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CONTENTS.

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Forestry Research in Great Britain.

IN days gone by, research work in connexion with forestry was regarded by the average forest officer, whether administrative or executive in grade, as of little practical value; only by the few was the idea even held that such work might have an academic value. That this was the accepted point of view throughout the greater part of last century can be readily ascertained by studying the work of the various forestry departments in European countries. Outside Europe, India and Japan may be instanced as examples where the same ideas prevailed amongst senior forest officers.

The dawn of the twentieth century witnessed the beginnings of a change of opinion in some of the more efficiently managed forest departments in Europe. The awakening came slowly, and cannot be attributed to any one set of factors. Greater demands for timber and other forest products, more intensive working of the forests, the larger areas of artificially formed forests, and the introduction and increase in areas of plantations of exotics, especially coniferous species—all of these may be said to have aroused interest in, and shown the necessity for, research work. The recognition resulted in the establishment of research centres or departments in several European countries, either in connexion with universities where forestry schools were in existence or in strengthening the pure science branches of the existing forest schools.

It was, however, one of the outcomes of the War which may be said to have given the greatest impetus to forest research work in Europe, as was the case in India, though the chief causes in the two instances were to some extent dissimilar. The greatly increased costs in connexion with forest work of all kinds necessitated a reduction, or elimination, where possible, of all waste. According to locality factors, climate, species dealt with, and so forth, a set of problems were presented to the forest administration which demanded a solution, the underlying financial idea being the production of forest crops yielding a larger volume of material on a smaller area or in a shorter space of time than had been the case in the past, or on poor quality land not under forests.

These types of problems have a varying importance for the research officer, depending upon the nature of the forest in question, whether indigenous or not. The matter becomes of the first importance, however, when (1) exotics, especially conifers in Europe, are being employed on a large scale to reafforest areas formerly occupied by indigenous

forest; (2) where bare lands, which have been for long unforested, and may or may not have carried forest before, are being planted on a wholesale scale, whether with indigenous or exotic species—the latter usually with the expressed or implied wish or hope that a larger volume of material will be produced per unit of area in a shorter space of time than is the case with an indigenous species.

The officers responsible for the introduction of the policy implied under (1) and (2) are the administrative forest officers, the executive officers carrying it out. Until comparatively recently, the research officer, if he existed, has had no voice in formulating an afforestation or reafforestation policy; nor was he often consulted with reference to the species to be made use of in afforesting bare lands, or in the choice between indigenous or exotic species. The part of the research officer came into play when disease had made its appearance in the plantations formed under a preordained policy.

Of late this position has been reversed in some of the countries of Europe. Sweden may be quoted as an illustration, since it is common knowledge that the Swedish forests play a most important part in the economy of the nation, forest produce taking a high place in that country's export trade. Apart from the ordinary work in regenerating the areas annually felled, Sweden has undertaken an extensive afforestation campaign on barren lands, of which large areas are of a varying type of peat. As Dr. Rayner has shown in her letter in NATURE of April 4, a close collaboration exists in Sweden between the pure science workers and forestry specialists at the research centres and the Swedish Forest Service. To quote Dr. Rayner's example: "the significance", she points out "of mycorrhiza in nutrition, and the urgent need for laboratory research directed to promote control of its formation in new plantations, have long been matters of concern in the Swedish Forestry Service, and are becoming so in those of other countries, for example, in certain of the North American States. . . . In Great Britain and many parts of the Empire the matter is one of special interest and concern in view of the extensive afforestation of non-woodland soils and the use of exotic tree species."

That research work would be necessary in connexion with an afforestation programme in Great Britain was realised by the framers of the 1919 Forestry Act, for under the powers given to the Forestry Commissioners was a clause "to conduct and assist research". In the interests of true research work (apart from its purely forestry aspects) it might have been better had the words 'to conduct' been omitted from the above clause; and so have left research without the fetters of Government control: more especially in the case of a new department with all to learn.

In their Annual Report for the year ending Sept. 30, 1925, in connexion with research and experiments, the Commissioners wrote: "The work embraces the establishment and periodic measurement of permanent sample plots of growing timber, from which valuable data on the rate of growth and methods of thinning are being obtained; extensive nursery and plantation experiments directed towards the improvement of afforestation technique; entomological and mycological work on the protection of nursery stock and trees from insects and fungi; as well as botanical, physiological, and chemical work on subjects such as the establishment of trees in peaty soils". This work, it was said, was carried out by the Commission's experiment officers, "while allied laboratory work is conducted at the educational institutions which are in receipt of grants from the Commissioners".

It may be at once admitted that some valuable work of a purely professional nature—the maintenance of sample plots; the preparation of yield tables for several species; investigations into the importance of the origin of seed; preliminary work on the treatment of peaty soils; the issue of leaflets on certain common diseases, and so forth—has been accomplished during the first decade of the Forestry Commissioners' work. They have also co-operated with the Forest Products Research Board. When, however, the question of pure research work and its value and importance to the future of forestry in Great Britain are considered, it cannot be said that the Commissioners have approached the matter from an unbiased point of view.

The Commissioners commenced their work with the underlying idea that they were to be the sole arbiters on everything connected with forestry in Great Britain. Up to a certain point this may have been sound. In the case of true research the contrary was the case. The research work to be carried out and the lines upon which it was to proceed were laid down by the Commissioners; and yet it is certain that they would be the first to admit that they laid no claim to be considered, as a body, men of scientific attainments. Choice of work to be carried out, choice of centres at which certain parts were to be undertaken, all were laid down in the absence of a knowledge of the broader and vital aspects of the work envisaged—aspects the

importance of which, as is so well indicated by Dr. Rayner's letter, can only be foreshadowed by the research worker. Perhaps as fatal to progress of real value was the policy, so common to Government departments in the past, of concentrating the work desired either in a cadre of inevitably more or less inexperienced 'experiment officers' of their own, or of confining part of the work to centres selected on some narrow system of choice and without a definite knowledge of the work being carried out at other institutions in the country, perhaps already better equipped than the ones chosen and accorded grants.

The next decade of the work of the Forestry Commissioners will be a momentous one. The money to be spent in pure afforestation work on new lands runs to a considerable figure. In this one instance it is becoming obvious that soil research work will perhaps be the deciding factor between success and failure. The Commissioners will be well advised if they mobilise for this work every centre in the country—and they are but too few—capable of assisting in this vital matter. A few more or less isolated investigations into peat areas barely touches upon the fringe of the soil investigation problem.

If research work in forestry in Great Britain is to achieve progress and be of practical utility, it will be necessary to enthuse all research centres and pure science research specialists throughout the country; and the programmes of research, under the different aspects required (as indicated by the forestry authorities), should be drawn up by the scientific investigators involved. In this way the principles and aims of forestry will become better understood by the latter, whilst the public will be assured, in so far as human agency can assure it, that the money being sunk in forestry is not being wasted.

Scientific Inference.

Scientific Inference. By Dr. Harold Jeffreys. Pp. vii + 247. (Cambridge: At the University Press, 1931.) 10*s.* 6*d.* net.

SCIENTISTS generally care so little for scientific principles that the title of this book may repel as many as its author's name attracts. Let it be, therefore, stated at once that it is not a formal treatise, but a collection of essays of which some have a value independent of the doctrines they illustrate. Everyone with a logical mind will enjoy Chapters vii., viii., ix., in which it is shown how three great branches of mathematical physics, mensuration, Newtonian dynamics, light and relativity, can be developed concisely from the minimum of experimental fact; and everyone will find something novel and suggestive in Chapter x., on miscellaneous questions.

