed in the past ; for example, 1 millidyne per sq. cm., which results in numerical values of loudness some 14 phons less than with the British Standard zero. In Germany the phon is based on a zero of 0·0003 dyne per sq. cm., which is equivalent to a 4 db. difference from the B.S. zero. As, however, a different method of listening is employed, the slight discrepancy between the two scales is not known exactly. The American scale agrees with the British, except that in the United States it is customary to use the decibel not only for expressing intensity measurements, but also for loudness levels, it being implied in the latter case that the decibel figure quoted refers to the energy level (above the arbitrary zero) of the standard tone when it matches the sound to be measured. As already mentioned, the British Standards Institution recommends that for greater clarity the decibel should be restricted to energy ratios ; and in its definition of the phon, the Institution kept open the way for eventual international agreement on the unit of equivalent loudness.

Happily such agreement came about at an international conference held in Paris last July, when it was unanimously agreed that the decibel and the phon should be adopted respectively as international units of intensity level and equivalent loudness, full agreement being secured on questions of the reference tone (1000 cycles per second), the reference zero (0·0002 dyne per sq. cm.) and the technique of listening. All these matters are in accord with the definitions in the acoustical glossary of the British Standards Institution.

Noise Meters

Subjective noise meters.—Subjective noise meters depend on the equality matching of the loudness of a noise, as heard by the ear, with a reference tone (usually a pure tone of specified frequency and of graduated intensity) as heard in a telephone

earpiece held tightly against one ear. The reference tone may be produced by an electric buzzer, valve oscillator or other means, various frequencies (for example, 1000 or 800 cycles per sec.) or mixed tones being used in commercial instruments. The usual Barkhausen technique involves simultaneous listening to the noise and the reference tone, but experience indicates that inconsistencies which are found to arise in aural measurements under such conditions are largely resolved when the two sounds are heard alternately for periods of not less than a second. Such a technique has been facilitated by Churcher in a subjective meter employing two earpieces, so that either the noise or the reference tone can be heard in turn using both ears simultaneously.

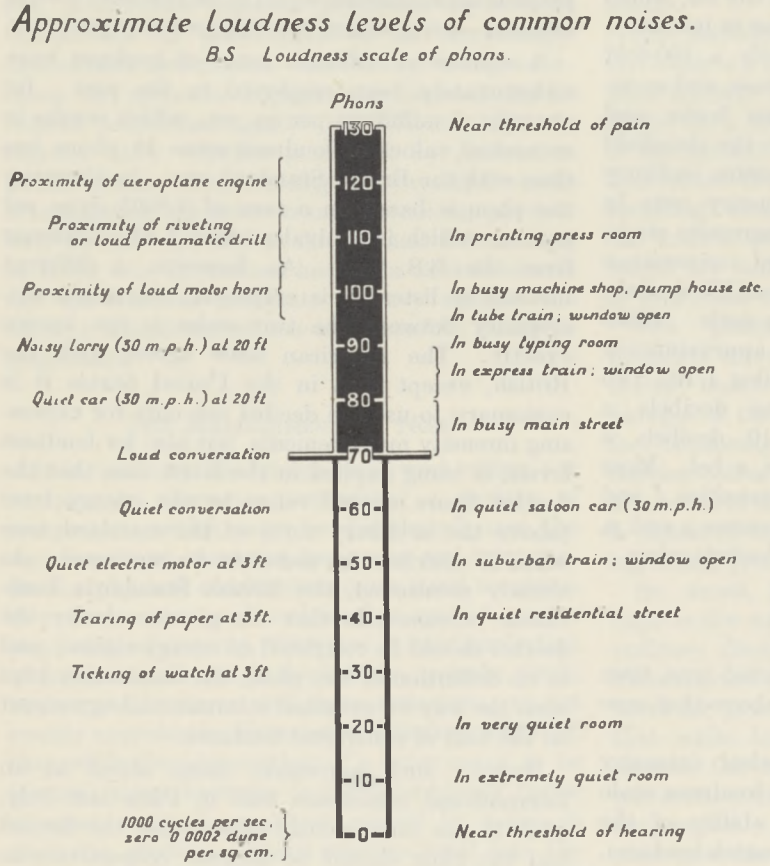

Fig. 1.

Subjective meters are useful for certain purposes, but the aural judging of equality of loudness of the reference tone and of a noise very different in character is not always easy. Observers are found to differ widely in their judgments, and the same individual is not always consistent. The accuracy of appraisement of a single observer is normally low (say 5 phons), and a team of trained observers is essential for higher precision (say 2 phons). In the case of unexpected or single impulsive sounds, the aural assessment presents great difficulties to the average observer.

Objective noise meters.—The problem of the designing of objective sound and noise meters, which has received much attention both in Great Britain and abroad, is of considerable complexity. The ideal aimed at by objective meters is to be able to measure every type of sound and noise on the subjective scale of phons, that is, to simulate the selectiveness and response of the average ear in all circumstances.

The various objective meters on the market all consist essentially of a pressure microphone connected to an amplifier provided with calibrated control, followed by some type of rectifier and an output indicator. As a first essential, objective meters are constructed to give the same reading for a range of steady pure tones which sound equally loud to the ear whatever the frequency. This is achieved by introducing into the amplifier electrical networks designed to modify the shape of the frequency characteristic so that it imitates the ear sensitivity at selected loudness levels. If the network is omitted, the meter measures intensity levels. Objective meters should be further designed to simulate the salient characteristics of the ear in dealing with either steady or impulsive sounds. For example, the ear does not record full strength until a steady sound has persisted for about one-fifth of a second, and in the case of pulsating sounds, the inertia of the instrument has to be of the right order to give readings corresponding to average aural appraisement.

There can be little doubt that the future of sound or noise measurement, from a practical point of view, lies with the objective meter. Even in its present state of development, its practical convenience often outweighs its limitations. It is free from personal bias, rapid in action and direct reading, and can be put into the hands of an untrained observer. Furthermore, as a dial instrument, it is well adapted to the enforcement of regulations or specifications.

Noise-Level Measurements

In connexion with problems of noise abatement, the National Physical Laboratory has made measurements and analyses of many noises of very varied origin. The positions which some of these noises occupy in a scale of phons are shown in Fig. 1, the upper half of which includes various noises the abatement of which would be acceptable in many circumstances. This is illustrated by the homely test which most of us apply as a test of background of noise, namely, the ease with which conversation is possible. At 60 phons, conversation is 'comfortable'; at 90 phons, difficult; and at 110 phons, virtually impossible.

Among the noise problems on which the Laboratory has been consulted in recent years, are the mitigation of the noises associated with aeroplane cabins and engine-testing factories, trains, ships, tube railways, buses, motor horns, pneumatic drills, printing works, transformer substations, cathedrals, assembly halls, business offices, flats, miniature rifle ranges, building operations, and so on. Assistance is also being given in connection with the Home Office experiments on air-raid warnings.

The loudness of a noise depends, of course, on its remoteness and to a less degree on its environment. The inverse square law appears to be followed fairly exactly in the open for average sounds such as those of motor vehicles. In a room or a tunnel, the law does not hold and a noise sounds louder than it would outside, owing to the building up of the sound level by multiple reflection. Similar conditions prevail in a narrow busy street and contribute to the noise discomfort of the occupants in the upper stories, though to a pedestrian the noise of, say, a passing car is but little louder than in an open space. Incidentally, drivers of cars are familiar with the sudden access of high-pitched components from the engines, exhausts or tyres of their cars as they pass reflecting walls or fencing or even minor way-side objects such as tree trunks or telegraph poles.

One has also to remember that the path of a sound may appreciably modify its composition. For example, the high-frequency components may be abnormally reflected or absorbed as compared with lower notes which tend to pass through or round obstacles. Even in the open, a hedgerow or a barrage of trees may, to a limited extent, so serve as a muffler of traffic noise. The high-pitched components of a sound may further be selectively enfeebled in passing over different types of ground, for which the sound absorption may be three or four times as much for high notes as for low. To judge by experience, the absorption figures for newly fallen snow must be rather high, though I am not aware that they have been measured. High-frequency components may also be selectively absorbed by the air itself if it is humid. Knudsen has shown that the effect is due to interaction between the oxygen and water molecules, the nitrogen playing no part. Incidentally, he estimates that if we lived in an atmosphere of oxygen at a humidity of about 20 per cent, the high notes of the violin and piccolo would be completely inaudible 50 yards away.

(*To be continued.*)

The Sex Ratio*

By Prof F. A. E. Crew

THE subject of the numerical proportions of the sexes in a population necessarily appeals to so many interests that it is not surprising to find that considerable attention has been paid to it. But so complicated are the problems that cluster around it that even yet our understanding of the significance of the sex ratio is still very incomplete. Recent developments in cyto-genetics have removed many of the difficulties that have surrounded this subject, so that it is possible now to re-examine the problem more hopefully.

The Registrar-General's Report for 1935 shows that the secondary sex ratio was 105 : 100; that the sex ratio among those babies who died during the 7th–9th months of intra-uterine life was 110 : 100; that there is a remarkable swing in the sex ratio, a numerical preponderance of males amongst the earlier age groups of the population giving place to a numerical equality of the sexes amongst the 15–19 year olds, whilst amongst the 20–24 year olds the females actually begin to outnumber the males; and thereafter, as age group succeeds age group, this female numerical ascendancy progressively increases until, among the 85's and over, there are more than twice as many women as men.

This swing in the sex ratio from high to very low is shown to be the result of a sexually selective

* From the presidential address for Section D (Zoology) of the British Association, delivered at Nottingham on September 2.

mortality, for the mortality tables make it clear that at all ages relatively more males are removed from the population by death.

A consideration of these and similar facts ultimately leads to the conclusion that in the case of man, for some reason or other, the male, in virtue of his maleness, is less viable than the female, and that, in unfavourable circumstances, both pre-natally and post-natally, the male, because of this greater inherent fragility, suffers more easily and more severely than does the female, and is removed from the population by death in greater numbers. Furthermore, since this selective elimination of the male occurs before, as well as after, birth, it follows that the primary sex ratio is probably considerably higher than the secondary sex ratio.

A comparison of the secondary sex ratio in different countries, in town and country, as affected by migration, amongst legitimates and illegitimates, amongst whites and coloured, living under the same conditions, in different social strata, and in its relation to infantile mortality would seem to show that the whole course of sex mortality in pre-natal life, in infancy, and in all subsequent age periods is consistent with the view that the male in man is the inherently weaker sex, more prone on account of his relative constitutional weakness to developmental anomalies, to congenital debility and to death from diseases of all kinds.

Male must be contrasted with female in an attempt to discover the cause of this, and a study of the sex ratio in other mammals, birds and insects, wild and domesticated, both in the open and under the controlled conditions of experimentation, must be made, for, in this matter of the sex ratio, to know only man is to understand nothing.

Male differs from female in genetic constitution. In the case of man the male is the heterogametic sex. This being so, it follows that in the homogametic female a mutant recessive gene in one *X* can be cancelled out by its wild-type dominant allele in the other, whereas the same recessive gene in the single *X* of the heterogametic individual is unchecked and unrestrained and is expressed to produce its full effect. Upon this firm basis of ascertained fact, the sex-linked lethal theory, which seeks to account for the sexually selective mortality and the swing in the sex ratio, has been built.

It is clear that genetic lethals exist in considerable numbers in all animal and plant stocks that have been subjected to genetical experimentation. They are genes which can be mapped and which have an effect upon the secondary sex ratio that can be predicted. But since differences in chromosome constitution may imply more than a difference in respect of sex-linked lethals, they may also mean a difference in genic balance. It may be that this difference is itself the cause of unequal mortality, though it is difficult to regard the male as being less well-balanced genically since he has endured as long a course of selection as has the female, and it would be expected that dosage compensation would ensure a proper balance in each sex regardless of dosage ratios.

There are other genetic differences between the sexes which are sex-limited and not sex-linked. It is established that many defects and derangements in man, formerly regarded as recessives, are partial irregular dominants, and that many of these are more often and more completely expressed in the male than in the female. Many characters previously regarded as sex-linked are now known to be sex-limited, being expressed only in the male.

There are other differences, metabolic and physiological, which quickly appear in development and which give rise to endocrinological differences which, when once established, take charge of the further differentiation and the maintenance of sexuality in the higher forms. The initial genetic constitution would seem to determine which of two alternative types of differentiation shall occur and, with the incoming of the gonad and the rest of the endocrine system, maleness or else femaleness becomes finally and firmly established. These two states are to be distinguished by sustained differences in oxidation rate. Experiment has shown that the higher metabolic rate of the male renders him less resistant to unfavourable conditions and more prone to death.

A survey of what is known of the sex ratio amongst livestock and laboratory animals shows that, in general, the male amongst them shares with the male of man a relative frailty and endures a selective elimination both before and after birth.

The figures for birds are somewhat confusing. As a whole, they seem to show that it is the heterogametic sex (the female in birds) upon which death falls more heavily pre-natally. If this is so, it can at once be decided that in the heterogametic mechanism itself a factor of importance is to be found.

As a general rule, the males of all groups, except those derived from wide crosses in which genic balance is more likely to be unusual, appear to show a relatively low viability, irrespective of their homo- or heterogamety, and the difference in the death rates of the sexes appears to be as much correlated with sexuality itself as with any particular type of chromosome or gene equipment. That this should be so is perhaps not surprising

when the relative reproductive values of the sexes are compared. The major task of one generation of gamete producers is the production, economically and efficiently, of a succeeding generation that numerically will be in harmony with the conditions and resources of the habitat. That of the females of a generation is the production of the requisite number of ova; that of the males the production of spermatozoa in numbers sufficient to make the fertilization of every available egg highly probable. The number of spermatozoa required will be determined by many factors—for example, the variety of the fertilization process, the pre-natal and post-natal relations of mother and offspring, the relationship of male to female in respect of parentage. If the male is merely a fertilizing agent, then economy and efficiency are observed if the male dies *in coitu* or is for other reasons shorter-lived than the female, so long as there are more or less equal numbers of males and females of the age when fertilization occurs. If the male is concerned with the protection of and food-finding for the female and her young, then the length of life of the male might be expected to be related to the duration of the period of dependency of the young upon the parents and of the female upon the male, and it might reasonably be assumed that when the male has served his purpose he would be removed so that savings in food energy could be effected and used for further reproduction.

Reference has already been made to the fact that in the Registrar-General's Report for 1935 the sex ratio most nearly approached equality amongst those in the population aged 15–19 years. In the Report on the Census of Scotland, 1931, table 31, vol. 2, it is seen that in this human population, though between the ages of 0–14 there were more males than females and between the ages of 20–100 there were more females than males, the sex ratio of those in the population between the ages of 15 and 19 years was equality. It can be stated, therefore, that in the case of these human populations, the sex ratio is equality only amongst those who stand at the threshold of their reproductive prime. This fact is surely not without significance. The age group in which the sex ratio is equality consists of those who, biologically if not socially, are newly equipped for ardent reproduction. Amongst them there is no surplus: there are equal numbers of males and females. If, during the biological evolution of man, pair-mating attached to itself a definite and positive value, it would be expected that all the mechanisms concerned in the establishment of a sex ratio of near equality among the 14–19 age group would, through selection, come ultimately to be related harmoniously to this end.

Implied in this suggestion is yet another: that in the case of any population of living things and under the conditions that exist in any given place and at any given time, there is an optimum sex ratio amongst those of the ages associated with the fullest expression of the reproductive function, and that through selection all the mechanisms, whatever they may be, which influence this are fashioned into harmony with this 'reproductive' sex ratio. It is necessary, therefore, to discuss the meaning in biological philosophy of mutation, sex and heterogamety, all of which are intimately concerned.

Mutation is a mechanism that has become adapted and elaborated for the provision of material possibilities of evolutionary movement. It takes the form of the replacement of one gene by an allelomorph—the substitution of a gene that, having been tested and found worthy, has come to be in harmony with the rest of the genotype, and through this with the conditions of the external environment, by another, the merits of which have yet to be determined. More often than not, therefore, mutation implies a disturbance of an equilibrium within the genotype itself, and between this and the external environment. It is usual, therefore, to find that mutation leaves the genotype less in harmony with the existing external conditions than was that which it has replaced. Mutation, the inception of a new heritable variation, thus usually equips its possessors with a handicap, imposing on them a disadvantage that can range from inconvenience to complete lethality.

Sex is the mechanism that has become adapted for the dispersal of a mutant gene amongst a population. Through its exercise a new gene can become incorporated into a variety of genotypes, and thus given the opportunity of finding itself associated with other genes with which it can interact. It is established that the quality of the action of a gene is largely determined by this interaction with others, for, as judged by its effects upon the life processes of the zygote, it can exhibit disadvantageous properties when in one gene association, advantageous when in another. For the quiet dispersal of a mutant gene in this way it is necessary that it should be recessive, initially at least, to the gene that it has displaced, for then it can pursue a cryptomeric existence for a considerable period of time.

If the great usefulness of sexuality lies in the opportunities it provides for variety in gene recombination and for the exercise of selection, then its advantages will be best exploited when, among those about to reproduce, there is a sex ratio of equality. This observation would not seem to apply to those instances in which gene combinations that are common or are exceedingly rare are

concerned, but a sex ratio of equality among the parents would seem to provide the greatest variety of recombinations in the offspring in the case of gene combination of intermediate rarity. Be this as it may, a device for the production of a sex ratio of equality has certainly been elaborated.

Heterogamety is a mechanism that has become adapted for the production of a primary sex ratio of equality. In its evolution in the higher forms it has taken the form of the replacement in one sex of an *X*-chromosome by a wholly or largely non-homologous *Y*-chromosome. The heterogametic sex, therefore, now possesses one *X*-chromosome, the homogametic, two. An indirect result of this evolution has been that a recessive mutant gene in the differential segment of the *X*-chromosome is at once uncovered in the case of the heterogametic individual, and so, if in its action such a gene is disadvantageous, deleterious or lethal, to it no time is allowed for the finding of modifying company and for the pursuit of its own evolutionary development. It is expressed and tested within a very short time of its first appearance, and should it cripple or kill, it is the heterogametic sex that is affected. In this way the sex ratio becomes modified, for the heterogametics either die before birth or else their early post-natal mortality is greater than is that of the homogametics. It is somewhat surprising that so few sex-linked lethals have so far been discovered in mammals. It would seem that the differential segment of the *X* is relatively insignificant and that the cross-over portion, which could not yield a differential mortality since its genes would not automatically be expressed in the male, is relatively large.

It is thus possible to look upon the inequality in capacity for continued life between the sexes as being partly of the nature of an evolutionary oversight due to a lag in the development of a harmonious relationship between the mechanisms of mutation and heterogamety. But this disharmony has been repaired by the invention of a supplementary device which can provide a compensatory primary sex ratio, high in those species with male heterogamety, low in those in which the heterogametic sex is the female. It is established that in many, though not in all, mammalian stocks, the primary sex ratio is much higher than is the secondary, and it is in such stocks that there is much sexually selective mortality operating to the disadvantage of the heterogametic sex. This being so, it seems reasonable to entertain the view that these three variables—the primary sex ratio, a sexually selective pre-natal and early post-natal mortality and the optimum reproductive sex ratio —are somehow related, the dimensions of the first being connected with the amount of the second. Should this prove to be the case, then it would follow that in general the greater the incidence of mutation, the more common the sex-linked recessive lethals and the greater the difference in the sex incidence of mortality in adolescence in a stock with male heterogamety, the higher will be the primary sex ratio; and, conversely, the rarer mutation is, the fewer the lethals and the less the difference in the sex incidence of mortality between conception and reproductive prime, the nearer to equality will this primary sex ratio be.

This suggestion, of course, demands that there should be genes which affect the functioning of the heterogametic mechanism, and also that it should be possible, by continued selection, to modify the primary sex ratio of a stock. This will be equality when the heterogametic sex elaborates its two kinds of gametes, *X*- and *Y*-chromosome-bearing respectively, in equal numbers, and when both of these are equally functional in fertilization. Conversely, the primary sex ratio will be removed more or less from equality if and when the two forms of gametes are not produced by the heterogametic sex in equal numbers, or when, between these two forms, there is functional inequality. The fact that in those instances where the primary sex ratio is not equality it is the *Y*-bearing gamete that is either produced in greater numbers or is greatly advantaged in fertilization, so that more *XY* than *XX* gametes are produced, is of great interest in view of the observed fact that it is the *XY* zygote that suffers more through the action of sex-linked lethals.

It has been shown to be possible, by continued selection within an animal stock, to produce high and low sex ratio strains, and thus it would appear that there are genes which can be concentrated in a genotype which, in their action, influence the heterogametic mechanism affecting either the relative production of the two kinds of gametes produced by the heterogametic sex or else their relative functional ability. If, as seems to be the case, the male in many forms and irrespective of his chromosome constitution is the weaker sex, then in those instances in which the male is homogametic an excess of *X*-chromosome-bearing ova is demanded from the heterogametic females or else there must be some form of selective fertilization, the *X*-ova being more often or more readily fertilized.

That genes which lead to the production of *X*- and *Y*-bearing gametes in unequal numbers do exist is shown very clearly indeed by the work of Sturtevant and others. One such gene was discovered as long ago as 1922 (Morgan, Bridges and Sturtevant, 1925) in a strain of *Drosophila affinis* in which occasional males were found to produce families consisting almost entirely of females. A

definite *X*-borne gene was suspected. Gershenson (1928) found a similar gene in *Drosophila obscura*, and showed that it was indeed resident in the *X*-chromosome. A male carrying this gene produces very few sons, regardless of the genetic nature of his mate. More recently (1936) Sturtevant and Dobzhansky have found that this gene has a very wide geographical distribution in both races of *Drosophila pseudo-obscura*, that it is sex-linked, lying in the right arm of the *X*-chromosome, and being associated with a small inversion. Cytological study has shown that in these cases the *X*-chromosome undergoes equatorial division at each meiotic division, whilst the *Y*-chromosome degenerates, with the result that a male carrying this gene produces nearly all *X*-sperm instead of the usual 50 per cent. It is to be expected, of course, that a sex ratio gene of this kind would be discovered only if its effects upon the sex ratio were profound. But the existence of such genes permits us to assume that other genes of the same kind, having less severe effects upon the heterogametic mechanism, also exist and are responsible for minor distortions of the sex ratio. If such genes do exist, then, of course, they can be incorporated into, or extruded from a genotype, and upon them selective agencies can work their will. These sex ratio genes may perhaps provide a partial explanation of the observation that hybridization commonly is attended by marked distortions of the secondary sex ratio.

But all this is so much speculation, and the only justification for toying with such ideas is that criticism may be aroused and experimentation launched. I have presented evidence to show that three possible causes of sex differences in mortality have to be considered: (1) sex-linked lethals, (2) sex-limitation of defects and derangements, and (3) sex-dimorphic physiological and endocrinological differences. It seems probable that sex-linked lethals play only a minor part and that the defects and derangements that have come to be manifested only or more completely in the male owing to his relative unimportance in respect of propagation, constitute the major cause, though as yet too little is known of sex differences in respect of hormones and their effects to permit us to regard these as unimportant.

The British Association at Nottingham

THE British Association opened at Nottingham on Wednesday, September 1, at a time when local residents feared that a pleasant spell of very fine weather was to be rudely broken; but after a severe storm had passed over, the Association settled down to enjoy days of bright sunshine. The attendance of more than two thousand members is regarded as quite satisfactory, and there is no doubt that those visiting the city for the first time were definitely impressed by the delightful setting of the University College and the accommodation it provided. The opening presidential address on the history of evolutionary thought was well supported, and Prof. W. W. Watts, in moving a vote of thanks, suggested that the fact that Sir Edward Poulton had a son who was president of a Section provided a proof of natural selection.

The presidential addresses to the Sections were crowded. Mr. H. G. Wells had some striking things to say about education, but, so far as one could judge, they served only to increase the admiration and adulation of the professional members in his audience. His contentions were, in a way, supported by Prof. E. J. Salisbury's address to Section K (Botany), which one member described as "short, simple and lovable". They were also supported by speakers at a later discussion on the educational function of a university. Prof. F. A. E. Crew's presidential address was regarded as one of the most stimulating of the whole meeting. It was, however, in Section A that records were broken in an extraordinary manner by Dr. G. W. C. Kaye. Here, for the first time, a president took acoustics as the subject of his address, and delivered it, appropriately enough, in a lecture theatre designed by Prof. E. H. Barton just before his death. Moreover, the address was for the first time illustrated by experiments, in which a selection of some forty motor-horns were used with great effect to produce another record in noise. Perhaps it was the general appeal of the subject which caused Section A to be crowded out and to provide a further record in the nature of a repeat performance of the experiments later in the day. Section A must also be credited with another record, which it certainly did not seek; one of its most pleasant social activities appeared in the programme under the heading "mystery trip".

The general discussions had clearly been well planned. Dr. F. L. Pyman's presidential address to Section B opened a stimulating symposium on various aspects of chemotherapy, while, at the same time, local geologists, headed by Prof. H. H. Swinnerton, had the pleasure of describing the geology of the Nottingham district to Section C.

Section A enjoyed a general discussion on the mode of action of the photographic plate, in which a theory of latent image formation put forward by Prof. N. F. Mott was closely followed. Sections A, B and I gathered to hear a useful symposium on surface action in biology initiated by Dr. Irving Langmuir. Prof. D. Brunt added much interest to a discussion of the upper atmosphere by releasing a sounding balloon, carrying a Dines meteograph to record the pressure and temperature at different stages of its ascent, and a ten-shilling note with an I.O.U. for a like sum to ensure its return. The balloon was released in the College grounds on Monday morning in the presence of an enthusiastic crowd. Less spectacular, but of considerable interest to local members, was the joint discussions of Sections C and E on the potential mineral resources of Nottinghamshire and Lincolnshire and their geographical significance. Perhaps the star turn in the joint discussions was the meeting of Sections C, D, E, F, K and M on Tuesday evening to talk about planning the land of Britain.

There can be no doubt that from a scientific point of view the Nottingham meeting was an unqualified success. From a social point of view it was equally pleasant. The excellent hostel accommodation, situated so close to the College and in the same beautiful surroundings, contributed greatly to the happiness of visiting members. The civic reception was obviously thoroughly enjoyed by guests and hosts alike, the flood-lit gardens of the Castle being much admired. Works visits, garden parties and excursions were heavily booked. Local firms and industrial undertakings were most generous in entertaining the Association. At the same time, the extraordinarily fine series of cinema films on subjects of biological interest, shown to members in the Savoy Cinema, proved to be a great attraction.

Forty-four years is the interval of time between the last two visits of the Association to Nottingham ; it is to be hoped that, both on scientific and social grounds, the Association will not wait another forty years before it returns.

On September 3 the General Committee adopted the nomination of the Council of Lord Rayleigh to succeed Sir Edward Poulton as president of the Association. The General Officers will continue to be Prof. P. G. H. Boswell as General Treasurer and Prof. F. T. Brooks and Prof. Allan Ferguson as General Secretaries. The new members of Council are Prof. T. S. Moore, Mr. R. S. Whipple, Prof. H. J. Fleure, Prof. J. G. Smith and Prof. J. C. Philip.

Future places of meeting of the Association are Cambridge (Aug. 17–24, 1938) and Dundee (1939). Invitations have been received for the Association to meet in Swansea in any convenient year, in Belfast in 1941 or any year nearly following, and in 1943 in Birmingham.

Under the arrangement proposed last year by the Council and adopted by the General Committee, the British Science Guild was incorporated into the Association as from November 30, 1936. In accordance with the agreement of incorporation a British Science Guild Committee has been appointed to continue arrangements for lectures already initiated by the Guild, and for any others of similar character which may be approved by the Council. The first of the lectures arranged by the Association under the above scheme was the Alexander Pedler lecture, given in Leicester on May 3, in co-operation with the University College in that city, by Prof. Allan Ferguson. The first Norman Lockyer lecture to be so arranged will be given by Dr. R. E. Mortimer Wheeler in the Goldsmiths' Hall, London, by kind permission of the Goldsmiths' Company, on November 24.

The first of the triennial lectures under the foundation of Mr. G. Radford Mather will be given by the Rt. Hon. J. Ramsay Macdonald, M.P., F.R.S., in the Royal Institution, London, by kind permission of the managers, on October 22.

The Council records with much satisfaction that Lord Rutherford has accepted the presidency of the joint Congress of the Indian Science Congress Association and a delegation from the British Association in January next.

Obituary Notice

Prof. F. C. S. Schiller

PROF. F. C. S. SCHILLER, who died in Los Angeles on August 7 after a long and lingering illness, was born in 1864, the son of Ferdinand Schiller of Calcutta. He was educated at Rugby and Balliol, and graduated in the first class of Literæ Humaniores, winning later the Taylorian scholarship for German in 1887. For a few years (1893–97) he occupied the post of instructor in philosophy at Cornell University. Then in 1897 he returned to Oxford, and became fellow and tutor of Corpus, where he remained for more than thirty years. His former pupils speak of him as a decidedly stimulating and suggestive teacher, who, although out of touch with the types of philosophical theory prevalent in Oxford, exerted considerable influence there as an

acute critic and searcher after truth. He was president of the Aristotelian Society in 1921, and had from 1906 onwards contributed to its *Proceedings* a large number of papers. At philosophical gatherings he was a well-known figure; he read, for example, a paper at the International Congress of Philosophy, held at Harvard in 1926. To *Mind* he was a frequent contributor, and was for many years treasurer of the *Mind* Association. In 1926 he was elected a fellow of the British Academy. In 1929 he was appointed visiting professor in the University of Southern California, and was accustomed latterly to spend half of each year in the United States and half in England.

Schiller's student life in Oxford began immediately after the death of T. H. Green, but from the outset he was out of sympathy with Green's idealism. In his earliest book, "Riddles of the Sphinx", published under the pseudonym "A Troglodyte" in 1901 (2nd edition, revised, with the author's own name, in 1904, new edition 1910), Schiller followed largely in the line of the evolution theory, as expounded by Darwin; and developed at some length a view, not unlike that of J. S. Mill, of God as a finite individual, immanent in the world as a living activity, but transcendent as a true personality. In the following year, in 1902, the volume entitled "Personal Idealism" appeared, containing contributions from eight members of the University of Oxford; Schiller's essay therein was on "Axioms as Postulates", and in this essay he outlined for the first time the position which, following William James, he designated as that of 'pragmatism', or later 'humanism'.

Truth, Schiller maintained, is *human truth*, and is incapable of coming into being without human effort and agency. Human action is psychologically conditioned; consequently, the concrete fullness of human interests, desires, emotions, satisfactions, purposes, hopes and fears is relevant to a theory of knowledge and must not be abstracted from. The world of our experience is not a ready-made datum; it is essentially what we make of it. Fruitless, therefore, is it to attempt to define it by what it was originally or by what it would be apart from us; it *is* what is made of it. Accordingly, the world is *plastic* and may be moulded by our wishes, if only we are determined to give effect to them, and are content to learn from experience, that is, by trying *by what means* we may do so. The principles we employ in such construction are, it was urged, in the beginning *demands* we make upon our experience, postulates or hypotheses, "starting-points and stepping-stones". Of these, when tried, many have to be abandoned; others remain precarious, and more or less 'matters of faith'; only a few rise to be unquestioned axioms. The "making of truth" is thus, it was contended, in a very real sense also a "making of reality". For in validating our claims to 'truth' we really 'discover' realities; and we virtually *transform* these by our cognitive efforts, thereby proving our desires and ideas to be real forces in the shaping of our world.

Perhaps Schiller's chief contribution to the thought of his time is to be found in his sustained insistence on the way in which principles, even those which appear to be the most self-evident and fundamental, are in point of fact tentative, and require to be tested by their success or want of success in enabling the investigator to get into touch with natural events; and in the repeated emphasis which he laid on the manner in which apparent facts receive modification through the growth of science. Furthermore, that man is not to be separated from Nature, and looked upon as a mere observer of a series of events which he can do nothing to alter, that revaluation and not static finality is a main feature of any truth discoverable by man—these are certainly points which it was worth while to emphasize, and upon them Schiller was constantly laying stress.

In addition to the works already referred to, Schiller was the author of "Humanism", 1903 (2nd edition 1912), "Studies in Humanism", 1907 (2nd edition 1912) and "Plato or Protagoras", 1908. He wrote also two books on logic—one, "Formal Logic: A Scientific and Social Problem", 1912, which was a sustained attack on what he regarded as the futility, the verbalism, the self-contradictoriness of the traditional logic; the other, which was a more constructive work, "Logic for Use", 1929. In the latter the logic which he desiderated was not the logic of proof but the logic of discovery, and he has said probably wellnigh everything there is to say on this subject. Nor must one omit to mention the two contributions he made to Singer's "Studies in the History and Methods of Science", on "Scientific Discovery and Logical Proof" in vol. 1 (1917) and on "Hypothesis" in vol. 2 (1921). G. D. H.

WE regret to announce the following deaths:

Prof. Hendrik Aldersloff, director of the State Serum Institute at Utrecht, president of the Dutch Society for the Advancement of Medicine, editor of the *Tijdschrift voor Sociale Hygiëne*, aged sixty years.

Prof. P. W. Cloassen, professor of biology in Cornell University, known for his work in economic entomology, on August 16, aged fifty-one years.

Prof. J. E. Duerden, who was associated with the Wool Industries Research Association, Torridon, Headingley, Leeds, and formerly professor of zoology in the Rhodes University College, Grahamstown, on September 4, aged seventy-two years.

Prof. Albert Heim, For. Mem. R.S., formerly director of the Geological Museum and Swiss Geological Survey, Zurich, on September 1, aged eighty-nine years.

Prof. M. Maclean, emeritus professor of electrical engineering in the Royal Technical College, Glasgow, on September 2.

Prof. Pietro R. Pirotta, formerly professor of botany in the University of Rome, on August 4, aged eighty-three years.

Mr. F. C. Thompson, lecturer in the Department of Leather Industries in the University of Leeds, aged forty-six years.

News and Views

The Right Hon. Lord Rayleigh, F.R.S.

THE British Association holds its annual meeting in Cambridge in August 1938, and the General Committee of the Association has elected Lord Rayleigh to the presidential chair for that meeting in succession to the veteran biologist Sir Edward Poulton. Readers of NATURE need little introduction to Lord Rayleigh, whose influence on the development of physical science has been so patent and so profound. First and foremost an experimental physicist, he has his father's flair for recognizing those aspects of an experimental investigation which most need stressing, and for extracting results of fundamental importance from apparatus of simple, even primitive, type. His work on radium and the earth's heat is classic in quality, and he has elucidated many diverse, and yet related, phenomena in his studies of the aurora borealis, the light of the night sky, the green flash, and the fluorescence of mercury vapour. He has lately studied the conditions of optical contact of glass surfaces, and has investigated, by admirably simple methods, the pull required to separate, and the work done in separating, contacted surfaces. He has measured the small amount of reflection between two contacted glass surfaces, and has shown that the blackness of the black centre of the Newton's rings formed between a spherical and a plane surface is by no means perfect.

LORD RAYLEIGH'S services to science on the administrative side are equally varied and weighty. He is chairman of the governors of the Imperial College of Science and Technology, and of the executive committee of the National Physical Laboratory. He had filled the offices of foreign secretary of the Royal Society, of president of Section A of the British Association, and of president of the Physical Society. Lord Rayleigh's contacts with Cambridge are many, and make the choice of the General Committee a singularly happy one. The nature and scope of his address remain to be seen, but, whatever be his choice, the scientific world, and indeed, the world at large, may look forward to receiving a pronouncement of fundamental importance.

Grass and the Nation's Food Supply

DR. R. E. SLADE'S evening discourse at the British Association, delivered on September 3, came well within the category of scientific contributions bearing upon social welfare, for it demonstrated the physical possibility of greatly increasing the nation's home-grown food supply, and incidentally of improving soil fertility and of helping to put the much-suffering farmer upon his financial feet. A conspicuous feature of recent agricultural progress has been the recognition of grass as a crop, and how by good management and the use of scientific methods of grass conservation, the productivity of pastures can be immensely increased. Early researches on grass as a food for stock were largely confined to hay, and though this form of 'bottled sunshine' is unlikely ever to disappear, the nutrients in grass can be best conserved either as ensilage or as artificially dried grass. No system of cultivating grassland can be adequate unless it takes cognizance of the reaction between the pasture herbage and the grazing animal, for by controlling the time and intensity of grazing or cutting, by judicious manuring, and by timely cultivations, a succession of palatable and nutritious herbage can be maintained throughout the grazing season, and this season can be extended at both ends, that is, in spring and in autumn. The re-discovery by Prof. T. B. Wood and Dr. H. E. Woodman of the high feeding value of leafy, young grass, and the breeding of leafy and highly nutritious strains of indigenous grasses by Prof. R. G. Stapledon and his co-workers at Aberystwyth, have opened up a vista of great possibilities for home agriculture and national food supply.

As an example of what can be done to improve the yield of food material from grassland, Dr. Slade described the results of a highly interesting experiment that has been carried on since 1935 at a large dairy farm near Middlewich, in Cheshire, where the climate is favourable and the management has been scientific as well as practical. Monthly records of milk production and live-weight increase of animals have been recorded throughout, and from these data the amounts of food (protein and starch equivalents) provided by the grass and the hay have been calculated. The average yield of crude protein per acre in 1935 and 1936 was 640 lb., which is three to four times as much as that given by an average pasture in Great Britain. Equally good results have been obtained on a 'farmer's farm' near Middlesbrough, in Yorkshire, over a period of ten years, and it was suggested that yields of crude protein up to 1,500 lb. per acre should be obtainable when Prof. Stapledon's new strains of indigenous grasses become available. A yield of 700 lb. protein per acre is equivalent to a yield of 45 lb. protein as dressed beef, or to 103 lb. protein as milk, which is just about the amount of protein provided for human food by an average acre of wheat. Pigs fed on grass protein could provide 70 lb. of pork per acre of grassland, but for this purpose the grass would have to be defibrinated. What is needed, and what seems feasible, is a protein-rich food made from grass deprived of its fibre, a kind of 'grass cheese', which could be fed to pigs for producing pork, and in times of national emergency could be eaten by the people.

Science and Progress

THE address, "Science in Everyday Life", given at Long Eaton on September 7 in connexion with the Nottingham meeting of the British Association by Dr. J. E. R. Constable, dealt with the more popular side of the activities of the Department of Scientific and Industrial Research and the laboratories engaged in research under its auspices. The National Physical Laboratory has, for example, fostered the use of X-rays for the detection of internal defects in steamship and aeroplane propellers, in almost all types of industrial products and in human teeth, and of foreign bodies in packed foods. It has also undertaken the measurement of noise and suggested methods of diminishing noises in buildings by the use of sound-absorbing devices. The Fuel Research Station has been investigating the best methods of getting the most heat and the least smoke from coal, while the Food Investigation Board has been finding out the best methods of keeping foods of all kinds in cold storage for long periods without its deteriorating.