However, the main purpose, indicated by the title, is to expound the views that the papers of Drs. Jeffreys and Wrinch have made familiar to those who study the logic of science. This view is explained generally in Chapter i. Probability is the fundamental notion in scientific inference; all propositions have a comparable, and therefore measurable, "probability on the data"; general propositions cannot have high probability unless they are "mathematically or logically simple". On these grounds it can be shown why the "classification of sensations" that science actually adopts is to be preferred to any other. Chapters ii., iii., together with certain appendices, develop the necessary calculus; Chapters iv., v., vi. apply it successively to quantitative laws, errors, physical magnitudes.

Chapter ix., on other theories of scientific knowledge, will seem to many readers the most important of all. For the feeling that discussions of scientific inference are necessarily barren is undoubtedly due to the contrast between the agreement concerning what is actually true in science and the disagreement concerning why it is true. Whether Dr. Jeffreys has succeeded at all in reducing this disagreement must be decided in the first instance by those whose theories he criticises. But it is permissible to point out that he has noticed only theories with some similarity to his own, and that even if he abolished all discrepancies between these theories, there would still remain others who reject the most fundamental postulates from which his arguments start. Prof. Bridgman's theory belongs to this class, I think; my own certainly does: perhaps I may show very briefly how completely irreconcilable our views are.

I maintain that the only propositions that have a measurable probability are those concerned with the happening of future events of the kind that can be shown experimentally to possess a measurable chance; such propositions form a very small fraction of all scientific propositions.* I maintain further that all scientific inference hangs on certain primary laws more fundamental than any that Dr. Jeffreys has considered; and, in particular,

* Thus I deny that, as Dr. Jeffreys' first postulate demands, the probability on the data of any one of the following three propositions is greater than, less than, or equal to that of any other:—The year 1933 will be wetter than 1934; There is extra-terrestrial life; King Alfred is one of my ancestors. The first will, the second may, the third will not some day be known to be definitely true or false.

that mathematical conceptions cannot be logically introduced into science until the non-mathematical laws that underlie measurement (and its inevitably associated error) have been investigated.

Can such extreme disagreement be resolved ? If it cannot, what is the use of all this discussion ? An obvious suggestion is that the disagreement arises from a preoccupation with one of the two distinct forms of scientific activity, experiment and explanation, to the exclusion of the other ; and that a thinker may arise some day, equally at home in the laboratory and in the study, who will weld these partial views into a single complete whole. The first part of this suggestion may be accepted without the second ; personally, I hold that certain outlooks are essentially antagonistic ; that, outside the narrow bounds of pure science and pure mathematics, one man's truth may really be another man's error ; and that mathematical science is the highest form of intellectual activity just because it permits co-operation, and not mere toleration, between diverse minds. But even if that is true, the discussions have some value. At the lowest, they amuse those who take part in them ; at the highest, they sometimes reveal an agreement in unexpected places, which should surely be regarded as peculiarly significant.

If there were a generally accepted theory of scientific inference, it would probably have little influence in determining the course of scientific investigation ; but it might have a great influence in determining the form in which conclusions were presented, particularly for instruction. Scientific education might cease to be mere absorption of unco-ordinated facts and become a training in precise thought. That stage has not yet been reached ; but some small steps towards it have been taken. It is encouraging to find that even Dr. Jeffreys and I can agree in condemning certain features of the theory of measurement that pervades our textbooks ; and it is not too optimistic to hope that our grandchildren will be taught the difference between fundamental and derived magnitudes and be no longer confused by nonsense about dimensions.

NORMAN R. CAMPBELL.

Science and Parenthood.

The Retreat from Parenthood. By Jean Ayling. Pp. xvi + 293. (London : Kegan Paul and Co., Ltd., 1930.) 10*s.* 6*d.* net.

IN "The Retreat from Parenthood", the author makes a vehement plea for the application of science to life in all the small details of home comfort, child-rearing, and marital relations—a plea for the emancipation of these provinces from the domination of age-old formulæ and customs. It is suggested that the traditional machinery of home life is particularly ill-adapted to the rearing of healthy and happy children, and that those more intelligent sections of the community typified by the professional classes will tend increasingly to curtail their reproductive activities unless biological ideals are applied to modern life. It is an acknowledged and deplored fact that during the last twenty or thirty years the birth-rate among the professional classes has fallen to an alarming extent. The author examines the causes of this curtailment of fertility and her analysis makes depressing reading ; indeed, if her diagnosis is correct, the vast majority of men and women of intelligence must be living most unhappy lives, dominated by the tyrannical inefficiency of modern life.

In the first part of the book, a survey is made of the conditions in modern homes : the practical difficulties connected with running homes in a world where science, while having revolutionised commerce, transport, production, and amusements, has scarcely, if at all, penetrated to the individual household ; the unfitness of most men and women, by reason of their upbringing and incomplete education, for happy marriage and intelligent parenthood ; the traditional shroud of mystery surrounding childbearing, which prevents any but the most determined of women from obtaining the knowledge necessary to produce children without undue physical and mental injury to themselves and to their offspring ; the economic and social influences which in so many cases relegate the child-bearing woman to a life entirely devoid of mental activities, with consequent harm to herself, the children, and conjugal relations.

In the author's opinion, the most important factors determining the present decline in birth-rate in the professional classes are : the prevalence of the idea that from the womb to the school door the needs of the child must be supplied within the family as a unit ; the fact that, in so many cases, women determined to bear children have to pay the price of exile from professional fields, while women determined on a professional life-work have to pay the price of sterility. If the provision of healthy and intelligent children is regarded as one of the most important services that any man or woman can render the community—and by a large section of our generation it is so regarded—then this penalisation of parenthood requires explana-

tion, especially since this obstructive attitude is directed particularly against those women who, by reason of sound physique, trained intelligence, and high ideals, are undeniably best fitted for maternity.

The author maintains that, instead of adapting the biological needs of the race to professional regulations, it might be possible to adapt professional regulations to biological needs. Accordingly, a scheme is outlined in the second half of the book for arresting the decline of birth-rate among professional workers, taking due account of the factors at present predisposing to failure, whereby services would be provided by a co-operative organisation to deal with all phases of child-rearing. Great stress is laid on the necessity for easily available, up-to-date medical supervision for the child from the moment of conception until it reaches school age.

The book suffers from diffuseness, repetition, and, above all, from irritating mannerisms and a certain immaturity of style reminiscent of the college debating society. But it is an illuminating account of the difficulties encountered by women attempting to conduct their parenthood in a sane and unsentimental way, and is a strong indictment of the progress of medical knowledge and availability of that knowledge on all matters concerned with pregnancy and child-rearing. The problems are difficult of solution and there is urgent need for organised research in this, as yet, almost virgin field. But the author justly remarks: "No one can visualise the splendour of man's material achievements without wondering why for so long the human race has neglected its own needs".

M. A.

The Wry-mouthed Feather-stars.

Smithsonian Institution: United States National Museum. Bulletin 82: *A Monograph of the Existing Crinoids.* By Austin Hobart Clark. Vol. 1: *The Comatulids.* Part 3: *Super-family Comasterida.* Pp. vii + 816 + 82 plates. (Washington, D.C.: Government Printing Office, 1931.) 2 dollars.

IT is ten years since the second part of this elaborate monograph was published, but, considering the enormous amount of detail here assembled after personal checking by the author, one cannot complain of undue delay.