ANOTHER branch of the activities of the Department to which Dr. Constable referred was that of the Road Research Laboratory, which is determining the best methods and materials for the construction of roads with good wearing qualities and non-skid surfaces. Machines for measuring the durability and non-skid property of sample roads and for determining when a road surface must be condemned as bad have been constructed and are giving valuable information. Closely associated with this laboratory is that for building research, which has succeeded in solving some of the difficulties in the production on a large scale of uniformity in structural materials such as concrete, and in the preservation of the stonework of buildings, and has investigated the best methods of dealing with many of the newer quick-setting plasters and cements. As a result of the work of the laboratory the smoking chimney need no longer be tolerated.

Dr. R. d'E. Atkinson

DR. R. D'E. ATKINSON has been appointed chief assistant in the Royal Observatory, Greenwich. Dr. Atkinson obtained a first class in the Physics Final Honour School in Oxford in 1922 and was elected to a research fellowship at Hertford College. In 1926 he obtained a Rockefeller travelling fellowship and studied in Göttingen for two years under Prof. Franck, taking the D.Phil. degree. After a short period as demonstrator in the physics laboratory of the Technische Hochschule in Berlin-Charlottenburg, he was appointed assistant professor and, in 1933, associate professor of physics in the Rutgers University, New Brunswick. Dr. Atkinson has published many papers. Of particular interest is his work on atomic synthesis and the source of stellar energy, in the course of which he deduced, before the discovery of the neutron, from general considerations of atomic abundance in the sun and stars, that there must be some type of particle that could penetrate a highly charged nucleus more easily than a proton.

Charles Bouchard (1837–1915)

CHARLES JACQUES BOUCHARD, a distinguished French physician, was born on September 6, 1837. He studied medicine first at Lyons and then in Paris, where he became house physician to Charcot, with whom he afterwards collaborated in the study of certain nervous diseases. He is best known for his works on the pathology of cerebral hæmorrhage (1866) and autointoxication (1887), both of which were translated into English, and the diseases caused by diminished nutrition (1870–80). He was also co-editor of a system of medicine with Charcot and Brissaud (1891–94) and of a treatise on general pathology in collaboration with H. Roger (1895–1903). In 1887 he founded the *Revue de la Tuberculose* with Verneuil, and in 1899 the *Journal de Physiologie et de Pathologie Générale* with Chauveau as his co-editor. Bouchard was one of the first physicians in Paris to take an interest in radiology, and installed a radioscopic apparatus at his own expense for the examination of his patients at the Charité hospital, where he was physician. In addition to occupying the chair of general pathology and therapeutics in the Paris faculty of medicine (1877) his distinctions included the presidency of the second French Congress of Medicine (1895), Société de Biologie (1896) and Academy of Sciences (1908). His death took place on October 28, 1915. The work entitled "Un Médecin Philosophe : Charles Bouchard, son œuvre et son temps", by Paul Legendre (1924), forms one of the outstanding medical biographies.

Trades Union Congress and Science

THE announcement made by Mr. Ernest Bevin in his presidential address to the Trades Union Congress meeting at Norwich of the formation of a scientific advisory council will be widely welcomed. Mr. Bevin paid tribute to the progress that science has made, but pointed out that society has not kept pace with it in making the fundamental readjustments and assimilating the results of research, discovery and invention. The General Council of the Congress believes that men of science can make a further contribution to progress by assisting such a movement as the Trades Union Congress with counsel and knowledge. It has accordingly decided to establish a Scientific Advisory Council, the purpose of which will be to enable the Congress and its constituent unions to secure the help and advice of leading scientific workers in some systematic and regular way. "The General Council are convinced that their prevision and foreknowledge of the significance of scientific discovery in all fields of research would be of incalculable value not only to the trade union movement, but to the community." Mr. Bevin gave a warning that this does not mean that scientific workers are to be invited to frame the policy of the Congress ; the General Council wishes to be in touch with representative men of science by means of such an advisory council and panels of scientific workers, from which it will be able to obtain information and advice in dealing with its own problems. It would

clearly be to the advantage of both science and labour if the Congress were represented upon research boards and research associations concerned with industrial developments. The human factor in industrial progress has often been neglected in the past, and by bringing representatives of labour into close association with scientific and inventive work, the degrading results of some of their past applications to industry may be avoided.

Racial Doctrine

A NEW periodical publication with the title *Races et Racisme* is devoted to the record of current development in the application of theories of race to the doctrine of nationalism, with special reference to Germany (office of publication, 47 rue de Miromesnil, Paris VIIIe, price 1 fr.). Its main object is to keep the French people abreast of the progress of a movement of supreme importance in the world of to-day, upon which, it is thought, they are not sufficiently well informed. It should also prove valuable to those who desire first-hand and trustworthy information in readily accessible form of the increasing restrictions and penalties which are being imposed on freedom of thought and scientific and intellectual development in the nationalist-socialistic State. The utility of such a publication must clearly depend upon its freedom from the taint of the selective activity of the propagandist. The names which appear on the lists of the Comité de Patronage and the Comité Directeur are a guarantee that an objective impartiality will be exercised in the selection of material for publication. The lists include such well-known names as M. Gabriel Hanotaux, Prof. Lucien Lévy-Bruhl, Prof. Paul Pelliot, Prof. G. Bouglé, P. Maurice Leenardt, le Comte Jean de Pange, and Prof. Paul Rivet, with Prof. E. Vermeil as one of two secretaries. *Races et Racisme*, of which numbers will appear at two-monthly intervals, will represent the trend of German thought in racial doctrine by verbatim reports, or full abstracts, of official documents, new laws and regulations, official pronouncements, articles and speeches of authority, as well as by analyses of books and a record of relevant events—all, as a rule, without comment, except when further explanation is considered necessary.

AN example of the commentary which the editorial body considers appropriate is afforded by the opening article, which runs through the two numbers before us and is still in progress. This is an exposition of the development of racial ideas in Germany by M. Edmond Vermeil. It begins with Leibniz and Herder and the concepts of the eighteenth century, and shows how the Germanic idea has progressed from the universalism of the philosopher to the Pan-Germanism upon which the doctrine of 'race' and 'blood' has been engrafted to implement Hitlerian nationalism. M. Vermeil, who takes a broad and philosophic view of his subject, will, in his later instalments, demonstrate how and why what appears to be no more than a political manœuvre, when judged by its objective, must necessarily permeate and transform activities, apparently remote from the political arena when functioning freely, to produce 'German' art, a 'German' science and a 'German' religion. It is to be noted, however, that the sweeping official claims for purity of race and the coincidence of Nordic and Aryan are so far abandoned that Prof. Oswald Kron of Tübingen is permitted to say that there are five or six races among the German people, while he claims for them a psychological unity.

Native Lands in South Africa: A "New Deal"

CONSIDERABLE progress has been made in the provision of additional reserves for the native population of South Africa since the passing of the Native Lands Act, which was promulgated in August, 1936. Up to July last, according to a dispatch from the Cape Town correspondent of *The Times*, which appears in the issue of September 3, £800,000 has already been spent on the purchase of farms from Europeans. The farms which have been bought up to the present are mostly situated in the Transvaal, where the need for native land is greatest, as this is the principal area of native location on European farms, a practice which will not be permitted in future. The land is being allotted to the natives and settlement will proceed as the present European holders vacate. They have been permitted to remain in possession until after their harvest, and land is being provided for them elsewhere. Under the provisions of the Native Trust and Land Act, 1936, the South African Native Trust, representing the Government, is authorized to acquire 7,250,000 morgen (about 15,000,000 acres) of lands for native use. It is anticipated that the work of settling the native on these lands, which will now go on steadily, will occupy a period of several years. It is clear, however, that if the situation is not taken in hand drastically, and the conditions which prevail on native lands, not only in South Africa, but also in territories to the north, are allowed to continue unchecked, a situation similar to that for which the present measures are intended to be a remedy will again arise before many years have passed, and probably then be more difficult to meet.

THE present deplorable condition of the existing native reserves and the agitation and discontent to which the shortage of native lands has given rise is not entirely due to overpressure of population, though this has been an important factor. Traditional methods of native agriculture and grazing, of which the ill effects were negligible when a practically unlimited area allowed freedom of movement and gave exhausted soil an opportunity to recover, have led, under the system of European restriction of boundaries and suppression of tribal raids, to a general impoverishment of the land, which has further deteriorated through the erosion consequent on the overstocking which follows from the Bantu regard for cattle as a sole and almost sacrosanct form of wealth. Since the passing of the Act, the Native Affairs Commission has been busily engaged in framing a policy which is intended to remedy these

adverse conditions. Regulations and remedial measures are to be applied to the existing reserves, such as fencing, irrigation, parcelling out the land for occupational and agricultural use, as well as for rotational cropping and the like, by which it is hoped to introduce into native tribal custom a more economical use of the land. On the new reserves agricultural officers will be appointed to instruct and, if necessary, discipline the natives in modern methods of cultivation. The educational process is bound to be slow; and its success, as previous experiments have shown, will depend very largely upon the discretion with which new methods are welded into traditional custom.

Physics and Society

In an address before the American Physical Society, Washington, on April 30, on Science and Society (*J. Applied Phys.*, 8, 373; 1937), D. Sarnoff, president of the Radio Corporation of America, referred to the relation of the physicist to the far-reaching social changes which follow his discoveries. The radio industry had its origin in the purely theoretical reasoning of Clerk Maxwell when in 1865 he advanced reasons for the existence of electromagnetic waves, although it was only in 1895 that Marconi gave the world a practical system of wireless telegraphy. Already 150 social effects have been traced directly to radio, and the end is not yet in sight. The major obstacles to the public introduction of television no longer lie in the field of research and engineering. The creation of a new art form has demanded new techniques of writing, direction and studio control. Here as elsewhere a scientific approach to the solution of human problems is required, and it is essential that mankind should learn how to use the assets which are the product of the scientific mind. Civilization depends for its advance upon our expanding knowledge of the social as well as of the physical sciences, for no society can solve its problems by intuition or rule of thumb. The advance of social science no less than that of physical science, calls for the creative imagination of a Newton and a Maxwell, an Edison and a Marconi. Obsolescence is a factor in social as well as in industrial machines.

The social investigator must approach the problems of society in the clear light of an unbiased mind. He must collect and analyse facts, seek to fathom causes and establish principles, which he must always be willing to reconsider in the light of results. The permanent advance of society depends on our following procedure similar to that of the experienced surgeon. We must not be afraid to operate but must know when a less spectacular and safer treatment will be adequate. Social and economic facts must be investigated, verified and analysed, and the analysis and conclusions disseminated widely by popular education and debate. Industry is continually entering new realms of knowledge, and close understanding and co-operation are required between its leaders and the investigators in the universities. Industry which has not learnt to employ scientific workers is doomed. Moreover, the problems created by technical science can only be solved by increasing and applying our knowledge of social science, and Mr. Sarnoff urged that the immediate goal of social science should be to achieve economic justice, peace and prosperity in a free democracy. Because that involves collective effort, it does not mean the suppression of individual liberty. Freedom of the individual is essential to the full expression of his creative faculties. Science and society depend upon each other, and when the basic lesson of science, that knowledge of the truth without fear or prejudice is indispensable to progress, is rejected, science—and society with it—goes backward instead of forward.

Education and Training for the Oil Industry

The days when a liberal education and an effective personality were sufficient qualifications for entry into the petroleum industry are now over. As Prof. A. W. Nash pointed out in a paper presented to the Chemical Engineering Congress, World Power Conference, 1936 (*J. Inst. Pet. Tech.*, 22; 1936), specialized vocational training is the only adequate background for technical men seeking employment in the industry. Moreover, this specialized training should be directed towards one particular branch of the industry, for example, geology, production, or refining, for in each of these branches different sciences are involved and correspondingly different technical knowledge is necessary for the solution of such problems as may be encountered. Before proceeding to specialize, however, the student must acquire a sound knowledge of the fundamental principles of physics, mathematics and chemistry, together with a working understanding of engineering and chemical engineering. Finally, having mastered these fundamentals and specialized in a particular branch of the industry, the technician should familiarize himself at least with the basic principles underlying the remaining branches of the industry, for in this way alone will he acquire a clear conception of any problem which may present itself from the point of view of the industry as a whole. Universities and other institutions which provide such training for the industry, are fully alive to the fact that, apart from the actual acquisition of knowledge, the student is there primarily to learn how to apply such knowledge, to interpret it and make use of it in the solution of new problems, and their curricula are adjusted accordingly. For the man who has made full use of any such training, there are openings in the industry unrivalled in any other from the points of view of scope and advancement.

The Spread of the Sahara

There is abundant evidence that early in the Quaternary age the Sahara was inhabited by man and that desiccation has since been proceeding. In so far as this process is one of climatic change, it is beyond the control of man; but there is also much evidence that the increase of desert conditions in both north and south is largely due to human interference.

In a pamphlet entitled "The Threat of the Sahara", reprinted from the *Journal of the Royal African Society*, Prof. E. P. Stebbing reviews the available evidence of progressive desiccation and discusses the causes. These can be summarized as war, primitive methods of agriculture, excessive grazing and pasturage and fire. Intertribal warfare has laid waste great tracts and so promoted soil erosion. The method of shifting cultivation, entailing the cutting down of successive areas of forest and their abandonment when annual burning produces too poor a supply of fertilizing wood ash, has allowed the spread of scrub land. This degraded forest is given over to pasturage which tends to destroy the vegetation, the last stage in its use being the pasturing of goats. Prof. Stebbing sees little evidence that the desiccation can be attributed to climatic oscillations, and is extremely doubtful that the succession of a wet period will reverse the present trend.

The Zoological Society of Scotland

THE increase in the number of visitors to the Zoological Park near Edinburgh to just short of half a million, and a surplus on the year's working of £1,708, indicate the material success of this Society (*Ann. Report Zoo. Soc. Scot.*, 1936–37). In other ways it has made notable progress. The new open-air enclosure for tigers, which occupies the site of an old sandstone quarry, is a most striking example of the use of natural rock, and a new restaurant, made necessary by the increase of visitors, has been completed and opened. During the year five king penguin chicks were hatched, of which three were successfully reared, and amongst mammals there were born and reared lion cubs, four beavers, three llamas, a nilghai and Barbary sheep. The chimpanzee born in January 1936 has developed well, and for many years the breeding of tropical freshwater fishes has been a feature of the Carnegie Aquarium. A successful innovation was the holding of a series of meetings of members at which lectures upon, and illustrated accounts of, their investigations of animal habits and behaviour were given by experts.

Survey of India

IN 1905 the hope was expressed by the Survey of India that in twenty-five years maps of the whole Indian Empire on a scale of one inch to a mile would be available. The Annual Report for 1936 (Calcutta. 2*s*. 6*d*.) points out that this hope is far from realization, and that a little more than half the area is now mapped on that scale. When it was realized in 1913 that the scheme could not be completed for many years, it was decided to reduce the scale of survey for the less populous areas. As a result, two-thirds of the country is now covered by modern maps ranging in scale from one inch to a quarter inch. In the year under review more than fifty-three thousand square miles was surveyed, in addition to a certain amount of revision. The report contains full index sheets to all the scales, including the sheets of the Carte Internationale on a scale of one million which cover India and adjoining lands.

Motor-boat Speed Record

ON September 1, Sir Malcolm Campbell, driving his new motor-boat *Bluebird* on Lake Maggiore, made two runs over a measured mile at an average speed of 203·3 km. an hour. His boat is equipped with a single Rolls-Royce engine of 2000 h.p., similar to that of his motor-car *Bluebird*. Sir Malcolm has thus achieved the distinction of holding the speed record for both land and water.

Announcements

MR. J. D. GRIFFITH DAVIES, an administrative assistant in the Higher Education Department at Leeds, has been appointed assistant secretary of the Royal Society as from September 1 in succession to Mr. R. Winckworth, who at his own request has reverted to his previous position in charge of the Society's publications.

THE following appointments and promotions have recently been made in the Colonial Service: E. F. Allen, to be agricultural officer, Malaya; D. B. Fanshawe, to be assistant conservator of forests, British Guiana; D. E. Faulkner, to be veterinary officer, Gold Coast; K. D. S. MacOwan, to be veterinary officer, Kenya; J. W. Ewart, to be assistant curator of gardens, Malaya; F. R. Mason (agricultural field officer, Malaya), to be deputy director, Department of Agriculture and Fisheries, Palestine; R. W. R. Miller (director of science and agriculture, Barbados), to be director of agriculture, Zanzibar; W. D. MacGregor (senior assistant conservator of forests), to be conservator of forests, Nigeria; H. G. Wiltshire (pathologist, Zanzibar), to be senior pathologist, Uganda; W. Horsfield (staff surveyor), to be district surveyor, Lands and Mines Department, Tanganyika; H. M. Pendlebury (curator, Selangor Museum), to be director of museums, Federated Malay States; J. L. Tetley (assistant analyst, Imports and Exports Department, Hong Kong), to be chemist, Institute for Medical Research, Federated Malay States.

DR. ROBLEY D. EVANS, assistant professor of physics at the Massachusetts Institute of Technology, recently received the first Theobald Smith award in medical science, consisting of a bronze medal and one thousand dollars, for his researches, which have led to a method of detecting radium poisoning before its fatal stage and a treatment for extracting radium from bones.

A USEFUL little volume on most aspects of map-making has been published under the title of "Cartography" (Special Publication No. 205. U.S. Dept. of Commerce. Coast and Geodetic Survey 1936. 60 cents). The pamphlet opens with a short historical survey, after which is a discussion of different kinds of maps and charts and their requirements. Then follows a chapter on compilation of the material for a map and a clear, though brief, account of the chief projections. The last section treats of the technique of construction. There are many reproductions of sections of various maps, American and others.

Letters to the Editor

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

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 468.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Asymmetry in Metals of Hexagonal Structure

THE axial ratio, c/a, of the majority of metals having a hexagonal close-packed type of structure differs appreciably from the value $2\sqrt{2/3} = 1{\cdot}633$ which corresponds to a hexagonal close-packed system of spheres. The two most notable deviations are for zinc and cadmium, for which $c/a = 1{\cdot}86$ and $1{\cdot}89$ respectively, while for beryllium, titanium, zirconium, hafnium, yttrium, ruthenium and osmium, c/a lies between $1{\cdot}58$ and $1{\cdot}59$. These facts have sometimes been expressed by describing the atomic domains as having the forms of prolate and oblate spheroids when c/a is respectively greater than and less than $1{\cdot}633$; but it is only recently that experimental evidence has been obtained which throws light on the nature of the asymmetry in these metals.

X-ray measurements for zinc[1] and cadmium[2] have shown that the atomic vibrations in these metals are markedly asymmetric, the mean atomic displacement along the hexagonal axis, the c-axis, being greater than normal to the axis; this suggests that the high values of the axial ratios arise partly, if not wholly, from the asymmetric character of the vibrations. This is further supported by X-ray measurements by us for magnesium[3], similar to the previous experiments on zinc and cadmium, which indicate that the lattice vibrations in magnesium are much more nearly isotropic; this may be correlated with the fact that c/a for magnesium is $1{\cdot}624$, which approximates closely to the ideal value, $1{\cdot}633$.

Results have recently been obtained, however, indicating the existence of an appreciable atomic asymmetry. It was first pointed out by one of us[1,2] (G. W. B.), that the $(10\bar{1}0)$ reflections from zinc and cadmium give abnormally high scattering factors compared with the adjacent reflections, and since these reflections occur at small angles for which lattice vibration has relatively little effect, it was thought that it might be an indication of atomic asymmetry. This has since been confirmed in the case of zinc by Jauncey and Bruce[4], who also have accepted it as evidence for atomic asymmetry, and by other workers in Jauncey's laboratory[5]; Wollan and Harvey[6] especially have carried the matter a step further by making measurements at two temperatures. In the light of this evidence, it appears well established now that the atoms in metallic zinc and cadmium are asymmetric and are more diffuse along the c-axis than normal to it.

We have recently investigated ruthenium, a hexagonal metal with $c/a = 1{\cdot}58$, which has provided evidence for a different type of atomic asymmetry. The lattice vibrations at room temperature are relatively small, so that this metal is particularly suitable for studying atomic asymmetry. The X-ray scattering factors of ruthenium are shown in Fig. 1, the length of the line attached to each reflection indicating the possible experimental error. Among the lower order reflections, 2 and 5 are well above the mean curve and 1, 3, 4 and 6 fall either on or below the curve, depending on how it is drawn. The indices of the reflections are given in the key attached to the figure. The curve is extrapolated to 42·8 at $(\sin\theta)/\lambda = 0$, which is the atomic number, 44, less a dispersion correction of 1·2. An interesting feature of these results is that whereas the second reflection

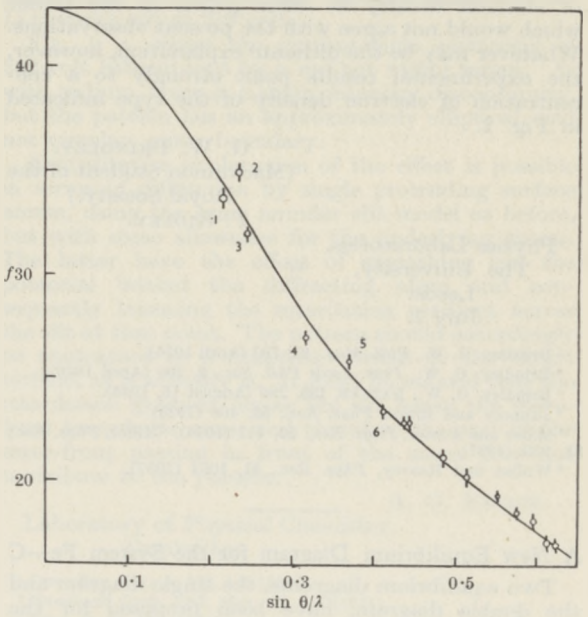

Fig. 1.

X-RAY SCATTERING FACTOR OF RUTHENIUM

1, $10\bar{1}0$	4, $10\bar{1}2$
2, 0002	5, $11\bar{2}0$
3, $10\bar{1}1$	6, $10\bar{1}3$

comes from the basal plane, the fifth reflection, which is also high, comes from a plane parallel to the c-axis, that is, normal to the basal plane. Evidently, then, a simple extension of the atoms either in the direction of the c-axis or in the basal plane will not explain these results.

An explanation is obtained, however, if we suppose that there is a concentration of electron density having its centre of gravity at the mid-point of every triangle formed by three atoms in the basal plane, as in Fig. 2, where the black circles represent the atoms and the clear circles the additional electron density. It is seen that the additional charge lies between planes of the type $(10\bar{1}0)$, $(10\bar{1}1)$, $(10\bar{1}2)$, etc., corresponding to reflections 1, 3, 4 and 6, and so gives low

scattering factors, but lies on planes of the type $(11\bar{2}0)$ and also on the basal plane (0001), the plane of the diagram. As to why there should be a concentration of electron density, which need only be of the order of 1–2 electrons to account for the observations, we cannot yet say; but it may perhaps be due to the overlapping of the wave-functions of the incomplete 4*d* shell, which for ruthenium have a considerable spread. An objection to this simple

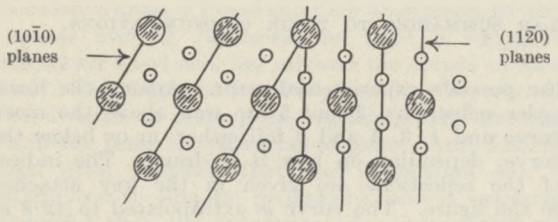

Fig. 2.

explanation is that it would require concentrations of electron density at other points in the lattice which would not agree with the present observations. Whatever may be the ultimate explanation, however, the experimental results point strongly to a concentration of electron density of the type indicated in Fig. 2.

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[1] Brindley, G. W., *Phil. Mag.*, **21**, 790 (April 1936).
[2] Brindley, G. W., *Proc. Leeds Phil. Soc.*, **3**, 200 (April 1936).
[3] Brindley, G. W., NATURE, **138**, 290 (August 15, 1936).
[4] Jauncey and Bruce, *Phys. Rev.*, **50**, 408 (1936).
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A New Equilibrium Diagram for the System Fe—C

Two equilibrium diagrams, the single diagram and the double diagram, have been proposed for the system Fe—C and we cannot, as yet, decide upon which is the correct one. The single diagram assumes that graphite never separates directly from molten iron, which was, however, recently experimentally disproved by different workers including myself. It meets with a second difficulty as it represents a metastable equilibrium; but a stable diagram for such an important alloy as Fe—C is required.

The double diagram indicates that graphite may sometimes be formed directly from the melt; it is free from the above difficulties, but it encounters more as follows:

(1) Two diagrams (stable and metastable) are drawn with an interval less than 10° C., and such a coupled diagram makes the matter difficult to understand. Several double diagrams have been proposed by different authors, and it is extremely difficult to chose from them.

(2) Two eutectic temperatures (austenite-cementite and austenite-graphite) are expected by the double diagram, but many authors have been able to find only one.

(3) The lower (metastable) lines of the double diagram express a super-cooling. We have now about 400 binary equilibrium diagrams and only three of them, Cd—Sb, Cd—As, Fe—C, include super-cooling. Super-cooling in the systems Cd—Sb and Cd—As is abnormal. Ordinary super-cooling is added only in the double diagram of Fe—C, which is unreasonable. We must have important reasons to justify the addition of super-cooling in the diagram, and the metastable equilibrium lines added should have been clearly proved by experiment; but neither condition is fulfilled. The double diagram includes the super-cooling at the eutectic but not that at the eutectoid (martensite formation is never included). This, again, is a self-contradictory feature of the double diagram.

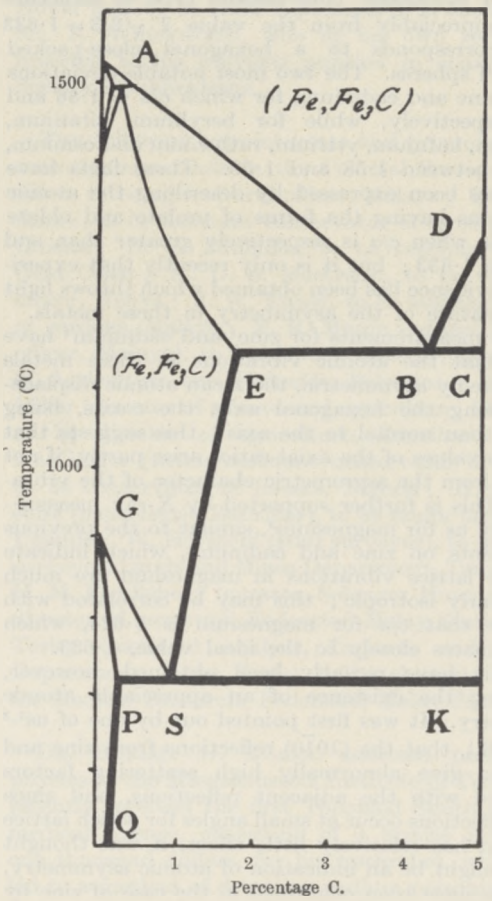

Fig. 1.

NEW EQUILIBRIUM DIAGRAM. LOW TEMPERATURES: STABLE EQUILIBRIUM Fe—C; HIGH TEMPERATURES: STABLE EQUILIBRIUM Fe—Fe$_3$C.

Fig. 1 shows a new equilibrium diagram. Super-cooling is omitted, thus avoiding all the difficulties of the double diagram. It shows a stable equilibrium, assuming Fe_3C to decompose on solidifying or on separating from austenite, eliminating the two difficulties of the single diagram.

The details will be published in the report of this Institute.

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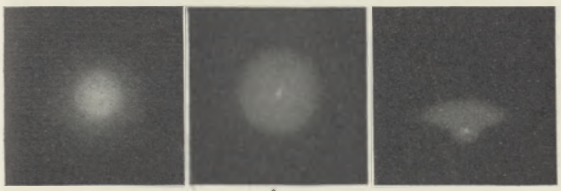
Diffraction of Slow Positive Ions

AN experimental method has been developed which permits photographic recording of the scattering of slow positive ions through angles of a fraction of a degree. This is accomplished by using a very fine, electrostatically focused incident beam and accelerating the ions, *after the scattering*, to a velocity high enough to affect a photographic plate. The high-voltage electrostatic lens used to give the acceleration also produces an angular magnification of the scattered rays.

Fig. 1 shows the scattering of lithium ions by a jet of sodium vapour, photograph *a* for 292 volt ions, *b* for 149 volt ions. Around the central spot is a sharply defined disk of nearly uniform intensity, having an angular radius of 0·0083 radians for the faster ions and 0·0151 for the slower ions. The plates also show a faint halo surrounding the disk and separated from it by about a quarter of the disk's diameter.



a *b* *c*

Fig. 1.

The pattern appears, at first sight, to resemble the diffraction of light by an opaque circular obstacle. However, a wave theory in which the atom and ion are treated as hard spheres gives a value of only 1 A. for the collision radius and also predicts a wrong variation of disk radius with ion energy. The repulsive field model considered theoretically by Massey and Smith[1] gives a monotonic decrease of elastic scattering with increasing angle and therefore also fails to account for the effects.

A satisfactory explanation of the results has been found which seems definitely to establish the wave nature of lithium ions. The essential features of the theory are the inclusion of the attractive force due to polarization of the sodium atom, and the division of the ion wave-front into three distinct parts corresponding, respectively, to exceedingly small, large and intermediate scattering angles.

The first part is taken in such a way that the retardation produced by the potential field of the atom is everywhere less than half a wave-length. Under these conditions there is negligible refraction of the wave-front and only slight diffraction corresponding to a large circular obstacle (in atomic units). This gives a central Airy's disk of about 0·0006 in angular radius, which is considerably less than the angular radius of the incident beam. The second or innermost part of the wave-front is where the retardation varies very rapidly, corresponding to large angle scattering.

The remaining annular part of the wave-front is what produces the observed pattern. Now, the calculations show that the retardation varies almost linearly across the width of this region and a hollow cone of rays would therefore be produced, were it not for diffraction. This has the effect of filling up the inside of the cone and also producing fringes, spaced in accordance with the width of the annulus. The fringes inside the cone are smoothed out by overlapping, thereby giving the observed uniform disk. The separation of the halo from the edge of the disk is related directly to the width of the annulus.

The calculations have been made for a force of the form[2]

$$F(r)=\frac{2\alpha e^2}{r^5}\left[1-\left(\frac{r_0}{r}\right)^4\right]$$

where α is the polarizability of the sodium atom and r_0 the equilibrium nuclear separation of Na Li$^+$. For both 292- and 149-volt ions the observed radii of disk and halo agree, within the limits of the experiment, with those calculated for $\alpha = 2{\cdot}5 \times 10^{-23}$cm.[3] and $r_0 = 2{\cdot}36$A. Since only two observations are needed to fix both α and r_0, this means that the theory correctly accounts for the observed variation of both radii with energy. The value of α fits in with the values found experimentally for Li, K and Cs by Scheffers and Stark[3], and r_0 is consistent with the spectroscopic values[4] of 2·67 and 3·07 for the neutral molecules Li_2 and Na_2. From the values of α and r_0 the binding energy of Na Li$^+$ works out at 2·9 volts.

Fig. 1, *c*, shows the grazing-angle scattering of 292-volt lithium ions by a red-hot nickel target. As with sodium, there is a sharp intensity discontinuity, but the pattern has an approximately elliptical, and not circular, outer boundary.

A qualitative explanation of the effect is possible in terms of diffraction by single protruding surface atoms, using the same annular slit model as before, but with some allowance for the underlying atoms. The latter have the effect of smoothing out the potential behind the diffracting atom and consequently lessening the retardation gradient across the slit at that point. The pattern should accordingly be contracted in a direction normal to the target surface, as it actually is. It must be noticed that the retardation gradient across the slit bends the wave-front *towards the atom*, and therefore the part of the wave-front passing in front of the atom does not contribute to the pattern.

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[1] *Proc. Roy. Soc.*, A, **142**, 142 (1933).
[2] Hassé and Cook, *Phil. Mag.*, **12**, 554 (1931).
[3] *Phys. Z.*, **35**, 625 (1934).
[4] Sponer, "Molekülspektren, 1", Tabellen.

Vibration Temperature in relation to Rotation Temperature in Band Spectra

THE problem of exciting band spectra of two different molecules in the same source has attracted some attention of late. Investigation of excitation temperatures of molecules under these conditions has given interesting results which require elucidation from theory. For example, Lochte-Holtgreven[1] found by examining CH and C_2 bands in the same discharge tube a temperature difference of more than 1,000° between the two. On the other hand, van Wijk[2] arrived at a common effective temperature from the negative (N_2^+) and second positive (N_2) bands of nitrogen in the same discharge tube. In view of these results, it was deemed necessary to undertake further work on the same lines.

The present investigation deals with AlO blue-green and CN violet systems excited in the same

arc and photographed simultaneously. The gross intensity measurements of all the bands in the two systems have been made by the methods of photographic spectral photometry by comparison with a standard source of known energy distribution. On the assumption of a Boltzmann distribution of vibrational energy in the initial state, temperatures have been calculated. These are shown below and compared with the results from the rotational energy distribution of previous authors for the same molecules examined in the carbon arc.

Band systems	Vibration temperatures (T. and T.)	Rotation temperatures (Ornstein and Brinkman)
CN, $B^2\Sigma \rightarrow X^2\Sigma$	6200° K.	6500° K.
AlO. $^2\Sigma \rightarrow {}^2\Sigma$	3450° K.	3275° K.*

* This is taken as the mean of two temperatures from 0,0 and 1,0 bands of AlO

It may be noted that the effective vibration temperatures of column 2 above agree fairly closely with the rotation temperatures of Ornstein and Brinkman. They are an indication of temperature equilibrium in the source (carbon arc) examined, as the values are supposed to be in the neighbourhood of the true temperatures for the zones concerned, for the CN bands are emitted from the inner violet part and AlO bands from the outer green halo.

The details of the investigation are being published elsewhere in a separate paper.

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Z. Phys., **64**, 443 (1930); **67**, 590 (1931).
[2] *Z. Phys.*, **59**, 313 (1930).
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Intensity and Structure Changes of the $L\alpha$ Emission Lines of Cu and Fe on Intense Cooling of their Anticathodes

THE only previous experiments on the effects of temperature of the anticathode on the changes in the character of X-ray lines either in absorption or emission, are those of H. S. Read[1], J. H. Purks[2] and F. C. Chalklin[3]. These investigations, as also those of J. D. Hanawalt[4], who studied changes in the fine structure of X-ray absorption spectra dependent on the physical and chemical nature of the absorber and temperature, were all concerned with the effects of high temperature alone. So far as we are aware, except for the experiment of Swedenborg and Claesson[5], whose results were published while our experiments were in progress, there seems to be no record of any experimental investigations of the effect on the character of the X-ray lines emitted of intensely cooling an anticathode.

For effectively cooling the target, we had recourse to rapid evaporation of liquid oxygen from a specially designed anticathode tube. A plane grating spectrograph of the type devised by Siegbahn and Magnusson and constructed by Messrs. Adam Hilger, Ltd., was employed; while a molecular pump supplied by Leybold Nachfolger backed by a suitable oil pump was used for exhausting the apparatus. The grating used was ruled at Uppsala and had 900 lines in a space of 3 mm. Exposures were made first with liquid oxygen evaporating and then with tap water circulating through the anticathode tube, on the same photographic plate. The time of exposure, bombarding electronic current (70 ma.) and the accelerating potential (4·8 kV.) were all kept constant during the two exposures. Although the grating used did not possess sufficient dispersion to resolve the L lines clearly, making quantitative measurements difficult, yet microphotometric studies of the photographs obtained have yielded the following interesting preliminary results:

(*a*) The line-curves of Cu and Fe L-lines possess considerable spread on the long-wave side but are steeper on the short-wave side at both the liquid oxygen temperature (− 183° C.) and room temperature (25° C.) of the targets.

(*b*) The intensity of the Cu $L\alpha$-line at the liquid oxygen temperature of the target is only 70 per cent of that from the target at room temperature. The corresponding figure for Fe is about 60 per cent.

(*c*) Although L-lines are not clearly resolved by the spectrograph used, which has a dispersion only of 4·95 A. per mm., there is unmistakable evidence of their shift relatively to one another with the temperature change of the target.

(*d*) Some changes in the widths of the lines are also suggested with the change of temperature of the target.

The experiment is being repeated with a new plane grating possessing double the dispersion of the former, the experimental arrangements remaining more or less the same. It is hoped that it will be possible, on the conclusion of the experiments now in progress, to give definite quantitative results of measurements.

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[2] Purks, J. H., *Phys. Rev.*, **29**, 352 (1927).
[3] Chalklin, F. C., *Proc. Roy. Soc.*, A, **155**, 366 (1936).
[4] Hanawalt, J. D., *Phys. Rev.*, **37**, 715 (1931); **41**, 399. (1932).
[5] Swedenborg, H., and Claesson, M., *Ann. Phys.*, **28**, 159 (1937).

Surface Tension of Strong Electrolytes

Jones and Ray[1] have recently found that on adding a salt to water the surface tension at first decreases, then passes through a minimum and finally at concentrations above about 0·001 N increases with increase of concentration. The interionic attraction theory of surface tension developed by Wagner[2] and Onsager[3] on the basis of the Debye solution theory and the principles of electrostatics requires, however, the slope of the surface tension - concentration curve always to be positive and greater at the lower concentrations. The accurate results of Jones and Ray are thus seen to be in complete disagreement with theory.

By postulating that the surface structure of water is such that there is a small number of surface locations where negative ions can become adsorbed from the interior of the solution with a large diminution of potential energy, it is possible to derive statistically the following equation for the number of moles of an ion kind adsorbed per sq. cm.

$$\Gamma_i = ck\nu_i\left[\frac{a - \{b - ck\Sigma\nu_i\}e^{W_-/RT} - ck\nu_-}{(b - ck\Sigma\nu_i)e^{W_-/RT} + ck\nu_-}\right] \quad (1)$$

which when coupled with the Gibbs adsorption isotherm yields (neglecting activity coefficients)

$$\gamma - \gamma_0 = RTkc\Sigma\nu_i + \frac{aRT\Sigma\nu_i}{e^{W_-/RT}\Sigma\nu_i - \nu_-} \ln\left[1 - \frac{\{e^{W_-/RT}\Sigma\nu_i - \nu_-\}kc}{be^{W_-/RT}}\right] \quad (2)$$

The term $e^{W_-/RT}\Sigma\nu_i$ can be shown to be very much smaller than ν_-, with the result that (2) reduces to

$$\gamma - \gamma_0 = RTkc\Sigma\nu_i - \frac{aRT\Sigma\nu_i}{\nu_-} \ln\left[1 + \frac{k\nu - c}{be^{W_-/RT}}\right] \quad (3)$$

where γ is the surface tension at concentration c (moles per litre), a is the number of adsorbing points per sq. cm., b is the number of water molecules per sq. cm., W_- is the potential energy of the negative ion at the surface in excess of its value in the interior of the liquid, and k is the ratio between the concentration in moles per sq. cm. and moles per litre, and depends on the thickness of the adsorbed layer, which we take as the diameter of the water molecule plus that of the adsorbed solute.