The unstalked crinoids herein discussed are those with the anus in the centre of the oral face and with the mouth consequently excentric. Though all are included in a single family Comasteridæ (formerly Actinometridæ), they are here placed in a super-family Comasterida. The object of this conception, which we owe to Gislén, is to contrast them with the super-families Tropiometrida and Mariametrida, which with the Comasterida make up the curiously named Oligophreata, one of the two sub-orders of the Comatulida. The Comasteridæ again are subdivided into three sub-families—Capillasterinæ, Comactiniinæ, and Comasterinæ, and these between them cover nineteen genera. As moderately familiar examples we may mention *Comaster* itself, based by L. Agassiz on *Comatula multiradiata* Lamarck, a species that has given occasion for much controversy; and *Comatula* Lamarck, with genotype *C. solaris*, of which *Actinometra* Müller and its genotype *A. imperialis* are respectively synonyms. These two species exemplify in intensified degree that variability which renders the identification of all these animals a task of perplexing difficulty, enhanced in practice by the mutilation of most available specimens. Those confronted with the problem will be grateful to Dr. Clark for his careful diagnoses and elaborate keys, which, as he says, should be followed very closely and literally.

The more general worker will value the introduction, which traces the development of the scheme of classification adopted in the present monograph. To that development the largest contributor has been Dr. Clark himself in a long series of papers, of which summaries are here given. Other writers, especially T. Gislén, are also mentioned. Besides this, the synonymies and references to literature at the head of each classificatory division give a brief précis of nearly every work cited. In view of these remarkably complete and detailed references, it is not easy to understand why on pp. 76 and 81 Dr. Clark assigns the establishment of the family Actinometridæ to himself in 1907. That family, with Atelecrinidæ and Thaumatocrinidæ, was already defined in the Echinoderm volume of "A Treatise on Zoology", edited by Lankester in 1900.

The numerous photographs of specimens reproduced in half-tone on 82 plates (back to back) add to the appearance and weight of the volume and make one marvel the more at its remarkably low price. It may, however, be doubted whether they are so useful for purposes of identification as the outline drawings of special structures used in previous volumes. There is an index to systematic names, but a complete index to vol. 1 is promised for part 5. We wish Dr. Clark health and strength to complete his great work.

F. A. BATHER.

A Survey of Television.

(1) *Television To-day and To-morrow.* By Sydney A. Moseley and H. J. Barton Chapple. Pp. xxiii + 130 + 47 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1930.) 7*s.* 6*d.* net.

(2) *A B C of Television, or Seeing by Radio: a Complete and Comprehensive Treatise dealing with the Theory, Construction and Operation of Telephotographic and Television Transmitters and Receivers; written especially for Home Experimenters, Radio Fans and Students.* By Raymond Francis Yates. Pp. viii + 210 + 13 plates. (London: Chapman and Hall, Ltd., 1929.) 10*s.* 6*d.* net.

(3) *Television: Present Methods of Picture Transmission.* By Dr. H. Horton Sheldon and Edgar Norman Grisewood. Second printing. Pp. x + 194. (London: The Library Press, Ltd., 1930.) 10*s.* 6*d.* net.

THESE three books together furnish a useful survey of television up to 1930. There have doubtless been subsequent developments. It may be convenient to deal first with the work by S. A. Moseley and H. J. Barton Chapple. This consists of a review of the work of J. L. Baird, who furnishes a foreword. The other two volumes, which are of American origin, are of a more general character.

(1) Mr. Moseley and Mr. Chapple deal with what is usually regarded as the real process of television, that is, the conveyance to a distance of a picture of something actually occurring at that instant, which may include moving objects. The wireless transmission of drawings, photographs, signatures, etc., by a graphic process that is far from instantaneous is really a different problem, though naturally also of great scientific interest. Mr. Baird's foreword refers to the difficulties in securing facilities for broadcasting and the limitations imposed by the narrow waveband available, which at present leads to images being restricted to simple scenes. He contends, however, that the number of pictures sent per second (about 12½ on his systems) need not be nearly so great as in cinematography.

The "History of Television", which forms the first chapter to this work, makes references to the early pioneering work of Nipkow (1884), and to the transmission of silhouettes by Jenkins (1925); but regards the demonstration by Mr. Baird, described in NATURE of July 3, 1926, and quoted by the authors, as the first instance of the wireless transmission of real images. In subsequent chapters the details of the apparatus are explained. It is shown how the object is illuminated by intermittent light, the reflection of which excites changing currents in a photoelectric cell, how such currents are transmitted, magnified, and ultimately operate at the receiving end a neon lamp, which reacts instantaneously to each change in current, and how scanning discs at the transmitting end and carefully synchronised complementary discs at the receiving end serve to produce the illusion of an actual image. The process, in this and other systems of television, is equivalent to selecting and conveying each element in a picture in turn, but with such rapidity that an apparently complete picture is presented. The reproduced pictures, thus formed by a series of luminous lines, are certainly recognisable portraits. The authors suggest that the equipment is relatively simple and within the scope of the amateur. Efficient results, however, obviously demand technical skill, and perfect synchronisation at the transmitting and receiving ends demands great care.

The concluding chapters are concerned with subsidiary recent developments, in themselves highly ingenious and interesting, but presumably requiring greater perfecting of the main process before they can be applied in practice. We have, for example, 'phonovision', a process involving the reproduction on a gramophone record of rhythmical sounds, corresponding to the changes in the photoelectric current, which are thus stored, and can be released at any time in order to repeat a television image. The authors also discuss the possibilities of colour and stereoscopic effects. The former involves two scanning discs and two sources of light, one of neon gas furnishing red light, the other a combination of helium and mercury vapour, furnishing yellow, green, and blue. Stereoscopic effects would require two identical but distinct sources and duplicate spirals on the scanning disc permitting 'double exploration'. Of considerable interest also is the 'Noctovisor' apparatus, which consists essentially of a television transmitter and receiver coupled together but adapted to respond to infra-red rays. It is claimed that with such an apparatus a mariner could detect the presence of a distant source of light, even though completely shrouded by fog.

(2) "The A B C of Television", by Mr. R. F. Yates, is conceived on somewhat broader lines. A chapter is devoted to "telegraphing pictures". Prior to this there is a review of existing television systems, which includes a useful explanatory diagram showing the details of transmitting and receiving ends. The experiments made in the Bell Telephone Laboratories are described in detail, one

interesting feature being the use of a neon tube image-forming grid with no less than 2500 independent electrodes. Other experiments mentioned are those of Max Diekmann (based on the movement of cathode rays) in Germany and Belin and Holweck in France. Subsequent chapters deal with photoelectric cells, amplification, the neon lamp, the problem of scanning, synchronisation, etc.

(3) Dr. Sheldon and Mr. Grisewood, in their historical survey, deal mainly with the conveyance of pictures by telegraph and devote only a small space to television proper. Subsequent chapters deal with optical systems and the eye, electromagnetic waves, selenium and photoelectric cells, glow-lamps and telephotography. In Chapter xii. and subsequent chapters, there is to be found what is perhaps the best review of various systems of television occurring in these volumes. The Baird, Bell, Jenkins, and Alexanderson systems are dealt with successively.

One cannot escape the feeling that the moving mechanism imposed by all these systems does not represent a final solution. A final chapter points out, however, that the technical difficulties of television, great as they are, may be surpassed by those involved in a general process of broadcasting. Had television arrived before the era of audible wireless, the use of the somewhat broad range of wave-lengths necessary for good reception would have presented little difficulty; to-day, possible interference with the existing wireless broadcasting systems all over the world has to be considered.

Universities of the British Empire.