Knowing the diameters of the water molecule and of the solute ions, and estimating a and W_- from the data of Jones and Ray, it is possible to calculate the surface tension from (3) for potassium chloride solutions, for example (lower solid line of Fig. 1), and to compare with the experimental results (crosses of Fig. 1). The agreement is satisfactory.

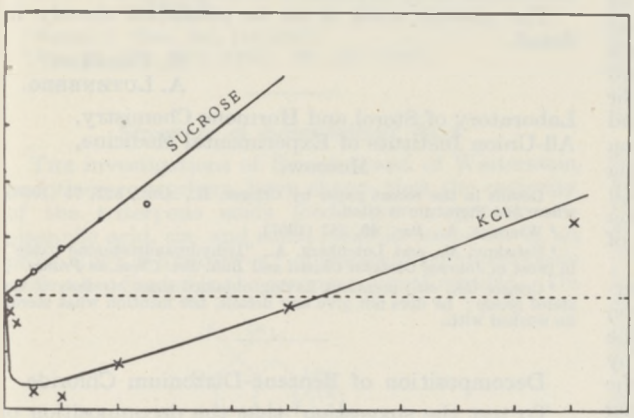

Fig. 1.

In the case of capillary inactive non-electrolytes like sucrose, a will be equal to zero and (3) becomes

$$\gamma - \gamma_0 = RTkc. \quad (4)$$

From the density of solid sucrose one can calculate an approximate value of its molecular diameter allowing an evaluation of k to be made and a computation of the surface tension from (4). The upper solid line of Fig. 1 represents the theoretical calculations, while the circles are the experimental data of Jones and Ray. Again the agreement seems to be satisfactory, and lends support to the original postulate.

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Northwestern University,
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July 19.

[1] Jones, Grinnell, and Ray, W. A., *J. Amer. Chem. Soc.*, **59**, 187 (1937).
[2] Wagner, C., *Phys. Z.*, **25**, 474 (1924).
[3] Onsager, L., and Samaras, N. N. T., *J. Chem. Phys.*, **2**, 528 (1934).

Viscosity of Monomolecular Films

ALTHOUGH the viscosity relations of films are of fundamental importance for an understanding of their structure, it has not in the past been possible, with the surface viscosimeters used, to determine the viscosity of a true film, that is of a monolayer. Two viscosimeters which are sufficiently sensitive are described below, and others are in process of development.

1. *Capillary slit viscosimeter for liquid surface films.* The film is allowed to flow under its own pressure, or a difference of pressure, through a long transverse slit in a barrier which confines the film. The following relation gives the viscosity (η):

$$\eta = \frac{f}{Q}\frac{d^3}{12l} \text{ dyne sec. cm.}^{-1},$$

where f is the surface pressure in dynes per cm., d is the diameter, and l the length of the slit, and Q is the number of sq. cm. of film which disappears through the slit per second.

VISCOSITY OF SURFACE FILMS OF FATTY ACIDS IN SURFACE POISES

No. of C Atoms		
	Saturated Acids at 25°C.	
14	Myristic	0·000161
15	Pentadecylic	0·000228
16	Palmitic	0·000248
17	Margaric	0·000317
18	Stearic	0·000307
19	Nonadecanoic	plastic solid
20	Arachidic	0·001790
	Unsaturated Acid at 20°C.	
18	Oleic	0·000162

2. *Torsion ring surface viscosimeter for liquid and plastic-solid films.* A torsion pendulum, with a horizontal circular disk at the bottom, was constructed. This disk may be allowed to vibrate in the surface, but is insensitive to the film. A thin metal cylinder, 1 cm. high, was soldered to the outside of the ring in such a way that only the sharp lower edge of this cylinder could be put in contact with the surface of the water. By allowing this ring (10 cm. in diameter) to vibrate in contact with the clean surface, and then with a film outside, but not inside the ring, the viscosity of the film could be calculated from the logarithmic decrements of angle between successive swings.

This instrument gave data of great interest. For example, cetyl alcohol on 0·01 molar hydrochloric acid at 22° C. compresses at very low pressure to a liquid monolayer of 21 sq. A. area permolecule. As the pressure is increased, the viscosity of the liquid film increases, as is shown by both types of viscosimeter. The force-area relation is linear to 11 dynes and 19 sq. A., and at this kink point a change of phase occurs, in which a plastic solid film of very much higher viscosity and lower compressibility appears. The viscosity of this film increases rapidly with pressure. Pentadecylic acid, which forms an expanded film the pressure of which begins to increase above 0·1 dyne per cm. at 44 sq. A., forms a liquid film both below and above the kink, and the solid plastic form appears where no kink is visible at a molecular area of 21 sq. A.

The viscosity of monolayers is found to be highly dependent upon the tightness of packing of the molecules in the film, and, as the table indicates, it increases rapidly with the length of the molecule in condensed films which exhibit an orientation of the molecules perpendicular to the surface.

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Spectroscopic Observations of Reactions between Lactoflavin, the Coulter Compound, 'Cytochrome *b*', and Cytochrome *c*

FROM diphtheria toxin, one of us (M. D. E.) has prepared a solution continuing the "complex porphyrin" of Coulter[1], and also a compound characterized by an α-band located in the same position as that of cytochrome *b* (563 mμ). The preparation will be described elsewhere.

When oxidized lactoflavin was added to this solution, at 30° C. and *p*H 7·4, the 574 mμ and 563 mμ bands disappeared instantly. When lactoflavin was reduced by hydrosulphite, the 574 mμ and 563 mμ bands reappeared at once. The 574 mμ and 563 mμ compounds must therefore be in the reduced state.

Reduced cytochrome *c* was added next to this solution. A paradoxical phenomenon was observed: the 574 mμ and 563 mμ bands again disappeared, as if reduced cytochrome *c* had oxidized the reduced 574 mμ and 563 mμ substances. Cytochrome *c* was obtained from a stock solution by acetone precipitation; the stock solution had been prepared in Prof. Keilin's laboratory by Dr. F. Stare.

In a separate experiment, oxidized cytochrome *c* was added to the solution of 574 mμ and 563 mμ substances. All the bands remained unchanged, indicating that no reaction had occurred.

Lactoflavin is not necessary for the reaction between reduced cytochrome *c* and the reduced 574 mμ and 563 mμ substances. This was shown by adding reduced cytochrome *c* to the 574 mμ and 563 mμ compounds. The 574 mμ and 563 mμ bands disappeared. This reaction can be partly reversed by the immediate addition of a few drops of 5 per cent potassium ferricyanide solution. Oxidized cytochrome *c* appears, and the 574 mμ and 563 mμ bands re-appear in diminished strength. The 574 mμ and 563 mμ substances alone do not react with ferricyanide. A solution containing the 574 mμ compound alone reacted exactly like the mixture of the 574 mμ and 563 mμ compounds.

The following hypothesis summarizes the observations and interprets the paradox: when the iron atom of cytochrome *c* is in the divalent state, the 574 mμ and 563 mμ compounds can be oxidized by the porphyrin ring of cytochrome *c*; but when the iron is in the trivalent state, the porphyrin ring cannot oxidize the 574 mμ and 563 mμ substances.

These reactions between cellular catalysts are interesting in themselves. In addition, a more exhaustive investigation will bring out whether or not they are related to the Pasteur reaction.

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[1] Coulter and Stone, *J. Gen. Physiol.*, **14**, 583 (1930/31).

Oxidation of Cholesterol and Dehydroandrosterone by Means of Osmic Acid

UNSATURATED compounds are known to add, under the action of osmic acid, two hydroxyl groups at the place of their double bond[1], these groups being in *cis*-position with regard to each other. The reaction course is analogous to that produced by $KMnO_4$. However, action of the latter on cholesterol[2] yields but 4–5 per cent of *cis*-cholestan-triol. Thus $KMnO_4$ is unsuitable for the oxidation of the double bond in sterol-derived hormones, in particular in dehydroandrosterone.

After we had obtained *trans*-androstan-(17)-one-(3, 5, 6)-triol from dehydroandrosterone oxide[3] we desired to obtain also the *cis*-compound for the sake of comparing their physiological activities. The method has been worked out for cholesterol[4], then transferred to dehydroandrosterone.

Equivalent amounts of anhydrous cholesterol and osmic acid, dissolved in water-free ether, are allowed to react for 2–3 days. The ether is then distilled off and the black residue boiled with an aqueous-alcoholic solution of Na_2SO_3 for two hours. When working with cholesterol only traces of the looked-for product—cholestan-triol—are found in the water-alcohol filtrate; most of it is obtained by extracting the black residue with boiling alcohol. The *cis*-cholestan-triol obtained melted, after washing with ether, at 238·5–239·5°. Mixed with the *trans*-compound it caused depression of the melting point.

On oxidizing dehydroandrosterone with OsO_4 almost the whole of the androstanone-triol passes into the aqueous-alcoholic solution (after boiling with sulphite). Yield of the crude product: 70 per cent. Recrystallized from ethyl-acetate; transparent rectangular prisms, m.p. 243·5–244° (corr.; sinters at 242·5°). Analytical data agree with the formula $C_{19}H_{30}O_4$.

We intend applying the same method also to androstene-diol, androstene-dione and testosterone.

The present work is to be published shortly in detail.

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[1] Details in the recent paper by Criegee, R., *Ann.*, 522, 75 (1936), where the literature is cited.

[2] Windaus, A., *Ber.*, **40**, 257 (1907).

[3] Ushakov, M., and Lutenberg, A., "Dehydroandrosterone oxide", in press in *Journal Obshchei Chimii* and *Bull. Soc. Chim. de France.*

[4] Criegee (*loc. cit.*) mentions having obtained some *cis*-diols of the sterol group; he does not give any details, nor mention what sterols he worked with.

Decomposition of Benzene-Diazonium Chloride

To test the suggestion[1] that the decomposition of aromatic diazo compounds might be non-ionic in mechanism, I have been investigating the decomposition of benzene-diazonium chloride in the presence of non-aqueous solvents. When suspended in an organic liquid, benzene, diazonium chloride appears to melt at about 50° C. and then immediately a violent decomposition sets in. There is great heat evolution, and, except on the small scale, the reaction tends to become explosively violent. Often hydrogen chloride is evolved, and whenever its formation has been observed, chlorobenzene has been found amongst the reaction products.

From an examination of the decomposition in acetone, it appears possible that the chlorobenzene is produced by a secondary reaction between the decomposing benzene-diazonium chloride and the hydrogen chloride, since when an excess of chalk is added to keep the mixture neutral, the principal reaction that occurs is

$$Ph.N_2.Cl + CH_3.CO.CH_3 = N_2 + Ph.H + Cl.CH_2.CO.CH_3;$$

for both benzene and chloroacetone were isolated in good yield.

Since chloride anions do not attack acetone, it follows that the decomposition of benzene-diazonium chloride, $(Ph.N_2) + Cl^-$, is not a direct decomposition of a diazonium cation, nor yet an intramolecular process. The mechanism:

$$(Ph.N_2) + Cl^- \rightarrow Ph-N=N-Cl \rightarrow N_2 + Ph\cdot + \cdot Cl$$

diazonium salt — covalent diazo-compound — free neutral radicals

will accord with facts. When this decomposition in acetone, kept neutral with chalk, is carried out in the presence of the relatively inert metals antimony, bismuth, lead and mercury, a rapid reaction occurs at room temperature and the metal is attacked. With mercury, phenyl-mercuric chloride is produced.

These reactions with metals are undoubtedly similar to those which I have previously observed during the decomposition of benzene diazo-acetate[1], and are closely paralleled by the observations of Nesmejanov and his colleagues[2], who have obtained organometallic compounds by decomposing certain diazonium double salts with metals such as copper, tin and zinc.

To substantiate the experimental evidence reported above, the work is being extended to reaction in other organic liquids.

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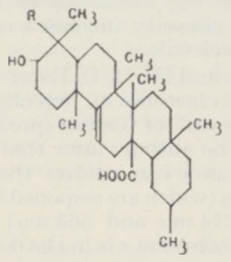
Aug. 6.

[1] Waters, *J. Chem. Soc.*, 114 (1937).
[2] *Ber.*, **62**, 1010, 1018 (1929); **68**, 1877 (1935).

Structure of β-Boswellinic Acid

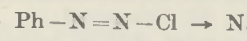
THE investigations of Ruzicka, and of Winterstein and their co-workers, have shown that the majority of the triterpene acids (hederagenin, gypsogenin, oleanolic acid, sia- and suma-resinolic acids) are in all probability θ-hydroxy-γ: δ-unsaturated mono-basic acids, as indicated in the accompanying formula[1]. On



I

the other hand, β-boswellinic acid, $C_{29}H_{46}(OH)COOH$, one of the principal triterpene constituents of frankincense, evidently possesses a somewhat different constitution, for on mild oxidation with chromic anhydride this acid is converted into a monoketone $C_{29}H_{46}O$, m.p. 196° (found: C, 84·53; H, 11·11. $C_{29}H_{46}O$ requires C, 84·80; H, 11·30 per cent), which has been characterized by the preparation of an oxime. Oxidation under similar conditions of β-boswellinic methyl ester, however, furnishes the corresponding keto-ester, m.p. 160° (found: C, 79·12; H, 10·20. $C_{31}H_{48}O_3$ requires C, 79·41; H, 10·33 per cent), which forms an oxime, m.p. 200°.

These findings necessitate the assumption that β-boswellinic acid is a β-hydroxy-acid, the expected facile elimination of carbon dioxide from the β-keto-acid first formed during the oxidation giving rise to the ketone $C_{29}H_{46}O$. The requisite grouping



—CH(OH).C.COOH may be derived from structure I by putting R = —COOH.

It is of interest to note that in gypsogenin R = —CHO, and in hederagenin R = $-CH_2OH$, and it is significant that oxidation of the primary alcoholic group of the latter compound gives a β-hydroxy-acid, the further oxidation of which is exactly analogous to that of β-boswellinic acid[2].

A full account of this investigation will be published elsewhere.

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July 26.

[1] Ruzicka, Goldberg, and Hofmann, *Helv. chim. Acta*, **20**, 325 (1937).
[2] Jacobs and Gustus, *J. Biol. Chem.*, **69**, 641 (1926).

Succession of Broods in *Lebistes*

IN connexion with the note by G. L. Purser in NATURE of July 24 on "Succession of Broods of *Lebistes*", it has long been known that several of the viviparous fish, such as *Lebistes*, are fertilized for a long time after one copulation. E. Philippi has described this phenomenon in *Glaridichthys*[1]. Johs. Schmidt found it in *Lebistes*[2]. He says that he had observed seven broods in succession. I have noted up to eight broods[3].

In my paper in 1922 I gave a photomicrograph showing the spermatozoa lying ready in the ovary for the next fertilization, with their heads as near the immature eggs as possible. Plainly enough there is competition between the spermatozoa, and it is remarkable that when a female has been fertilized by a male of one race of *Lebistes* and has produced some few broods within a few months, and then a new male of another race of *Lebistes* is put into the tank immediately after a birth, the next brood will be from fertilization by the new male. The old spermatozoa cannot compete with the fresh ones. Ordinarily a mixed brood is only obtainable when both males are together with the female at the same time.

Ö. WINGE.

Carlsberg Laboratory,
Copenhagen.
August 13.

Zoo. Jahrb., **27** (1908).
[1] *Comptes-rendus Laboratoire Carlsberg*, **14** (1920).
[2] *J. of Genetics*, **12** (1922); **18** (1927).

Homologous Loci in Wild and Cultivated American Cottons

ON cytological grounds[1], the New World cultivated cottons are thought to be allopolyploids with two genoms each of thirteen chromosomes derived from species cytologically homologous with the present Asiatic *arboreum-herbaceum* group of species and with the North American thirteen chromosome species (*aridum*, *Armourianum* and *trilobum*). Genetical confirmation of the part played by the present cultivated Asiatic cottons or their ancestors in the origin

of the New World cultivated group, was later provided by my demonstration[2] that a gene could be transferred from an Asiatic to a New World cotton by repeated back-crossing.

Genetical confirmation is now available regarding the existence in the thirteen-chromosome North American species of genes which have alleles in the cultivated cottons with $n = 26$ chromosomes. Hybrids between *G. barbadense* L. (Sea Island) and the wild species *G. aridum*, *G. Armourianum* and *G. trilobum* were found to be weakly fertile on the male side. After making two successive back-crosses of the hybrids with *barbadense* or *hirsutum*, fertility was completely restored, and the following transferences of genes from the wild to the cultivated species were effected :

1. Normal (C^r) from *aridum* to *barbadense* (c^r).
2. Normal (C^r) from *Armourianum* to *barbadense*. (c^r).
3. Normal (C^r) from *trilobum* to *barbadense* (c^r).
4. (S^E) Petal Spot from *aridum* to *barbadense* and *hirsutum*.
5. (S^{AR}) Petal Spot from *Armourianum* to *barbadense*.

The slight impairment of dominance of the crinkled heterozygotes of *aridum* and *trilobum* which persists in the second back-cross of *barbadense* crinkled, suggests that the normal alleles of these species may not be identical with the *barbadense* normal allele, but may differ in dominance potency. If they prove to differ in this way, they will resemble the weaker normal alleles at this locus established to be present in upland cotton (*G. hirsutum* L.).

The genes for petal spot of *aridum* and *Armourianum* respectively appear to be different from the petal spot genes of either *barbardense* or *hirsutum*, but their relationship with the spot genes of these species has not yet been elucidated.

To sum up : it is now established on genetical as well as cytological grounds that the New World cultivated cottons are amphidiploid in origin and that thirteen-chromosome species from both Asia and North America have played a part in their formation. My previous hypothesis[2] that the New World group originated in late Cretaceous or early Tertiary time in a former Polynesian land mass also receives further support.

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July 19.

[1] *Ann. Bot.*, **47**, 227 (1933). *J. Genet.*, **28**, 407 (1934). *Emp. Cotton Grow. Corp.*, Rept. 2nd Cong., 46 (1934). *J. Genet.*, **30**, 447. *J. Agric. Res.*, **51**, 1047.

[2] *J. Genetics*, **30**, 465.

Points from Foregoing Letters

Dr. G. W. Brindley and P. Ridley discuss the two kinds of asymmetry found in certain metals having a hexagonal structure—asymmetry of the lattice vibrations and asymmetry of the atoms. It is pointed out that in ruthenium the atomic asymmetry is of a different type from that found in zinc and cadmium.

A new equilibrium diagram for the system iron-carbon has been prepared by Dr. I. Iitaka. The author claims that it eliminates the difficulties of the 'single' diagram by assuming Fe_3C to decompose on solidifying or on separating from austenite, and overcomes those of the 'double' diagram by omitting super-cooling.

Photographs showing the scattering of lithium ions by sodium vapour and by a red-hot nickel target (at grazing angle) are submitted by A. G. Emslie, who also supplies an explanation which, he considers, establishes the wave nature of the lithium ions.

By photographing AlO blue-green and CN violet bands simultaneously in the same arc, gross intensities of both have been measured by Dr. N. R. Tawde and S. A. Trivedi by the methods of photographic spectral photometry. Vibration temperatures have been calculated and compared with the available rotation temperature data on these molecules.