The Yearbook of the Universities of the Empire, 1931. Edited by Sir H. Frank Heath. Published for the Universities Bureau of the British Empire. Pp. xiii + 917. (London: G. Bell and Sons, Ltd., 1931.) 15*s.* net.

THIS annual, first published in 1914, is primarily a conspectus of the staffs, organisation, and activities of universities, the numerous colleges connected with them, and a few other, unattached, colleges situated in various parts of the British Empire, as follows:

	Universities.	Unattached Colleges.
England	11	4
Wales	1	...
Scotland	4	...
Ireland	3	...
Canada	21	...
Newfoundland	...	1
West Indies [1]	...	1
Australia	6	...
New Zealand	1	...
South Africa	5	...
Mauritius [2]	...	1
Malta	1	...
Palestine [3]	1	...
India	18	...
Ceylon [4]	...	2
Singapore [5]	...	2
Hong Kong	1	...

[1] Imperial College of Tropical Agriculture, Trinidad.
[2] College of Agriculture.
[3] Mandated Territory. The Hebrew University, Jerusalem.
[4] Medical College and University College, Colombo.
[5] King Edward VII. Medical College and Raffles College.

From the calendar of each of these institutions have been selected such items of information as are likely to prove of interest to the members of other universities, schoolmasters, persons engaged in scientific researches, government departments, clubs, and the general public. A directory of the officers and members of the staff of each university is followed by information as to its constitution, equipment, residential accommodation, courses of instruction, fees, scholarships open to graduates, extra-mural work, publications, etc., and a summary of events of outstanding interest which occurred during the past academic year, with statistics of the number of students in attendance and degrees, diplomas, etc., conferred. In the staff directories the names are grouped under subject headings and an additional indication is thus afforded of the scope of the instruction offered. An alphabetical index at the end of the volume contains upwards of 12,000 names.

In chapters introductory to the sections dealing with the universities of Great Britain and Ireland, of Canada, of Australia, of South Africa, and of India, respectively, are given summaries of information regarding their history, regulations, and practice, but not reviews of the academic year. The Canadian chapter has been largely rewritten for this year's issue by Dr. Stanley Mackenzie, of Dalhousie University, and now gives British readers a clearer idea of a series of developments of extraordinary interest. The Canadian universities are kept in touch with one another by annual conferences, the fourteenth of which was held in May 1930 at Toronto, and by co-operation with a National Council of Education which organises triennial conferences, the next of which will be in Toronto in 1932. The Australian universities, like the Canadian, hold conferences, which are arranged by a Standing Advisory Committee established in 1920. Similarly, in South Africa, since 1923, representatives of the universities and university colleges have met from time to time to discuss matters of common interest. These universities,

moreover, have statutory powers to make joint regulations regarding matriculation, professional examinations, etc. The Indian universities set up in 1924 an Inter-University Board which meets annually: it has published a handbook of Indian universities. The question suggests itself whether it would not be worth while, with the help of these various co-ordinating organisations, to add to the introductory chapters annual reviews of the past academic year.

Appendices, extending to 170 pages, include summaries of the conditions governing admission, in Great Britain and Ireland, to the universities and to the medical and other professions and careers for which university studies are a fitting preparation, lists of open post-graduate scholarships, fellowships, etc., both British and foreign, and lists of centres of scientific research and information in the Empire, whether connected with universities or not, to which independent research workers are admitted. These lists have been greatly extended and rearranged and, of course, brought up to date. The aids open to British students in Great Britain and Ireland have now been arranged by grouping under subjects of study instead of under the names of the institutions offering the aid. This has not been done in the case of the Dominions and foreign countries, because the number available was too small. Anyone desiring to discover the relative amounts of provision of this kind made by universities, governments, scientific societies, or other bodies, can easily collect the information by using the general index.

The centres of scientific information in Great Britain are grouped under the four heads—botany and agriculture, industrial, pure science, and medical; the centres of research under these heads and forestry, fisheries and tides, and meteorology. The list of centres of research and information in the Dominions, India, and the Colonies is much fuller than before.

The extent and variety of the ground covered in the "Yearbook", especially the appendices, are such that the labour expended on it would be to a large extent wasted unless it were furnished with an adequate general index. This matter has evidently received the attention it deserves. In connexion with the indexing of the names of staff and officials, the treatment with any kind of uniformity of the Indian, Burmese, and other Oriental names presents extraordinary difficulties which the editor seems to have grappled with successfully.

Glancing through the summaries of events of the past year, one sees many significant items. Among the lists of benefactions one finds numerous gifts from American philanthropic foundations associated with the names Carnegie and Rockefeller. The beneficiaries include, naturally, many of the Canadian universities, eight of which participate in the benefits of the pension scheme of the Carnegie Foundation for the Advancement of Teaching, and the Universities of London, Cambridge, Durham (Armstrong College), Tasmania, Otago (New Zealand), and the Witwatersrand and University colleges at Exeter and Christchurch (N.Z.).

The 1931 "Yearbook" will have more than ordinary importance by reason of the fact that the fourth Congress of the Universities of the Empire is to be held this year, July 7–10, at Edinburgh. The previous congresses were held in 1912 (London), 1921 (Oxford), and 1926 (Cambridge).

Our Bookshelf.

The Psychology of Clothes. By Dr. J. C. Flügel. (The International Psycho-Analytical Library, No. 18.) Pp. 257 + 17 plates. (London: The Hogarth Press, 1930.) 21*s*.

Books which deal with dress from any but the historical point of view are only too few; and it is therefore refreshing to meet with a new one. Dr. Flügel's "Psychology of Clothes" should be read by everyone who takes an interest in modern garb, for it contains a wealth of facts and theories bearing on its origin, its effects, and its future.

To the widespread belief that clothes originated to enhance the attractiveness of the wearer, the author adds another, that they were intended to direct attention to the sexual organs. He further contends that garments may actually represent these, but his examples do not seem to be very convincing. To-day he finds the essential opposition between the motives of decoration and modesty to be the most fundamental fact in the whole psychology of clothing.

In the chapter on "Individual Differences", Dr. Flügel recognises a number of types, among them those who like to feel their skin uncovered and their muscles unhampered. Of these, some never get resigned to dress. Then there are unemotional individuals whose feelings fuse clothes and body into an harmonious whole.

One of the most striking matters touched upon under the heading of "Sex Differences" is the "great masculine renunciation", or sudden reduction in male decorativeness at the end of the eighteenth century, which it is claimed was connected with the French Revolution.

In discussing the "Why of Fashion", it is explained that the higher classes, when their sartorial distinctions are gradually appropriated by the lower, seeing that sumptuary laws seldom prove effective, adopt a different dress in order to re-establish their signs of superiority. In our days of levelling up, however, we are inclined to look for

commercial influences behind the scenes, which result in mistress and maid both wearing—shall we say ?—' Russian boots '.

Dr. Flügel dwells in detail on other matters connected with fashion, and devotes a chapter to the " Evolution of Garments ", a subject to which Sir George Darwin first directed attention.

W. M. W.

Principles of Soil Technology. By Prof. Paul Emerson. Pp. xv + 402. (New York : The Macmillan Co., 1930.) 14*s.* net.

THE success in the arrangement and presentation of the subject matter in this book is the result of long teaching experience by the author. This branch of agricultural science has progressed rapidly in recent years, and it is essential, therefore, that the establishment and development of the fundamental principles involved should be clearly understood by the student.