Intense cooling of copper and of iron anticathodes changes the character of the X-rays which they emit. Prof. K. Prosad and A. T. Maitra find that the intensity of the copper L_a line is decreased at liquid oxygen temperature. The L-lines shift relatively to one another, and there are indications of changes in width.

Prof. M. Dole suggests a formula for calculating the surface tension of strong electrolytes which gives calculated values in satisfactory agreement with those found experimentally for potassium chloride solutions, including the observed decrease in surface tension at low concentrations. The formula is obtained by postulating a small number of surface locations where negative ions can be adsorbed from the interior of the solution with a large diminution of potential energy.

Two methods for measuring the viscosity of monomolecular films are described by Prof. W. D. Harkins and R. J. Myers : one, in which the film flows through a transverse slit in a barrier confining the film, and another method depending on the vibration of a ring the inner circumference of which is in contact with a pure surface while the outer is in contact with the film. A table giving viscosities of fatty acid films shows that the viscosity increases rapidly with the length of the molecule.

Prof. F. Urban and Dr. M. D. Eaton describe several reactions between lactoflavin, cytochrome *c* and the "complex porphyrin" of Coulter (prepared from diphtheria toxin). The authors infer that the porphyrin ring of cytochrome *c* can oxidize the compounds in Coulter's complex (which are responsible for the absorption bands at 574 mμ and 563 mμ) only when the iron atom of cytochrome *c* is in the divalent (reduced) state, and not when it is in the trivalent state.

The oxidation of the male sex hormone, dehydroandrosterone, by osmic acid to produce the *cis* form of androstanone-triol, by addition of two hydroxyl groups, is described by Prof. M. Ushakov and A. Lutenberg.

Dr. W. A. Waters finds that when benzene-diazonium chloride decomposes in acetone in presence of chalk, benzene and chloroacetone are formed, and if metals such as lead, antimony or mercury are present, these are attacked. The reactions are explained by supposing that free neutral radicals are liberated as the diazo compound decomposes.

From the products of oxidation of β-boswellinic acid (one of the principal constituents of frankincense) Dr. J. C. E. Simpson concludes that the compound is a β-hydroxy-acid.

Research Items

Antiquity of Man in Rhodesia

WITH the view of determining the disputed question of the age of the stone implements of the Zambezi gravels, first described in 1905, the Rhodesian Archæological Expedition of 1929 undertook to investigate the antiquity of man in Rhodesia as demonstrated by the implements occurring in the gravels south of the Falls, their cultural sequence and the relation, if any, of the gravels and their contents to the stages in the recession of the Falls and the excavation of the Zambezi gorge. The results of the archæological investigation have now been reported by Mr. A. Leslie Armstrong and the Rev. Neville Jones, while the necessary geological preliminary considerations are embodied in notes on the geology of the area by H. B. Maufe, director of the Geological Survey of Southern Rhodesia (*J. Roy. Anthrop. Inst.*, 66, 2). The conclusions are summarized as follows: Over the area examined south of the Falls, the Zambezi formerly flowed over the site of the existing gorge at a level comparable with that of the river to-day north of the Falls, and more than 400 ft. above its present level. The terrace gravel and the old river-bed gravel are true residual Zambezi gravels, deposited when the river flowed over the site of the present gorge. The contained implements of Lower and Middle Palæolithic type are at least as old as the gravels in which they occur. The implements belong to a definite sequence of seven cultural groups from Pre-Chellean to Bambata (Aurignacian). With the exceptions of groups (1) and (7) the cultures represented are South African equivalents of the recognized European series, occurring in the same order of succession, at least as ancient in time, and showing close parallels in type and technique thereto. The Pre-Chellean implements are the earliest recognizable traces of man's occupation of the valley, and antedate the erosion of Gorge 5, the Falls then being to the south. The successive stages in the recession of the Falls and erosion of the Gorge since Pre-Chellean times can be related to the successive stages of culture. Since Pre-Chellean times, two arid and two pluvial periods have supervened. Man in Rhodesia is of an immense antiquity, at least equal to man in Europe.

Colour Changes in Elasmobranch Fishes

THE question of the control of the colour changes that occur in the elasmobranch fishes is a vexed one, and indeed the method may not be the same in different members of the group. Light has been thrown on the subject by G. H. Parker (*Proc. Amer. Phil. Soc.*, March 1937). The animals were anæsthetized by immersion in very cold water, a method that has advantages over anæsthetizing by drugs. The dark phase is induced by a neurohumour produced by the posterior lobe of the pituitary gland. The pale phase in *Raia erinacea* is due to the absence of a dispersing factor and in *Mustelus canis* and *Squalus acanthias* in part to nervous action. The concentrating neurohumour in the last two species is in the nature of a lipohumour soluble in olive oil but not in water, and a stable substance possibly a sterol.

Feeding Mechanism of *Apseudes*

THE Crustacean *Apseudes* is of special interest to the morphologist since it links the Isopoda with the primitive Mysidacea, which are presumed to form the starting point of the Peracaridan series. Very little, however, is known of its habits and mode of life. This deficiency is in part supplied by R. Dennell in a finely illustrated memoir (*Trans. Roy. Soc. Edin.*, 59, Pt. 1, No. 2, 1937) in which the method of feeding is discussed in relation to the evolution of the feeding mechanisms in the Peracarida. The exact relations of mouth-parts, carapace and associated structures are described in greater detail than has hitherto been done, and the mode of action partly described from observations on the living animal and partly inferred from a study of anatomical relations. It is concluded that the essential features of the primitive Peracaridan filter-feeding mechanisms are represented, but that this method of obtaining food is of little importance and is in process of replacement by raptatory feeding, which is the method followed by most Isopoda. Modifications in the carapace and particularly in the organs concerned in maintaining the respiratory current are adaptations to life in a muddy habitat.

Egg-Killing Washes

IT has been shown that the ovicidal properties of tar oils to *Cheimatobia brumata* L., *Lygus pabulinus* L., *Plesiocoris rugicollis* Fall. and *Psylla mali* Schm. increase with increase in boiling range. Petroleum oils, however, although their general insecticidal properties are known to increase with boiling range, fail to inhibit the hatching of aphis and psyllid eggs, which has led to the suggestion that ovicidal action to such eggs is associated with a chemical toxicity possessed by tar oils but not, in general, by petroleum oils. Moreover, some diversity of evidence exists regarding the relative toxicity of high- and low-boiling tar oils to *Aphis pomi* De Geer. Kearns, Martin and Wilkins (*J. Pom. and Hort. Sci.*, 15, 1, 56; 1937) have investigated this discordance in an examination of the comparative ovicidal efficiencies of high- and low-boiling oils, the validity of solubility in dimethyl sulphate as a criterion of toxicity and the importance of chemical composition. A wide range of tar and petroleum oils was tested and parallel chemical analyses carried out together with determinations of boiling ranges and solubilities in dimethyl sulphate. Ovicidal efficiency showed no relation to the total content of hydrocarbon oil in the emulsions, but was highly correlated with the content of neutral oils soluble in dimethyl sulphate. The toxicity of oil from which certain oxygenated derivatives were removed by fractionation with hydroferrichloric acid was not significantly different from untreated oil, and an examination of a number of individual compounds for possible toxic properties gave no indication of any specificity of this kind. In the absence of any large differences in the ovicidal properties of high-boiling neutral oils soluble in dimethyl sulphate derived from various sources, the solubility test is regarded as an adequate practical method of assessing the toxicity of hydrocarbon oils to *A. pomi*.

Run-off after Rainstorms

A PAPER by Mr. J. R. Daymond, an abstract of which is published in the *Journal of the Institution of Civil Engineers* (No. 7, 1936–37; June 1937), discusses the estimation of run-off from areas subjected to rainstorms in connexion with a law first proposed by Mr. Emil Kuichling in a paper contributed to the American Society of Civil Engineers (*Trans. Amer. Soc. Civ. Eng.*, **20**; 1889) that ". . . in drainage areas of moderate size the heaviest discharge always occurs when the rain lasts long enough at its maximum intensity to enable all portions of the area to contribute to the flow. For large areas, on the other hand, a more elaborate analysis becomes necessary in order to find under what conditions the absolute maximum discharge will occur, . . ." As the law is often misquoted to the extent of ignoring the provisos and is thus misinterpreted, the object of Mr. Daymond's paper is to show that the reservation regarding large area is valid and important. In addition, an important general conclusion is arrived at, applicable to all areas, namely, that provided the rain falls at a constant intensity, the storm that gives the maximum run-off is one which lasts for a time less than, or equal to, the time of flow from the farthest point of the drainage area to the point of outfall from the area.

Precursors of a Volcanic Eruption

THE tilting of the flanks of the volcano Asama (Japan) in 1936 is described by R. Takahasi and T. Minakami in a recent *Bulletin* of the Earthquake Research Institute (**15**, 463–491; 1937), while the changes in depth of the crater in 1934–36 are recorded by Minakami (*ibid.*, **15**, 492–496; 1937). Tiltmeters were erected at three stations, 4 km. east, 5 km. north, and 12 km. south-west of the crater. In 1936, explosions were frequent in February–March and July–August, and, during intervals of 7–30 days before then, marked changes of tilt were recorded almost simultaneously at the three stations, the variations being about five times as large as those observed during intervals of quiescence and being clearly independent of changes in air temperature. The tilts were accompanied by remarkable uplifts of the crater floor as a whole. The depths of several points on the floor were determined by triangulation from stations on the crater rim. After a pause of inactivity in July–October 1934, the floor began to rise, the uplift being about 70 m. by the time of the violent explosions on April 20, 1935.

Surface Layers on Glass and Silica

LORD RAYLEIGH (*Proc. Roy. Soc.*, A., **160**, 514) observed that there was always some reflection from the boundary when polished glass surfaces were put in optical contact. Further investigations were made by immersing plates of glass or silica in a liquid adjusted to have the same refractive index as the bulk material. The reflection from fire-polished surfaces was found to be very low, but the reflection from surfaces which had been polished was quite appreciable, indicating the existence of a surface film of refractive index different from the bulk material. The refractive index of the film could be determined by finding a liquid mixture which gave minimum reflection. The index rises with the violence of the polishing treatment. In the case of fused quartz ($\mu = 1{\cdot}46$) the index of the surface film could be brought up to 1·6 by polishing. The modified surface film could be removed by hydrofluoric acid. It appears to be in fact a modified form of silica, probably with a depth of about 300 A. Similar but much less marked effects were observed with glasses, and a very small effect with crystalline quartz. Crystalline quartz surfaces can therefore be optically contacted without much reflection at the interface, due to the skin effect. It is shown that most of the reflection observed in this case is due to the distance between the contacted surfaces, which is found to be about seven times the crystal spacing of the silicon atoms.

Built-up Molecular Films

K. B. BLODGETT and I. LANGMUIR (*Phys. Rev.*, **51**, 964) have been able to build up films of various stearates on glass or metal surfaces by dipping the plates through a monomolecular layer of stearic acid spread on water containing salts of barium or other metals. The monolayer is kept under two-dimensional pressure. The first layer attaches itself to the surface by its carboxyl groups as the plate is raised from the water, the second layer attaches with its molecules reversed when the plate is dipped again, and so on. The layer is thus folded back on itself at each dipping. The presence of a little copper facilitates the production of thick films, and films containing 3000 layers have been built. The films are uniaxial crystals with the optic axis perpendicular to the surface. The optical properties of the film have been studied and the ordinary and extraordinary refractive indexes are 1·491 and 1·551 respectively. If a film which has been built up on a barium solution at *p*H 6·5 is treated with benzene, stearic acid is dissolved out and the resulting skeleton film has a nearly unaltered thickness but a much lower refractive index.

Double Stars and Relativity

IN a paper delivered at the Tercentenary Conference of Arts and Sciences at Harvard on September 4, 1936, Prof. T. Levi-Civita shows that the relativistic equations of motion of two bodies of comparable size can be integrated by treating relativistic effects as perturbations (*Amer. J. Maths.*, **59**, 225; 1937). Two results are obtained, which, it is hoped, may be tested by observation of double stars. The first gives a formula for the angular precession of the periastron of the satellite star. The second is more striking. It predicts that the acceleration of the centre of mass of a double star lies entirely in the plane of the relative orbit. This acceleration may be divided into a fluctuating periodic part, and the secular part, the effects of which accumulate during the successive revolutions. The secular acceleration of the centre of mass is directed along the major axis towards the periastron of the principal star. A formula is obtained for the increase of the velocity of the centre of mass during a century, which ought to be detectable eventually by spectroscopic observation. Prof. Levi-Civita has also considered the general case of n bodies (*ibid.*, **59**, 9; 1937), but in this case no definite results capable of observational test have been reached. In a discussion on this paper at Princeton (October 7, 1936), Prof. A. Einstein suggested that an extra term, corresponding to the stresses keeping a body together, was needed in the equations. Prof. Levi-Civita adopted this suggestion, but found that it did not affect the conclusions previously reached.

International Population Congress in Paris

A VERY successful Congress to discuss population problems was held in Paris on July 29–August 1 last, under the presidency of M. Adolphe Landry. The Congress was honoured by the patronage of M. Albert Lebrun, President of the Republic, who attended the opening session. Before this, on July 28, a meeting of the General Assembly of the International Population Union took place; and it may be noted that the Congress was held under the auspices of the Union, which took a definite part in the arrangements for the Congress. At the General Assembly, M. Adolphe Landry was elected president of the Union in succession to Sir Charles Close. M. Landry is a former Minister of State, whose interest in demographic matters is well known. He has written several works on the subject, particularly "La Révolution Démographique" (1934). His management of the Congress was most happy.

During the four working days of the Congress, about 170 papers were presented for reading and discussion. Abstracts of the papers were available at the opening of the Congress, but, as always happens at international meetings of this kind, individual delegates must select their lectures and must necessarily miss some contributions of importance. Some of the papers, particularly the mathematical ones, were difficult to follow at the time, but will be available for study when the proceedings are published. Perhaps the real value of these congresses consists largely in the personal contacts established between workers of different nationalities, who cease to be abstractions to each other and can use the occasion for informal discussions and exchange of views.

The Congress was divided into five sections which were simple and sufficiently comprehensive to cover the whole field. A few of the titles of the lectures will serve to give an idea of the kind of questions which were discussed, thus: "The Calculation of Death-Rates"; "Sur les possibilités de retour à l'équilibre pour une population régressive ou rétrograde"; "A Population Growth-Curve for England and Wales"; "Essai d'établissement d'un indice de densité économique de population"; "Considérations sur la politique démographique d'Auguste et ses effets"; "The Length of Life in the Early Roman Empire"; "Recent Population Movements in the Irish Free State"; "Les types de migrations"; "Die natürliche Bevölkerungsvermehrung Wiens"; "L'évolution sociale de la population italienne à travers les recensements"; "Growth of Urban Population in the United States"; "Fécondité et classe sociale en Suède"; "L'influence du chomage sur la famille"; "Die neue deutsche Bevölkerungsentwicklung"; "Rural Population and Government Policies in the United States"; "Biotypes et fécondité"; "Constitution physique de la jeunesse polonaise".

Now, this is a very mixed bag; but the various aspects of the subject are inter-linked and affect one another. It would be a mistake, for example, to discuss only the statistical side of the population question and to omit consideration of quality. In the same way, an adequate examination of present-day tendencies necessarily involves a study of what has happened in the past; and a discussion of demographic facts in one country is imperfect without reference to what is happening elsewhere.

In view of the considerable range of matter discussed and of the impossibility of being present at more than one section at a time, one can only get a limited, personal impression of the meeting, an impression to be corrected by a study of the proceedings when these are eventually published. Meanwhile, no one can have attended this Congress without having learnt something more about the intricacies of the subject than he knew on arrival. Such papers as that of Prof. Burgdörfer, for example, which dealt chiefly with the effect on the birth-rate of Germany of the new population policy in that country, have an importance for all of us. The abstract of his paper ends with the following sentence: "L'exemple de l'Allemagne prouve que, dans notre civilisation occidentale, il est possible de lutter avec succès contre la baisse du taux de natalité".

Amongst numerous other important contributions to the proceedings may be mentioned the paper by Prof. A. M. Carr-Saunders and Mr. R. S. Walshaw, on "Recent Population Movements in Ireland". The authors remark that, "There is less emigration [from Ireland] than formerly, and it is going to the United Kingdom instead of to the United States. This raises important problems for the United Kingdom, which is faced with the prospect of a declining population. The United Kingdom is still pursuing a policy of giving financial assistance to emigrants going to the Dominions. It is doubtful if this can be continued, and it is a question whether the United Kingdom will not be peopled from Ireland".

Race and Racial Doctrine

ONE section of the International Congress was devoted to matters coming under such heads as biometry, biotypology and heredity. Opportunity was thus afforded for the discussion of a variety of problems connected with the racial question, of which advantage was taken by the Management Committee of the Groupement d'Etude et d'Information "Races et Racisme", an organization which has undertaken the dissemination among the French people of information relating to the fallacies and consequences of the racial doctrines now current in Germany, and is responsible for the publication of the periodical *Races et Racisme* (see p. 458). Arrangements were made for presentation to the Congress of a number of communications dealing with questions bearing upon "race" and their formal discussion. The following account is based upon a report furnished by the organization.

Among those present were the veteran Prof. Franz Boas, who notwithstanding his advanced years had crossed the Atlantic from America for the special purpose of taking part, and Prof. Lips and Prof. Fairchild, also from the United States. A certain 'liveliness' developed in the proceedings owing to the presence of numerous representatives of Germany, among whom were Prof. Rüdin, director of the Kaiser Wilhelm Institute, Prof. Verschuer of the University of Frankfort, and Prof. Hellpach of Heidelberg.

In opposition to views put forward by German delegates on 'purity' of race and 'nordization', Prof. Boas, basing his remarks on the experience of half

a century, contended that a definition of race more in accord with realities was an urgent necessity. In even the most inbred populations there were family lines of descent which included different genetic characters, while in every family line were frequently included individuals of most diverse genetic types. There was, he maintained, no population which from the racial point of view was so uniform as to be considered either anatomically or physiologically a unity. The different groups of the white races so far resemble one another that often extremes of the same type are more diverse than the means of two different types. He stressed the influence of environment, and showed how, in the United States, attitude and gesture, which have been said to be determined by race, were modified in the American-born descendants of immigrants.

Prof. J. Brutzkus dealt with the racial bearing of his research on the blood groups of Jews, which he said pointed to a differentiation of four types: Semitic, Western European, Mixed Eastern European and Mongoloid. Further, this differentiation corresponds with the differentiation of head-form. The diversity of Jewish types is due on one side to the crossing of the Semitic type with the proselytes of the Roman Empire, and on the other with those of the Khozar. He maintained that according to the evidence of the blood group the Jews of Berlin are more purely European than the Germans themselves, while the Jews of the Crimea and the Caucasus are more purely Asiatic than the autochthonous Tartars.

The fundamental principle of racial doctrines was attacked by Dr. Zollschan of Prague, who maintained that recent research among the most remote peoples in Europe and the most primitive in other parts of the world had shown that the doctrine of the persistence and immutability of racial type was untenable. The claim to a superiority of racial type was based on the desire to dominate. In conclusion, he suggested a world-wide collaboration of scientific institutions, concentrating on the investigation of the problems of race.

This proposal was strongly condemned by Prof. J. Thurnwald of Berlin, who maintained that no man of science was capable of considering any scientific problem whatsoever without importing into his conclusions elements which were the immutable outcome of his race.