The four sections of this book are (1) soil genesis, morphology, and classification, (2) soil physics, (3) soil chemistry, (4) soil biology. In the first section the author stresses rightly the importance of studying the soil *in situ*. Readers will appreciate the definitions and explanations that are given of the many less familiar terms used in soil classification and morphology, together with a description of the soil areas of the United States. The presentation of soil physics to a student, without entailing the use of an advanced treatise on mathematics, is a difficult task. The author has, however, succeeded, and conveys to the reader the essential principles and the results of recent work on soil structure, air, and water movement, and their effects on plant growth. Equally well treated is the section on soil chemistry, where the mechanism of base exchange is explained, as well as the source and utilisation of plant nutrients. It should be pointed out, however, that a wrong impression of the salts of ortho-phosphoric acid is given on p. 242. All secondary and tertiary phosphates are not water insoluble, nor is the use of the descriptive terms, acid soluble and insoluble, for these, very fortunate. Both forms, if we consider the case of calcium only, are soluble in dilute weak acids.

Apart from this, the book is very well written. It contains, in addition to the sections already mentioned, a very useful glossary of terms, numerous tables, graphs, diagrams, and maps of the United States.

The excellent printing and binding make reading a pleasure, the price is low, and the references to the literature will be useful to post-graduate workers.

Elementary Biology : for Matriculation and Allied Examinations. By Mary E. Phillips and Lucy E. Cox. Pp. xiv + 480. (London : University of London Press, Ltd., 1931.) 7*s.* 6*d.*

NOW that biology has been introduced by all examination boards of England and Wales for the school certificate, as well as in many cases for the matriculation examinations, we may expect an outcrop of British text-books in a field which hitherto has been largely in the hands of American authors. The book under consideration is one of the first of the new series to enter the lists, and though primarily designed for matriculation examinations, its authors express the hope that it " may also prove useful in those schools in which biology is studied as a cultural subject ". And why not ? It is attractively written, well printed, and copiously illustrated. No pains have been spared to render into assimilable form the subject matter, which is marshalled into five well-balanced sections. Thus : (1) Simple living forms of increasing complexity ; (2) external morphology and mode of life of some members of the chief classes of animals ; (3) general morphology and physiology of the mammal ; (4) general morphology and physiology of the flowering plant ; (5) the soil, bacteria, parasites and saprophytes, distinction and interrelation between plants and animals.

With discrimination, the practical work is sifted from the text and collected at the end of each chapter. The 282 illustrations cover a wide range of subjects ; a very large proportion of them have an accuracy of finish which is not always associated with elementary text-books. There is no chapter on evolution ; but the outlook of the authors is quite clear from their all too short " Introductory ", while only the dullest reader could fail to be stimulated to think on evolutionary lines, by many remarks in the text.

A Handbook of Physics Measurements. By Ervin S. Ferry, in collaboration with O. W. Silvey, G. W. Sherman, Jr., D. C. Duncan and R. B. Abbott. Vol. 2 : *Vibratory Motion, Sound, Heat, Electricity and Magnetism.* Third edition. Pp. xi + 277. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1929.) 12*s.* 6*d.* net.

THIS book is devoted to measurements in vibratory motion, sound, heat, electricity and magnetism. Practical details are preceded by a theoretical treatment which should enable the student to understand what he is doing. The considerable space allocated to the theory of damped vibrations and the logarithmic decrement is welcome in view of their importance in relation to alternating currents, though in this connexion it is a pity that the theory of forced vibrations has not been included.

A Junior Course of Practical Zoology. By the late Dr. A. Milnes Marshall and the late Dr. C. Herbert Hurst. Eleventh edition, revised by H. G. Newth. Pp. xliii + 519. (London : John Murray, 1930.) 12*s.* net.

NOT many scientific text-books first published in 1887 have still a demand in the laboratories of to-day, at least in anything like their original form. In preparing the eleventh edition, Mr. Newth was probably well advised not to introduce physiology, which would, as he says, " have added greatly to its bulk, and the result could only have been a hybrid of very doubtful viability". In its present form, the book is likely to retain its position as the standard work on animal morphology for junior students.

Letters to the Editor.

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

The Action of a Crystal as a Two-Dimensional Lattice in Diffracting Electrons.

KIKUCHI [1] first described examples of electron diffraction in which a crystal appeared to behave as a two-dimensional or cross-grating. Very thin sheets of mica give an equilateral net-like pattern of diffracted beams on the photographic plate (the N pattern), as if the only conditions for interference were those required by the lattice-net of the mica cleavage plane. Kikuchi further showed that, with increasing thickness of the mica, some spots are enhanced and others weakened until what he termed the L pattern is obtained. The selection of the enhanced spots was accounted for satisfactorily by the operation of the third condition for interference, which depends on the regular repetition of the crystal structure in successive planes. The L pattern, in other words, is explained by diffraction at a three-dimensional lattice, in the manner familiar in the case of X-rays.

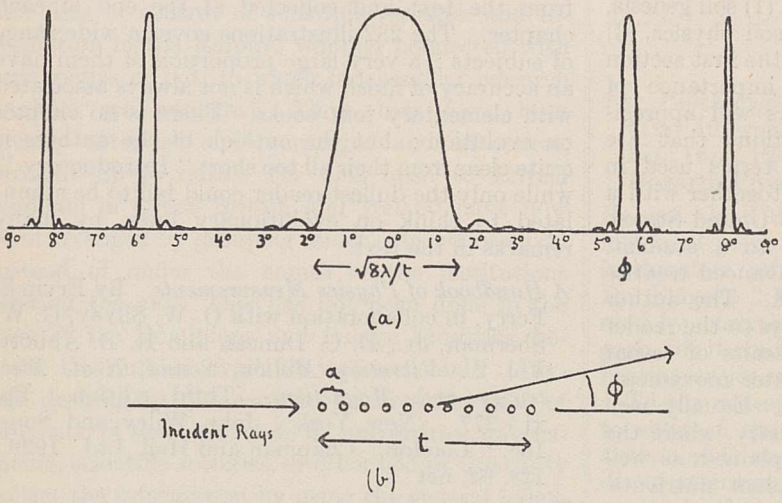

FIG. 1.

Linnik [2] obtained patterns somewhat like Kikuchi's N pattern, with copper K_α rays and mica which had been heated. He suggested that they were due to a breaking up of the mica into sheets so thin that each acted as an independent two-dimensional grating. W. L. Bragg put forward an alternative explanation [3] that Linnik's effect was due to a slight distortion of the mica, which might be described as a random orientation of the normal to the cleavage plane over a small range. It was suggested that a similar explanation might account for Kikuchi's N pattern.

Certain experiments on electron diffraction by very small crystals made by one of us (F. K.) seem to show very clearly, however, the disappearance of the third condition for interference, namely, that depending on the repeat of the crystal pattern in the direction of the incident beam. It is interesting to examine how thin a crystal must be for this condition to become inoperative.

Let a row of n scattering points with spacing a be parallel to the incident rays, as in Fig. 1 (b). The intensity of radiation scattered in a direction Q is proportional to $\sin^2 n\psi/\sin^2 \psi$ where $\psi = \pi a\,(1 - \cos\phi)/\lambda$. This curve is plotted in Fig. 1 (a) for the case where $\lambda = 0{\cdot}05$ A., $n = 10$, $a = 10$ A. (thickness of crystal $t = na = 100$ A.). Its interesting feature is the breadth of the central maximum, which is nearly 4° ($2\phi_0 = \sqrt{8\lambda/t}$). For all directions within this range, the whole row acts as a single diffracting unit and gives a strong resultant effect.*

In actual cases of electron diffraction by a small crystal, the wave-length is so short (0·05 A. for 60,000 volts, as compared with 1·54 A. for copper K_α) that many diffracted beams appear at angles well within this range. The crystal in a fixed orientation can therefore give simultaneously a complete series of cross-spectra, for the crystal may be considered as a cross-grating of these rows, each of which acts as a single unit. For example, in the case considered above, if the crystal also had spacings of 10 A. at right angles to the beam, the cross-spectra would be 17′ apart and more than one hundred would appear within the central maximum. The difference between the patterns of X-ray diffraction and electron diffraction is apparent; it is not merely one of angular scale. For the row to act as a unit, it is necessary that $t(1 - \cos\phi) = t\phi^2/2 < \lambda$. When ϕ is small, $t\phi^2/2$ is a small quantity of the second order, and the condition is readily satisfied for directions of electron diffraction and crystals of the order of 100 A. in thickness. In the case of X-rays, the 'cross-grating' spectra fall outside the central maximum when the crystal is more than one or two atomic planes thick, and we have the familiar effect that only one diffracted beam is formed at a time, and that only appears when the crystal is correctly oriented.

We may picture electron diffraction by a small crystal as follows. Whenever the crystal is so oriented that a zone axis (row of scattering points) is approximately parallel to the incident beam, a complete cross-spectrum flashes out. The cross-grating is the projection of the crystal on a plane at right angles to the zone. Such an orientation is a very special case. More generally, when the crystal is so oriented that a set of planes is nearly parallel to the rays, the crystal acts as a *line-grating* and forms several orders simultaneously on either side of the central beam.

Both cases are shown in Fig. 2. A powder photograph, taken with a coarse powder, has spots on the Debye-Scherrer rings due to individual crystal grains. These spots, in the case of electron diffraction, mostly occur in pairs symmetrically placed on either side of the central spot. Each crystal grain is obviously diffracting spectra to both sides simultaneously. The effect is very marked in powder photographs of sodium fluoride, where more than one order often appears on either side, but these photographs are difficult to reproduce here. Fig. 2 (b), which shows the same effect, is taken with crystalline matter in a collodion film, and the centro-symmetry is very striking. In Fig. 2 (a), a single crystal chances to have a zone axis parallel to the beam, and the complete cross-spectrum appears. These sheets were less than 100 A. in thickness.

We were privileged to hear recently a lecture by Dr. Eisenhut in which slides of similar cross-grating spectra produced by single crystals of cadmium iodide

* G. P. Thomson ("Wave Mechanics of Free Electrons", p. 72) refers to the same feature in discussing the extent of the electron wave-packet.

and iron oxide (Fe_3O_4) were shown (O. Eisenhut and E. Knapp, I.G. Farbenindustrie Forschungs-Laboratorium, Oppau).

This explanation is only partial, because the patterns are often more extended than any broad central diffraction maximum which is probable. The central maximum can be seen in Kikuchi's photographs (for example, Fig. 5, loc. cit.), but the corresponding mica thickness proves to be 200 A., which is much smaller than Kikuchi's estimate for the sheets he used. In the single crystal photographs, the pattern is sometimes so extended as to indicate impossibly small crystal thicknesses. It is interesting to note, however, that theoretically a small three-dimensional crystal produces the effect of a two-dimensional grating and gives a number of diffracted electron beams simultaneously. Its dimensions at right angles to the beam can be sufficiently great to give a sharp cross-grating spectrum, while an equal depth in the direction of the beam is insufficient to bring in the third condition for interference.

(*a*) FIG. 2. (*b*)

W. L. BRAGG.
F. KIRCHNER.

Munich, March 1931.

[1] *Japanese Journal of Physics*, vol. 5, No. 2.
[2] NATURE, **123**, 604, April 20, 1929.
[3] NATURE, **124**, 125, July 27, 1929.

The Velocity of Light.

IN a recent discourse broadcast by the B.B.C., reference was made to my communication in NATURE of April 4 on the subject of the velocity of light. Two objections were presented to the deduction that the velocity of light decreases, derived from the values quoted; these must have occurred to the readers of my letter, so that perhaps I may be allowed to refer to them briefly.

(1) The possible errors do not rule out the possibility that the values are evaluations of a constant. I stated this myself. Physicists, however, are apt to overlook the fact that possible errors are no guide whatever in such a case as the one occupying our attention. They are a mere mathematical guess as to the accuracy of any individual determination, and no more. They leave entirely out of account the fact that observers, methods, apparatus, conditions, etc., may be different. Of course, identical results from different observers have more weight than if the observers were the same person, and similarly for the methods, apparatus, etc. For example, the value of a constant for which two different observers, working with entirely different techniques, have obtained results such as, say, 126 ± 50 and 128 ± 60 respectively is far more likely to be in the vicinity of either value, and therefore far better established, than if a single observer had obtained, say, 102 ± 4 and 152 ± 6, using the same method and apparatus. What is true of the constancy is also true of any law of variation.

(2) In my letter, I have limited myself to determinations made in the present century. This does not mean at all that I have rejected values obtained before which were acknowledged as being reliable. Those who quote these earlier values without having made a thorough investigation, such as that which was published in NATURE, Sept. 17 and Oct. 22, 1927, little realise how they allow themselves to be misled by a mere number alongside a name. The value 299,853 obtained by Michelson in 1882, for example, has been mentioned as disproving a decrease of the velocity of light, when considered together with the four determinations I gave in my letter. The fact is overlooked that this determination is one of three, made on relatively short bases, and therefore more liable to be affected by systematic errors of a given magnitude than the values obtained over very long bases or with a technique giving results of an equivalent order of physical accuracy, such as that of Karolus and Mittelstaedt, in which the high order of frequency of interruption of the luminous beam compensates for the shortness of the base. These three values are:

Michelson	1879·5	$299{,}910 \pm 50$ km./sec.
Newcomb	1882·7	$299{,}860 \pm 30$,, ,,
Michelson	1882·8	$299{,}853 \pm 60$,, ,,

They were obtained by two observers in close relationship, using the same method and the same experimental technique, with apparatuses which were similar; they constitute a set of their own, being the only observations made on such short bases (excluding the pioneer experiments of Foucault, which are admittedly mere attempts to ascertain the possibilities of the method). Now, each of these observations gives a result smaller than the one before! The one before that of 1879·5 is Cornu-Helmert's value, $299{,}990 \pm 200$. They, therefore, demonstrate a decrease of velocity, during the period which they cover; at any rate, their distribution along a perfect straight line, which, moreover, points exactly towards Cornu-Helmert's value, cannot be said to be accidental, any more than their agreement in giving a constant value, if they did so, could be said to be accidental!

I have treated the whole question at full length in a series of articles in *Ciel et Terre* (*Bulletin de la Société Belge d'Astronomie*, 1927–1931). In these, I establish the twenty-two coincidences referred to in my letter. There is not a single one against a decrease of velocity. Can this be accidental?

Another point to be remembered is that the method of the revolving mirror, used by Michelson, is based on assumptions which, to my knowledge, have not yet been proved, namely, that the laws of oblique reflection on a moving reflecting surface, having a speed which is small compared to that of light, are the same as if the surface was at rest, and that the laws of

reflection of a pencil of light from a source, real or virtual, having a transverse speed of the same order as that of light, are the same as if the source was at rest.

M. E. J. GHEURY DE BRAY.
40 Westmount Road,
Eltham, S.E.9,
April 23.

Deep-Focus Earthquakes.