Considerable discussion was also aroused by a communication from Dr. Ritter on the racial composition of the gipsies of Central Europe, in which it was shown that their mixed racial character justified the measures of 'purification' which had been taken by the Third Reich. This contention was opposed by Dr. Brutzkus, who maintained that the "Bohemians" were the most authentic and the purest descendants of the Aryan race.

Debate became particularly lively in discussion of the report on "The Eugenics of Mental Disease", presented by Prof. Rüdin, in which the necessity was urged for the sterilization of all persons known to be affected by hereditary disease. Prof. Schneerson argued in opposition that it had been proved that certain men of genius descended from families subject to hereditary disease, while they themselves were often abnormal, quoting the cases of Dostoiewski and Nietzsche. The doctrine of mental eugenics meant the elimination of outstanding personalities and in the end the lowering of the intellectual standard of humanity. The increase in mental disease, notwithstanding the progress of medical science, was due to the increased nervous tension of modern life, and suggested a remedy in the improvement of material and social conditions. The surest eugenic measure was the instinct of love. Any other detracts from the dignity of man and deprives him of all his faculties of intellectual and moral progress. The proposals of the report were also criticized by Prof. Beck of Prague, who pointed to the contradiction inherent in the application of all racial doctrine and theories of "the blood", which while imputing insubordination to the law of the blood, maintained that a blind racial destiny imposed a determinism, which denied freedom of will to adopt such measures of eugenics as would foster the intellectual advancement of the species—the voluntaryist conception of the problem.

Among other communications may be mentioned Mme. Haiser (Amsterdam) on the effects of environment on the sounds of language, and Dr. Schreider's report on biometric investigations among the Otomi of Mexico. The proceedings of the section closed with a full session devoted to consideration of a masterly report by Mlle. Weinberg on "Differential Biometry and Biotypology in the Classification of Individuals and Groups".

The Central (Native) Medical School, Suva, Fiji

By Sir James Barrett, K.B.E.

THE major problem in the attempt by a civilized nation to develop people who, by our standards, are regarded as backward, is the control of disease and the preservation of health.

It is difficult of solution for several reasons. The native is not inclined to co-operate, as he does not understand—and finds it difficult to understand—the mode of thought and the technique of the European medical officers. The employment of many European medical officers is economically impossible, hence the training of the native himself is essential. Knowing the language, customs and mode of thought of his countrymen, he can effect changes which otherwise would be out of the question. For these reasons the Central (Native) Medical School at Suva, Fiji, furnishes a great object lesson, since it represents a sincere and successful attempt to apply the principles of Western medicine to Polynesians, Melonesians and (now) Indians in the South Pacific. Like most British institutions, the growth has been gradual and the adaptation to needs has been effected as occasion arose.

The Principal Medical Officer in Fiji in 1885—Dr. Coney—obtained the passage of an ordinance providing that any native student who had received hospital training and practice for three years and been examined in medicine and surgery might be enrolled as a native medical practitioner. There was no medical school building and the training was effected at the Colonial Hospital, Suva. In 1900 a

lecture room and a hostel for the residence of students were built, and with diagrams, models, text books and lectures a more comprehensive system was organized. At this date there were about twenty practitioners. In 1918 there were forty-eight, who did fine work in the influenza epidemic of that year, but during which eight of them lost their lives.

In 1923 the hospital was rebuilt and re-organized and called the Colonial War Memorial Hospital, and with subsequent development has become an excellent and extensive institution. Students from other Islands than the Fiji group were admitted and the School became a central school for the Western or Southern Pacific.

At this stage Dr. Montague was Chief Medical Officer, and in co-operation with Dr. Lambert—director of the Rockefeller Foundation in the South Pacific—a notable development took place. A School was built with the generous aid of the Foundation, containing lecture rooms, dissecting rooms, chemical and physiological laboratory, library and museum. Accommodation was provided for forty resident students. Quite recently the Foundation has given an excellent pathological, bacteriological and biochemical block and a post-mortem theatre. It is hoped that this laboratory will become the centre of investigation for scientific study in the South Pacific. The staff of the School consists of a whole-time tutor and fourteen honorary lecturers. The teaching in the old school was in the Fijian language. In the new school good knowledge of English is required of all students, and an entrance examination on the basis of the New Zealand proficiency examination is required. The course of study until 1931 was of three years' duration, but it was then increased to four years' and post-graduate courses came into existence.

Whilst this development has taken place, the training of native nurses was organized on a three-year basis, and in 1935 there were fifty-five nurses in the department and stationed throughout Fiji. It is hoped to make the hospital a central School for Nurses in the South Pacific by similar methods to those adopted in the Central Medical School. Such then is the mechanism of this really useful institution.

The students are divided into two groups—junior and senior. The junior course occupies 1½ years and the senior course 2½ years. The junior course covers chemistry, physics, biology, anatomy and physiology with some voluntary out-patient hospital work. The senior course includes medicine, surgery, public health and the smaller clinical subjects, including the study of diseases of children, diseases of the eye and some dentistry. The number of students in 1935 and their source is set out in the accompanying table:

	1st year	2nd year	3rd year	4th year	Post-graduates	Total
Western Samoa	3	–	–	1	–	4
Eastern Samoa	1	–	–	–	–	1
Tonga	1	–	1	2	–	4
Gilbert and Ellice Islands	1	–	1	2	1	5
Solomon Islands	1	1	1	1	–	4
New Hebrides	–	1	–	–	–	1
Nauru	1	–	–	–	–	1
Cook Islands	2	–	–	1	–	3
Fiji—Fijians	4	–	5	5	1	15
Rotumahans	–	–	2	–	–	2
Indians	1	–	1	–	–	2
	15	2	11	12	2	42

During the year there were 40 students in residence at the two dormitories. The two post-graduates in the above list are qualified native medical practitioners, and do not reside in the students' dormitories. The 12 Fijian students who reside in the smaller dormitory are required to keep their rooms and grounds in good order. The remaining 28 students who live in the large dormitory are expected to keep their own bedroom tidy and clean, but an Indian servant is provided to assist in the general management of the other rooms and the surrounding grounds. The students' dining-room is in the large dormitory, so that during the continuous rainy weather, which lasted for about six months during 1935, the Fijian students were put to great inconvenience as the two dormitories are about a quarter of a mile apart.

Recently Dr. Hoodless, the medical tutor, in answer to some questions of mine, furnished the following information:

Roughly, the 40 students at present (October, 1936) at the Central Medical School, include 19 Polynesians, 6 Melanesians, 6 mixed Polynesian and Melanesian, 7 mixed European and Polynesian and Melanesian, and 2 East Indian. The Polynesian students win most of the prizes at class and yearly examinations, but this is due to their numerical ratio, 19 out of 40 students: and also due to the fact that the mission and Government schools in the Polynesian islands are much superior to those in the Melanesian islands, so that the Polynesian students enter the Medical School with a very satisfactory preliminary education while the pure Melanesian students come here with very little elementary education. Indian students generally speaking are very good at book learning, but they do not make the same success at practical work. For steady regular work and good progress in medical knowledge, the mixed type of student, part Polynesian, is perhaps the most successful of all, but here again there are other factors at work.

Supervision of the students when they return to their own Islands is entirely in the hands of the local administrations. For Tonga, the Gilbert and Ellice Islands, and the Solomons, the native medical practitioner ordinances in each Administration can be controlled from Fiji through the Western Pacific High Commissioner, who is also Governor of Fiji. For Eastern Samoa (U.S.A.), Western Samoa (N.Z.), Cook Islands (N.Z.) and the New Hebrides (Fr. and Brit.) the position is different. The success of the native medical practitioner system in each of these Administrations depends on: (*a*) A sympathetic understanding and control from the Administration concerned. (*b*) A close personal and very sympathetic understanding from the European medical officers in any of these Administrations in regard to the *native* medical practitioners sent back from Suva to that Administration. (*c*) A continuously developing *esprit de corps* among all the qualified native medical practitioners far and wide in the South Sea Islands. This is obtained through the *N.M.P. Journal*, personal correspondence, and occasional post-graduate courses.

Pensions have been granted for retired native medical practitioners in Fiji only. The native medical service is only a few years old in the other Administrations, and the question of retirement on pension has not yet arisen, nor is it likely to arise for another fifteen years or more. It is anticipated that pensions will be granted in Tonga and in Western

Samoa, but in the other Administrations it is probable that increased salary and allowances will be given during the actual period of service and that no pensions will be granted.

The native medical practitioners receive salaries varying from £60 to £150 per annum, which apparently meet their wants adequately. They are medical officers and do not seek private practice as we understand it. Their journal, *The Native Medical Practitioner*, is an excellent publication which will interest any European practitioner.

In the *Tropical Diseases Bulletin* of November 1936 a detailed account of the working of the Central School is published by Dr. Clunie (Medical Superintendent of the Colonial War Memorial Hospital, Suva) and Dr. McGusty (late Inspecting Medical Officer, Fiji). The Islands served contain about 500,000 people, and at present there are 84 medical practitioners distributed as follows: Fiji 56, Samoa (Western) 9, Samoa (Eastern) 0, Tonga 4, Cook Island 2, Gilbert and Ellice 10, Solomon Islands 2, New Hebrides 1, total 84; native obstetric nurses, Fiji, 47.

Their conclusion is as follows: "Taken individually the Administrations participating in the Native Medical Practitioner scheme have not the means to embark on elaborate enterprises to provide adequate medical services, but by a pooling of their resources, as is now the case at the Central Medical School, it is felt that they will be able to elaborate a common form of health organization that will bestow further benefits on the native peoples. In Fiji the system has proved successful after a long and searching trial, and if it is too early yet to claim the same success with regard to its more recent ramifications into the other Pacific Administrations, the similarity of conditions and the favourable reports that are coming to hand appear to provide full justification for the confidence which those of us who are in the closest touch feel with regard to the future of the Native Medical Practitioner in the Pacific. As the system becomes more permanently established everywhere it will suffer progressively less from the effects of destructive criticism, but there will always remain the danger that some over-enthusiastic supporters may lose sight of the fundamental cause of its success and in a misguided attempt to raise the status of the Native Medical Practitioner may defeat the purpose for which the school was created, namely to make a health service available to these native peoples at a low cost and in the form that is most easily assimilable by their society."

The School is administered economically, the average cost per student being about £75 per annum; that is, total cost about £3,000 per annum. Amongst the many tributes to the efficiency of the School place must be given to the observation of Prof. Buckmaster and Dr. Wright made after a visit to the School when returning to England in 1931 from Australasia. Their comment was as follows: "The Hospital and Medical School at Suva for Natives of Fiji, Samoa and Other Islands is really a wonderful place to find in the South Pacific. We not only saw all over the Hospital, but conducted a short class in anatomy and physiology in the School and both thought the students equal to what we might have expected to find in an ordinary Medical School in London. Indeed we were both astonished at the information they had acquired. I ask how many Englishmen know anything about this remarkable Hospital in Fiji?"

In conclusion I have one caution to emphasize. If enthusiastic people try to extend the course and to increase the expense, much damage may be done in seeking something economically impossible. There is, I am glad to say, no evidence at present of any such intention. Depopulation has ceased in Fiji and with prudent administration the Central School may prevent depopulation in the other Islands. I am very grateful to Dr. A. H. B. Pearce, Principal Medical Officer, Fiji, and his staff for the information furnished on several visits, for the personal contact obtained with these fine young men and for many reports.

The Radio Exhibition at Olympia

THE annual radio exhibition at Olympia, which this year was held on August 25–September 4, is generally a partial disappointment to those interested in the scientific and technical aspects of broadcasting, as it is usually quite difficult to ascertain what technical progress and improvements are being displayed. The exhibition is largely an elaborate display of the external cabinets, although most firms nowadays provide simple means for inspecting the internal construction and layout of the receiver itself. This year there was abundant evidence to show that most manufacturers have realized that the modern broadcast receiver has to take its place as an article of domestic furniture, and as such it must not be made especially conspicuous by its curious shape and appearance. Another notable advance in what may be termed the external features of the receiver is constituted by the enlargement of the tuning scale and its ease of operation. There is, however, still room for greater uniformity in the location of the control knobs among receivers of different makes.

In order to appreciate the improvements made in the internal portion of broadcast receivers, the visitor to the exhibition was fortunate in having as a guide the detailed reports given by such technical journals as the *Wireless World*, which has published three special show numbers on this occasion. A general survey of this year's exhibits of the various manufacturers indicates that many fundamental features of the broadcast receiver have become sufficiently stabilized for the designer to concentrate upon the steady improvement of detail. The great majority of receivers now manufactured are of the supersonic heterodyne type, since this provides both the sensitivity and the selectivity required by modern broadcasting conditions. The selectivity has now generally been made adequate by the incorporation of a properly tuned amplifying stage operating at the incoming signal frequency. A noteworthy advance this year is the incorporation of a correctly designed short-wave range as a standard feature; and the division of the short-wave broadcasting band into

two ranges is a factor which adds considerably to the ease of operation of the receivers so fitted. Those familiar with difficulties of tuning in short-wave stations will also appreciate the improvements in the mechanical portion of the slow-motion drive to the tuning condensers, as well as the large easily read scale which is generally provided nowadays. Several of the receivers shown at the exhibition were provided with a wave-length range in the ultra-short wave band, so that they may be used for the reception of the sound portion of the television programmes.

This year's exhibition was not so conspicuous as some of the previous ones for radical modifications in the types of valves incorporated in receivers, but two points here are worthy of note. The development of the tetrode output valve has caused the rating of most mains-operated receivers to be raised from the previous value of 2–3 watts to 5 watts or above. Secondly, one manufacturer of an all-wave supersonic-heterodyne receiver is experimenting with the use of the Harries all-stage valve. In this receiver all six valves are of the same seven-electrode type, the valves being adapted for their functions in the various stages by suitable external connexion to the electrodes. It will be interesting to observe the results of this innovation, since the advantages of using the same type of valve in any position in a receiver are self-evident.

In the case of battery-operated sets, the main problem all the time is to obtain sufficient output of good quality without overloading the normal high-tension battery, the size of which has now become fairly well standardized. Although the output from such receivers seldom exceeds half a watt nowadays, considerable improvement in acoustic sensitivity has been attained by the use of improved magnetic alloys for the small permanent magnet loud-speakers generally employed in such sets. There is ample evidence that the portable wireless receiver has still a wide field of service, and the attractions of several of this year's models are enhanced by the inclusion of a properly designed short-wave range.

Probably the most interesting feature of Radiolympia this year, from a technical point of view, was the fact that more than a dozen manufacturers showed fully developed television receivers suitable for the programmes now regularly provided from the London station. Direct reception of these programmes was carried out at the exhibition, and facilities were provided for each firm to give demonstrations to the public under comfortable viewing conditions. So far, little uniformity is noticeable in the design of the television receivers produced by the different manufacturers, although they naturally all employ the cathode ray tube for the reproduction of the picture image. There is a tendency to favour the use of the supersonic heterodyne receiver, although in a number of sets the amplification is carried out at the ultra-high frequency employed for the television service. There is as yet no uniformity in the methods employed for the control of the electron beam in the cathode ray tube, as both magnetic and electric methods are employed for focusing and deflection. One of the most interesting television receivers exhibited employs a tube of only 4 inches diameter; the image produced on the fluorescent screen of this tube is projected on to an etched glass screen giving a picture of size 20 in. × 16 in. The more normal method, however, is to produce the final picture on the screen of the cathode ray tube and to view this either directly or through an inclined mirror. The normal size of picture for receivers priced at 60 guineas upwards is about 10 in. × 8 in.; but some cheaper receivers are now available giving a picture size of about 7½ in. × 6 in. With the view of obtaining the utmost economy in the production of a television receiver, one type shown provides the circuits for the vision signal only, a normal broadcast receiver being required in addition to reproduce the sound accompaniment. In this way, a receiver giving a picture about 6 in. × 4½ in. in size can be obtained for about £35. This is a development likely to be worth exploring in the attempt to produce a television receiver at a price sufficiently low to appeal to a large number of listeners who already possess a normal broadcasting receiver.

In concluding this review of the exhibition organized by the Radio Manufacturers Association, mention must be made of the interesting museum provided to illustrate the evolution of the modern broadcasting receiver, and of the extension to the television field of the interesting demonstrations provided by the Post Office to illustrate the deleterious effect of various classes of electrical interference on the conditions of broadcast reception. Finally, it must not be forgotten that one of the most popular attractions of Radiolympia is the provision by the British Broadcasting Corporation of daily variety concerts in a specially constructed hall, which this year contained accommodation for an audience of more than 5,000.

R. L. S.-R.

Isotopes of Strontium

WORK on the isotopes of strontium has recently been reported by Mattauch, and by Hahn and co-workers. Mattauch (*Naturwiss.*, 25, 170; 1937) has determined the packing fractions of the isotopes ^{86}Sr and ^{87}Sr by the doublet method, using $^{29}SiF_3$ and $^{30}SiF_3$, respectively, for comparison. Using the data of other workers for the masses of ^{29}Si and ^{30}Si, the packing fraction of ^{87}Sr is found to be $-8{\cdot}7 \pm 0{\cdot}3$, and its mass $86{\cdot}924_3 \pm 0{\cdot}004$. The packing fraction of ^{86}Sr is $-9{\cdot}0 \pm 0{\cdot}5$, and its mass $85{\cdot}922_6 \pm 0{\cdot}004$.

The radioactive transformation of rubidium into the strontium isotope of mass 87 has been investigated by Hahn, Strassmann and Walling (*Naturwiss.*, 25, 189; 1937), who examined the strontium occurring in a mica from Silver-leaf mine, Manitoba. The mica was comparatively rich in rubidium (containing 2–3 per cent of it), but contained only a very minute amount (a few hundredths of a per cent) of alkali earth metals. Careful treatment of the mineral resulted in the isolation of 250 mgm. of strontium carbonate. If rubidium breaks down by radioactive disintegration to give strontium, it would be expected that the product of disintegration would be present in the mineral in comparatively small amount. As alkali earth metals were actually almost entirely absent, it is very likely that the small quantity of strontium present was derived from this disintegration. The geological age of the mica is estimated at

500–1,000 million years, whilst the half-life period of rubidium is between 2×10^{11} and 4×10^{11} years.

An investigation of the isotopic constitution of the strontium from the mineral throws much light on its origin. This has been carried out by Mattauch (*Naturwiss.*, 25, 189; 1937), who finds the strontium to contain 99·97 per cent of the isotope of strontium of mass 87. It is therefore very probable that the β-radioactive disintegration of ^{87}Rb results in the formation of ^{87}Sr. This is in agreement with the rule that stable isobares of neighbouring elements do not exist. A rough estimate of the quantity of strontium produced during the life of the mica shows that the half-life period of radioactive rubidium is more nearly 2×10^{11} years than the upper limit mentioned above.

University Events

CAPE TOWN.—Prof. A. W. Falconer has been appointed to succeed Sir Carruthers Beattie as principal and vice-chancellor of the University. Sir Carruthers Beattie will retire at the end of the year. Prof. Falconer is at present professor of medicine in the University.

CAMBRIDGE.—T. R. C. Fox, of Jesus College, and J. Diamond, of St. John's College, have been appointed demonstrators in engineering.

Dr. R. A. Lyttleton and M. H. L. Price have been appointed Faculty assistant lecturers in mathematics.

J. Hart-Mercer has been elected to the Gwynaeth Pretty studentship and to the Nita King scholarship.

At St. John's College, a Strathcona exhibition for physics has been awarded to R. E. B. Makinson, University of Sydney, and a Hutchinson studentship for zoology to J. H. Sang, University of Aberdeen.