WITH reference to Mr. Scrase's letter in NATURE of Mar. 28, p. 486, a few additional remarks concerning deep-focus earthquakes may be of interest. Such earthquakes are comparatively rare occurrences, and in the years 1918–1926 the late Prof. H. H. Turner reported only 138 in the "International Seismological Summary".

Turner's very great focal depths, amounting in one instance to 0·090 of the earth's radius below normal, had to some extent fallen under suspicion, for three reasons:

(1) His depth of 0·040 for a normal earthquake shock is certainly faulty; the Montana earthquake of June 28, 1925, examined by Byerly, was not found by Turner to have an abnormally *high* focus, yet Jeffreys was able to show that the time-distance curve agreed with that found for the Jersey and Hereford earthquakes of 1927, for which the foci were less than 20 km. deep, and he furthermore deduced from Byerly's curve a set of corrections to the Zöppritz-Turner tables that agreed with a set inferred by Turner from the residuals of a very large number of earthquakes.

(2) Turner's estimates of focal depth depended upon Knott's seismic rays, which were in turn calculated from the Zöppritz-Turner tables; the known errors of these tables, particularly for small epicentral distances, require a revision of Turner's focal depths.

(3) The crucial test had not been applied to Turner's deep-focus earthquakes that, in view of a general reciprocal theorem in dynamics, the amplitude of a surface wave generated by a deep-focus disturbance should be small if the amplitude of the disturbance of a wave of that type is relatively small at the depth in question (cf. H. Jeffreys, "The Earth", 2nd edn., p. 136). Actually, the presence of *L* and *M* readings in the "International Seismological Summary" for many of the earthquakes of supposed very deep foci seems *prima facie* to constitute a valid objection to presuming foci of these depths.

As regards (1), it seems definite that Turner's value of the normal focal depth must be abandoned; (2) awaits the thorough testing of much-improved tables, but a definite answer may be expected in the near future; (3) has recently been the subject of a detailed investigation, and the result, which I am publishing in the forthcoming number of *Gerlands Beiträge*, entirely supports the idea of abnormal focal depth, at any rate for the additional focal depths of 0·040 and more; a further investigation is being undertaken for depths of less than 0·040 below normal. The typical deep-focus earthquake is most interesting: most of the energy is carried by body waves, and *P*, *PP*, *PPP*, *S*, *SS*, *SSS* are of very great amplitude; at the time where *L* and *M* normally appear there is a disturbance which is just the general motion corresponding to the dying down of the distortional waves. This weakening of the normal long wave phase is, of course, one of the distinctive features that Mr. Scrase refers to.

There is one partial exception to the previous statement. Although the normal *L* and *M* phases are practically absent from the shocks of very great depth, the phase known as *G*, Gutenberg's "Early Long Wave", of velocity about 4·4 km./sec., is often still discernible, although of rather small amplitude. It is to be expected that this wave of very long period should be sensible at much greater depths than the long waves of the normal *L* and *M* phases.

There is no difficulty in explaining the recorded *L* and *M* of the "International Seismological Summary". A graph shows at once that they are sometimes *G*; but more often the large amplitudes of *S*, *SS*, *SSS*, so conspicuous in these deep-focus shocks, are mistaken for surface waves.

It is greatly to be regretted that Prof. Turner, who carried out so many of the pioneer investigations of focal depths and to whose energy and enthusiasm their systematic study and report in the "International Seismological Summary" are due, has not lived to see the confirmation, both by the reciprocal theorem argument adduced by Dr. Jeffreys and by the important method discovered by Mr. Scrase, of the occurrence of abnormally deep foci.

R. STONELEY.
The University, Leeds,
April 17.

Opacity and Stellar Structure.

THE emission of the nuclear γ-rays from radioactive elements is accompanied by the photoelectrons emitted from the atom giving rise to the γ-radiation. This has been described by Ellis[1] as the internal photoelectric effect. For a long time, the obvious explanation has been that the γ-ray is sometimes absorbed by the extranuclear electron which is emitted with the energy given by the Einstein equation. Calculations based on this view, made recently by Casimir, lead to the conclusion that the probability of emission of the photoelectron is about 1/10 to 1/30 of that experimentally observed. Thus, for RaC γ-ray of energy $6{\cdot}12 \times 10^5$ volts, experiment shows that in 994 disintegrations out of 1000 the γ-ray escapes and in 6 it is absorbed. Therefore, the value for the probability of absorption is 6×10^{-3}, while the calculated value for this case is only $0{\cdot}46 \times 10^{-3}$: that is, *the experiment shows the atom to possess about ten times more opacity for its γ-radiation than is indicated by calculation.*

The wave mechanics[2] does suggest, however, a different kind of energy transfer between the nucleus and the outer electron: that is, energy can pass directly from the nucleus to the electron without the intervening process of the emission of radiation in the nucleus and its absorption by the electron taking place. This may be called a radiationless energy transfer, and in fact the experimental results taken in conjunction with the calculations of Casimir indicate that such radiationless transfers are ten to thirty times more frequent than the radiational ones. We now turn to the stellar structure.

The recent investigations of Prof. Milne[3] have led us to consider every star as made up of a degenerate core surrounded by a gaseous envelope. In the case of white dwarfs this gaseous envelope is negligible. The important question in connexion with the theories of stellar structure is that of opacity. The greatest difficulty of the theory of Eddington has been that it demands stellar opacities about ten times higher than can be allowed by physical considerations. It has been said[4] that Milne's theory only enhances this discrepancy.

The purpose of this note is to suggest that Milne's theory is capable, at least qualitatively, of overcoming this difficulty. In the degenerate core,

because of the interaction between the electrons, there is a finite probability for the energy (and momentum) of an electron in one part of the core to pass directly to another electron in some other part of the core without the intervening process of radiation taking place: that is, in the degenerate core the transfer of energy mostly takes place by the radiationless process and this energy is then converted into radiation in the non-degenerate envelope surrounding the core. Because the energy is transferred by the radiationless process, the 'opacity' may be (as in the case of the radioactive atom) considerably higher than it would be if this transfer of energy took place in the form of radiation. *We may thus connect the discrepancy in stellar opacity to the same cause as that of the internal photoelectric effect in the atom.*

Another interesting point which may be mentioned is that of the emission of high-speed electrons from the white dwarfs, which are almost completely degenerate, and hence the chances of collision for an escaping electron are very small. These high-speed electrons *will in some cases have energies comparable to the cosmic radiation.* In fact, it can be easily seen that due to this electron escape a black dwarf will lose almost all of its mass—*the final state of a black dwarf is a diffuse mass.* These considerations will be published elsewhere in detail.

D. S. KOTHARI.

45 Belvoir Road, Cambridge,
April 19.

[1] Ellis: a very lucid account is given in *Science Progress*, April 31, p. 615.
[2] Fowler, *Proc. Roy. Soc.*, vol. 129, p. 1.
[3] Milne, *Mon. Not. Roy. Ast. Soc.*, vol. 91, p. 4.
[4] *Observatory*, Feb. 1931, p. 36.

Coherent Expanded Aerogels and Jellies.

THE continuity of the liquid permeating jellies is demonstrated by diffusion, syneresis, and ultrafiltration, and the fact that the liquid may be replaced by other liquids of very diverse character indicates clearly that the gel structure may be independent of the liquid in which it is bathed. Hitherto the attempt to remove the liquid by evaporation has resulted in shrinkage so great that the effect upon the structure may be profound.

Mr. Charles Learned and I, with the kindly assistance and advice of Prof. J. W. McBain, undertook to test the hypothesis that the liquid in a jelly can be replaced by a gas with little or no shrinkage. Our efforts have met with complete success.