Science News a Century Ago

J. D. Forbes among the Dolomites

IN the course of his Continental tour of 1837, J. D. Forbes after leaving southern Germany explored the Tyrol and early in September entered the then little-known 'Dolomite' country, proceeding in the direction of the peak of Marmolata. In his journal, under the date September 14, he said: "This morning, whilst warming myself dreamily during the rain at the kitchen fire at Cavalese, I got an excellent geological lesson from the boiling of certain thin porridge made of Indian corn (polenta) and milk. The air-bubbles disengaged during the process formed the most beautiful elevation craters, often with little interior ones, formed by the immediate sequence of another bubble at the same point. . . . I walked from Cavalese to Vigo, in order to understand fully Von Buch's section of the adjacent beds of rock, and in this I succeeded beyond my expectations. But the strata of limestone and sandstone do not all dip towards the axis, as he has represented, but some from it, and with evident disturbance. I went in search of minerals to a dealer's, but only found some very indifferent specimens.

"The scenery from Vigo to Campedello, and from that to Canazea, is in the highest degree striking—in fact, I know nothing of its kind to compare with it: one is entirely surrounded by jagged peaks of dolomite. The amazing crags of the Lang Kofel come into view near Campedello, and afterwards the magnificent outworks of the Marmolata and Sasso di Val Fredda are seen in all their majestic beauty. As I wished to examine the Lang Kofel more minutely, as well as Von Buch's sections between Grödon and Colfusco in the Abteier-Thal, I availed myself of a tolerable horse track which wound through the forest, and after passing close under the precipices of the Lang Kofel, entered the Grödener-Thal. . . ."

Prof. William Ritchie, F.R.S.

ON September 15, 1837, William Ritchie, the professor of natural philosophy at the Royal Institution and also in University College, London, died at the age of forty-seven years. Born in Scotland in 1790, he was educated for the ministry and became Rector of the Royal Academy of Tain, Ross-shire. Having saved money he went to Paris, where he attended the lectures of Thénard, Gay-Lussac and Biot and on his return to England became known to Sir John Herschel. Papers he contributed to the Royal Society on a differential thermometer and radiant heat brought him into notice, and in 1829 he was given the professorship at the Royal Institution and in 1832 that at University College. He published papers in the *Philosophical Magazine* and other periodicals and made researches in electricity and electric magnetism. He was also known as a skilful experimentalist, and at one time was engaged on experiments connected with the manufacture of glass for optical purposes.

Animal Magnetism

THE *Gentleman's Magazine* of September 1837 gives the following information: "At the North London Hospital, M. Duportet, the French professor of animal magnetism, lately performed some experiments before a party. He commenced his operations on a young girl, about 17 years old, an inmate of the hospital, who has been ill for some time, but who is at present almost convalescent. She was seated in a chair in the middle of one of the wards, and M. Duportet seated opposite to her commenced the operation of magnetizing, which is done by waving the hand up and down in a perpendicular line before the face and body, as closely as possible without almost actual contact. After these motions of the hand had been continued for some minutes without effect, the professor, nothing disconcerted, left off, and another patient was introduced, who, we understood, had been operated upon more than once, deriving, it is stated, some benefit in her health. She was a young woman named Lucy Clarke, who having for some time past been subject to epileptic fits, had been induced to come to the hospital from Tottenham, where she resided, that the experiment might be made upon her. As soon as she was seated Prof. Duportet commenced the wafting of his hands, and in a few seconds an appearance of extreme drowsiness became evident to all who stood around his chair, and she frequently rubbed her eyes as children do when sleepy. She at length ceased to have the power of opening her eyes. The magnetizer, however, who had placed her under the spell, had the power also of restoring her to a state of wakefulness. This he did by placing his fingers on the centre of the forehead and drawing them asunder towards the temples, and afterwards waving the hand to and fro before her face."

Cholera in Europe

AN editorial in the *Lancet* of September 23, 1837, gives the following account of a pandemic of cholera at that time: "The cholera—that terrible epidemic, which after having exercised its ravages in all parts of the old and new world, seemed on the point of returning to the country which gave it birth, has again appeared raging with unabated violence not only in many of the southern States of Europe, but in some of the northern kingdoms, already more than once visited by the pestilence. Our readers are doubtless aware that the Asiatic cholera has been stalking along the Mediterranean shores of Europe for the last two or three years, and that, at the time we write, it has reached the capital of the Papal dominions. The progress of the disease through countries, the inhabitants of which are forcibly kept by their rulers in a state of ignorance, has been almost universally accompanied by disorder of the most serious nature.

"At Palermo the Governor has fallen a victim to the fury of a terrified and excited populace; and at Rome, if we are to believe the reports which have just reached us, the medical men are everywhere compelled to conceal themselves in order to avoid sharing the fate of several of their brethren, who are massacred during the period of excitement and consternation, which are produced at the onset of the malady. Marseille also has been attacked, for the third time, by the epidemic, which during several days carried off nearly 100 persons daily, and we are sorry to announce that the disease is spreading rapidly throughout the department of which that city forms the capital".

Societies and Academies

Paris

Academy of Sciences, July 5 (*C.R.*, 205, 1–96).

WOLFGANG DŒBLIN: The elements of a general theory of the simple constant chains of Markoff.

KENTARO YANO: Totally geodesic non-holonome spaces.

MARCEL BRELOT: The best harmonic majorant of a sub-harmonic function.

RAPHAËL SALEM: A method of summation nearly always valid for Fourier's series of continuous functions.

NATAN ARONSZAJN: A theorem of the theory of analytical functions of several complex variables.

JEAN LERAY and LOUIS ROBIN: Complement to the study of the movement of an unlimited viscous liquid.

PIERRE VERNOTTE: Navier's equations and the dissipation function, in a hydraulic system. The thermal phenomena produced in the fluid by a rapid movement.

MAX TEISSIE SOLIER, LUIS CASTAGNETTO and MARCEL SABATHE: The beats which accompany the formation of the alternate vortices of Bénard Karmann.

ANDRÉ LICHNEROWICZ: Extension of the Gauss-Whittaker theorem.

FRITZ LONDON: The quantum theory of the diamagnetism of aromatic compounds.

TH. DE DONDER and J. GÉHÉNIAU: The electronic model of Dirac's wave mechanics.

JEAN JAFFRAY: Observation of the stratified Geissler discharge in different gases at atmospheric pressure. Under certain conditions, described in detail, stratification can be seen and photographed in Geissler tubes containing various gases at nearly atmospheric pressure.

FRANTZ PERRIER: The action of an electric field on an electrified insulator placed in air: the ionization of the latter.

ALEXANDRE DAUVILLIER: A universal counter. A modification of the Geiger-Müller counter, utilizing Richter and Geffcken relays with Neher and Harper mounting. The working voltage can be reduced to 300 volts, and the arrangement is suitable for measuring the intensity of the cosmic rays with captive balloons.

GEORGES AHIER: Christiansen filters. These filters are cells containing a transparent powder mixed with a liquid of the same refractive index. Study of the results obtained by varying the solid (flint and crown glass, fused silica, fluorspar) and the liquid.

CASIMIR JAUSSERAN, LÉON GRILLET and MICHEL DUFFIEUX: The fine structure of the 5998·9 band of nitric oxide.

BERTRAND GOLDSCHMIDT: Study of the fractionation coefficients of salts possessing several hydrates. Study of the crystallization of barium acetate, with actinium X as indicator, and of strontium nitrate in presence of a trace of lead nitrate, with thorium B as indicator.

JEAN PERREU: The equation of solubility of a pure substance forming a solid compound with the solvent. Control of a differential equation obtained theoretically by an experimental study of the system sodium iodide and acetone.

MARTIAL FÉLIX TABOURY and MARCEL BELLOT: The action of light on the Liesegang phenomenon.

HALDUN N. TEREM: The oxidation of beryllium bronzes.

EUGÈNE CATTELAIN and PIERRE CHABRIER: Contribution to the separation of the phosphoric ion and its estimation by a volumetric method.

JEAN BARON and PAUL LAFFITTE: The inflammation of acetaldehyde. Determinations of the temperatures of spontaneous inflammation of various ternary mixtures of acetaldehyde and oxygen with nitrogen, argon or carbon dioxide as diluent.

MARC TIFFENEAU, PAUL WEILL and BIANCA TCHOUBAR: The isomerization of cyclohexane methylene oxide into hexahydrobenzaldehyde, and the conversion of the corresponding amino-alcohol into cycloheptanone.

MARCEL SOMMELET: A particular mode of intramolecular rearrangement. Study of the decomposition by heat of $(C_6H_5)_2CH\text{-}N(CH_3)_3OH$.

WERNER LIPSCHITZ and ERNST BÜDING: The *d*- and *l*-borneolglucosides.

PANOS GRAMMATICAKIS: Some modes of hydrolysis of the substituted N-benzaldoximes.

JEAN KANDEL: The hydrocarbons, halogen derivatives, ethers and esters corresponding to tetrahydroionol.

JOSEPH HOCH: Contribution to the study of substances with female hormone properties. The synthesis of 2-oxo-6,7,8,9-tetrahydro-4,5-benzoacenaphthene.

ANDRÉ GUILLEMONAT: The oxidation by selenious oxide of cyclohexene and of the 3 and 4 nonenes.

RAYMOND HOCART: The structural scheme of proustite and pyrargyrite.

ANDRÉ VATAN: The comparative mineralogy of the sandy sediments of the Paris basin.

J. GOURC and FRANCK BOURDIER: Pollen analysis and stratigraphical position of the Quaternary lignites of the Chambéry region.

THÉODORE MONOD: The geological constitution of the Mauritanian Adrar.

ALEXANDRE GUILLERD and PIERRE ETRILLARD: The persistance of fluorescin in the soil. The influence of ferruginous formations.

NICOLAS STOYKO: The periodicity in the irregularity of the rotation of the earth.

ARTHUR BRUNEL and ROBERT ECHEVIN: The evolution of nitrogen, appearance of allantoinase and of urease in the germination of rust (*Agrostemma Githago*).

JOSEPH LEFÈVRE: The reversal of polarity produced in cuttings of *Salix*.

A. GUIEYSSE-PELLISSIER: The presence of striated muscular fibre in the pulmonary arteries of the rat and the mouse.

MAURICE VILLARET, HENRI BÉNARD, LOUIS JUSTIN BESANÇON and MLLE ANDRÉE ABADI: The mathematical study of the kinetics of hæmolysis (kinelysis).

LÉON KÉPINOV: The antiglycogenolytic action of insulin.

RENÉ SALGUES: Nutrient leucocytosis in reptiles in bad conditions of captivity.

JEAN LOISELEUR: The adsorption of polypeptides by proteins. The behaviour of a solution of peptone.

Forthcoming Event

FARADAY SOCIETY, September 13–15.—General discussion on "Reaction Kinetics" to be held in the University of Manchester.

Appointments Vacant

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

ASSISTANT LECTURER AND A DEMONSTRATOR IN ELECTRICAL ENGINEERING in the Imperial College of Science and Technology (City and Guilds College), Prince Consort Road, S.W.7—Secretary (September 13).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING in the Manchester Municipal College of Technology—The Registrar (September 20).

LECTURER IN PHYSICAL CHEMISTRY (Grade II) in the University of Bristol—Secretary and Registrar (September 24).

SOIL CHEMIST for the Rubber Research Scheme, Agalawatta, Ceylon—The Chairman (November 15).

INSPECTORS OF MINES in the Colonial Mines Service—The Director of Recruitment (Colonial Service), 2 Richmond Terrace, Whitehall, S.W.1.

Official Publications Received

Great Britain and Ireland

Forestry Commission. Special Leaflet No. 1: Pit-Props. Pp. 8. (London: Forestry Commission.) [178

Iron and Steel Institute. Special Report No. 18: Reports upon Blast-Furnace Field Tests. 1: An Investigation of a Blast-Furnace smelting principally Lincolnshire Ores at the Frodingham Works of the Appleby-Frodingham Steel Co. Ltd. Pp. v+98. 10*s*. Special Report No. 19: Foamed Blast-Furnace Slag. By Dr. T. W. Parker. Pp. v+32. 5*s*. (London: Iron and Steel Institute.) [208

Forestry Commission. Bulletin No. 14: Forestry Practice; a Summary of Methods of Establishing Forest Nurseries and Plantations with Advice on other Forestry Questions for Owners and Agents. Revised edition. Pp. 99. (London: H.M. Stationery Office.) 1*s*. 6*d*. net. [238

The Journal of the Institute of Metals. Vol. 60. Edited by G. Shaw Scott. Pp. 456+59 plates. (London: Institute of Metals.) [238

Air Ministry: Meteorological Office. Southport Auxiliary Observatory (the Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1936. By Alfred Goodwill. Pp. 32. (Southport: Fernley Observatory; London: Air Ministry.) [238

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1760 (2458 and 2459): Progress of Experiments in Aero-Engine Exhaust Silencing. By A. W. Morley. Pp. 18. 2*s*. 6*d*. net. No. 1761 (2362): The Stress in Certain Tubes of Rectangular Cross Section under Torque. By D. Williams. Pp. 34. 4*s*. 6*d*. net. No. 1766 (2607): Experiments on a Sphere at Critical Reynolds Numbers. By A. Fage. Pp. 20. 3*s*. net. No. 1771 (2722): Tests of Four Airscrew Sections in the Compressed Air Tunnel. By D. H. Williams, A. F. Brown and E. Smyth. Pp. 20. 3*s*. net. No. 1774 (2675): Aerodynamic Characteristics of Tapered Wings with Flaps and Slots. By Dr. S. H. Hollingdale. Pp. 43. 6*s*. net. No. 1779 (2693): Experiments on the Use of a Static Tube in the Wing Wake and a Short Pitot Tube in the Leading Edge as an Airspeed Indicator. By the Aerodynamics Staff, R.A.E. Pp. 6. 1*s*. net. (London: H.M. Stationery Office.) [258

Other Countries

Government Museum, Trivandrum. Administration Report for the Year 1111 M.E. Pp. 8. A concise Guide for Visitors. Pp. 8. (Trivandrum: Government Museum.) [188

U.S. Treasury Department: Coast Guard. Bulletin No. 19: The Marion and General Green Expeditions to Davis Strait and Labrador Sea under direction of the United States Coast Guard 1928–1931–1933–1934–1935. Scientific Results, Part 2: Physical Oceanography. Pp. vi+259. (Washington, D.C.: Government Printing Office.) 75 cents. [188

Report of the Kodaikanal Observatory for the Year 1936. Pp. 4. (Delhi: Manager of Publications.) 3 annas; 4*d*. [198

Madras Fisheries Department. Administration Report for the Year 1935–36. By Dr. B. Sundara Raj. Pp. iii+68+3. (Madras: Government Press.) 8 annas. [198

Meteorological Office. Note No. 17: Climatic Notes—New Zealand Districts. By Dr. E. Kidson. Pp. 32. (Wellington: Government Printer.) [238

Statens Meteorologisk-Hydrografiska Anstalt. Tillgör Årsbok 18, 1936. Årsberättelse för 1936. Pp. 19. Årsbok 18, 1936. 1. Månadsöversikt över väderlek och vattentillgång. Pp. 76. 2.50 kr. (11*s*.) Nederbörden i Sverige. Pp. 15. 2.50 kr. (Stockholm: Staten Meteorologisk-Hydeografiska Anstalt.) [238

Anales del Museo Argentino de Ciencias naturales. Antropologia, Etnologia y Arquelogia, Publicación No. 78: Fueguidos y Láguidos, posición actual de la raza Paleo-americana o de Lagoa Santa. Por J. Imbelloni. Pp. 79–104. Publicación No. 79: Deformación del cráneo en la región de los Atacamenos y Diaguitas. Por el Prof. Ricardo E. Latcham. Pp. 105–124. (Buenos Aires: Museo Argentino de Ciencias naturales.) [238

Report of the Botanical Survey of India for 1935–36. Pp. 11. (Calcutta: Government of India Press.) [238

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 105: Investigations on the Associated Growth of Herbage Plants. By H. C. Trumble, T. H. Strong and R. E. Shapter. Pp. 40+10 plates. Bulletin No. 106: Investigations on "Spotted Wilt" of Tomatoes. 3: Infection in Field Plots. By Dr. J. G. Bald. Pp. 32. (Melbourne: Government Printer.) [238

U.S. Department of the Interior: Office of Education. Bulletin, 1937, No. 2: Trends in Secondary Education. Pp. vi+44. 10 cents. Pamphlet No. 71: An Annotated Bibliography on the Education and Psychology of Exceptional Children. Prepared by Elise H. Martens and Florence E. Reynolds. Pp. iii+42. 10 cents. (Washington, D.C.: Government Printing Office.) [238

Classified List of Smithsonian Publications available for Distribution, August 10, 1937. (Publication 3394.) Pp. vi+35. (Washington, D.C.: Smithsonian Institution.) [238

Smithsonian Miscellaneous Collections. Vol. 96, No. 1: Archeology of St. Lawrence Island, Alaska. By Henry B. Collins, Jr. (Publication 3411). Pp. xi+431+84 plates. (Washington, D.C.: Smithsonian Institution.) [238

Proceedings of the United States National Museum. Vol. 84, No. 3017: Revision of the North American Species of Ichneumon-Flies of the Genus Exetastes Gravenhorst. By R. A. Cushman. Pp. 243–312+plates 16–21. Vol. 84, No. 3018: A Revision of the Clapper Rails (*Rallus longirostris* Boddaert). By Harry C. Oberholser. Pp. 313–354. Vol. 84, No. 3019: Moths of the Genus Rupela (Pyralididæ: Schoenobiinæ). By Carl Heinrich. Pp. 355–388+plates 22–33. (Washington, D.C.: Government Printing Office.) [238

Nyasaland Protectorate. Annual Report of the Forestry Department for the Year ended 31st December 1936. Pp. 18. (Zomba: Government Printer.) [238

Publikationer fra det Danske Meteorologiska Institut. Communications magnétiques, etc., No. 18: Contribution à la connaissance de l'effet magnétique de l'électrification des chemins de fer. Par Dr. Edm. Hoge. Pp. 11. (København: G. E. C. Gad.) [238

Mauritius Institute Bulletin. Vol. 1, Part 2: Revised Catalogue of the Testaceous Mollusca of Mauritius and its Dependencies. By R. Viader. Pp. xiii+111. (Port Louis: Government Printer.) [238

Bernice P. Bishop Museum. Bulletin 143: Revision of the Polynesian Species of Peperomia. By T. G. Yuncker. Pp. 73. Bulletin 144: Polynesian Botanical Bibliography, 1773–1935. By E. D. Merrill. Pp. 194. Bulletin 145: Ethnology of Uvea (Wallis Island). By Edwin G. Burrows. Pp. 176+8 plates. Bulletin 147: The Genus Gouldia (Rubiaceæ). By F. Raymond Fosberg. Pp. 82+3 plates. Bulletin 149: Report of the Director for 1936. By Peter H. Buck (Te Rangi Hiroa). Pp. 33. (Honolulu: Bernice P. Bishop Museum.) [248

Nutrition. Final Report of the Mixed Committee of the League of Nations on the Relation of Nutrition to Health, Agricultural and Economic Policy. (Official No.: A.13.1937.II.A.) Pp. 327. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 7*s*. 6*d*. [248

Proceedings of the California Academy of Science, Fourth Series. Vol. 23, No. 9: Mammals of Death Valley. By Joseph Grinnell. Pp. 115–169. (San Francisco: California Academy of Sciences.) [248