The procedure that we have adopted is as follows: The jelly is first formed in a suitable liquid in dilute form. The liquid is then replaced by another which does not dissolve the structure and has a reasonably low critical temperature. Alcohol has proved quite satisfactory for most of the inorganic gels, ether has advantages in the case of easily reduced substances, and propane was used for all of the organic jellies. In making the replacement, it is necessary that each liquid used be completely miscible with both that which precedes and that which follows it. For example, water may be replaced by alcohol and then by ether. Mere evaporation would inevitably cause shrinkage. However, the jelly is placed in a closed autoclave with an excess of liquid and the temperature is raised above the critical temperature of the liquid, while the pressure is maintained at all times at or above the vapour pressure, so that no evaporation of liquid can occur and consequently no contraction of the gel can be brought about by capillary forces at its surface.

When the critical temperature is passed, the liquid has been converted directly into a permanent gas without discontinuity. The jelly has had no way of 'knowing' that the liquid within its meshes has become a gas. All that remains is to allow the gas to escape, and there is left behind a coherent aerogel of unchanged volume.

Silica aerogel with a density so low as 0·1 is very easy to prepare, and we have prepared some with a density of only 0·02. The silica aerogels are highly opalescent, although quite transparent; they display a glassy fracture and small pieces emit a metallic ring when dropped.

So far, we have prepared silica, alumina, nickel tartarate, stannic oxide, tungstic oxide, gelatine, agar, nitrocellulose, cellulose, and egg albumin aerogels and see no reason why this list may not be extended indefinitely. Apart from the scientific significance of these observations, the new physical properties developed in the materials are of unusual interest.

S. S. KISTLER.

College of the Pacific, Stockton, and
Stanford University, California,
April 8.

Two Modifications of Liquid Nitrobenzene.

THE changes of dielectric constant and density of liquid nitrobenzene with temperature, studied by one of us (J. M.) and described in communications to NATURE, suggest that at 9·5° the liquid undergoes an energy transformation analogous to that found for liquid helium by M. Wolfke and W. H. Keesom,[1] and for liquid ethyl ether by M. Wolfke and J. Mazur.[2]

To confirm this supposition we have made a study of the heating curve of carefully chemically purified nitrobenzene. Nitrobenzene cooled to a temperature lower than the point in question (6° C.) was contained in a Dewar vessel provided with a nickel-plated

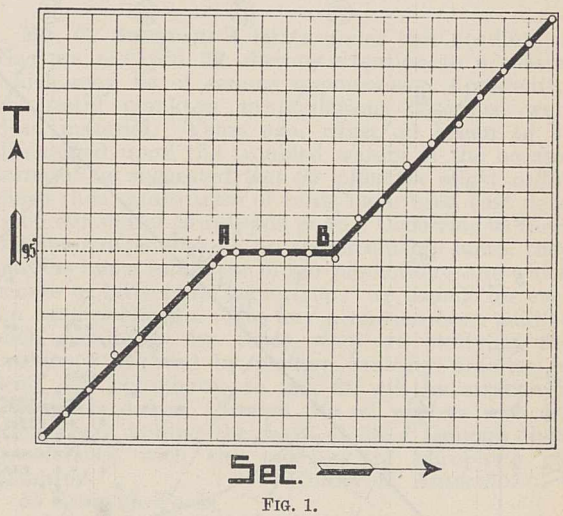

FIG. 1.

refrigerator. We have studied the change with time on gradually increasing the temperature of nitrobenzene which was isolated from all external disturbances.

The platinum resistance thermometer, calibrated with the aid of the standard thermometer of the Cryogenic Laboratory at Leyden, was used as a stirrer.

The experiments were repeated three times and they show that at 9·5° there is a distinct slowing down of the rate of change of temperature (see the part *A B* of the curve, Fig. 1). The parts of the curve above and below the point 9·5° are parallel straight lines, which

shows that the specific heat of nitrobenzene does not undergo a change at 9·5°.

This phenomenon is a third case of appearance of a transformation point for two different modifications of a liquid.

M. WOLFKE.
J. MAZUR.

Physical Laboratory,
Technical Institute, Warsaw, April 4.

[1] Comm. Leiden, 190*b*.
[2] NATURE, **126**, 684, Nov. 1, 1930; *C.R. Sci. Soc. Polon. de Physique*, **5**, 3; 1931.

Adsorption of Hydrogen on Charcoal.

IN connexion with the recent development of the theory of activation of adsorption processes by H. S. Taylor (*J.A.C.S.*, **53**, 578; 1931), it may be interesting to note that a 'Norite' charcoal, which adsorbed practically no hydrogen at room temperatures, adsorbs hydrogen at increasing rates as the temperature is raised. Thus, when 1·17 c.c. hydrogen were admitted to the charcoal at 395° C., the pressure fell from 0·514 cm. to 0·076 cm. after 9 hours, about 1 c.c. of gas being adsorbed. At 340° C., with an admission of 1·19 c.c., the pressure only fell from 0·572 cm. to 0·251 cm. in a similar period, showing a much smaller and slower adsorption of hydrogen than at 395° C. At temperatures below 200° C. the rate of adsorption is too slow to be measurable.

F. E. T. KINGMAN.
Department of Physical Chemistry,
University of Bristol.

The Wall of the Cotton Hair.

MEASUREMENTS of the dimensions of cross-sections of cotton hairs have been obtained by us at Gîza, in some preliminary studies for technological purposes, of different pure lines of Egyptian cotton. On plotting correlation diagrams between the thickness of the cell wall and the 'ribbon width' (the maximum diameter of the collapsed cell tube) we have detected several facts which are of exceptional interest to plant physiology as well as to technology. A characteristic diagram is here reproduced (Fig. 1).

The nomograph lines drawn on this diagram are self-explanatory, excepting perhaps those of equal cell diameter, which are the result of the fact that a fully thickened hair cannot collapse at all, so that its ribbon width is identical with the cell diameter; contrariwise, a very thin-walled hair collapsed until its ribbon width is almost equal to half the circumference of the cell.[1] Strictly speaking, these lines should not be straight; also there are small sources of error in measuring the ribbon width of very thin-walled hairs, but we can disregard these minutiæ for the present purpose.

The outstanding feature is that the correlation axis tends to follow the curved lines of equal cross-sectional area. Otherwise stated, the volume of cellulose-forming material which enters each cell would be approximately constant if the cells were of equal length. A strong cross-checking observation has been formerly recorded by one of us [2] in the fact that variations of wall-thickness during the whole fruiting season are not of linear dimensions, although the quantity measured is a linear one, but they are definitely of square dimensions, that is, areas. This result is, however, not simply a matter of volume of cellulose, because the hair-weight per centimetre is known to be nearly constant for all lengths of hair,[3] so that we cannot describe the wall-thickness as being conditioned by the area of primary wall surface which has to be covered, in spite of the fact that it is so conditioned by the perimeter of the tube. This curious discrepancy may help to illuminate the mechanism of cellulose deposition.[4]

Actually the diagram shows that in the cells of larger diameter the wall is even rather thinner than a strict adherence to constant area would suggest; the curvilinear correlation axis (not drawn) crosses the 79 μ^2 line.

A problem of the cell wall as yet unsolved is whether thin walls have the normal number of growth-rings, or whether they are thin because only a few growth-rings have been deposited. The form of the lower boundary of the group of dots (bounded as it is by the 28 μ^2 line) strongly suggests that every one of

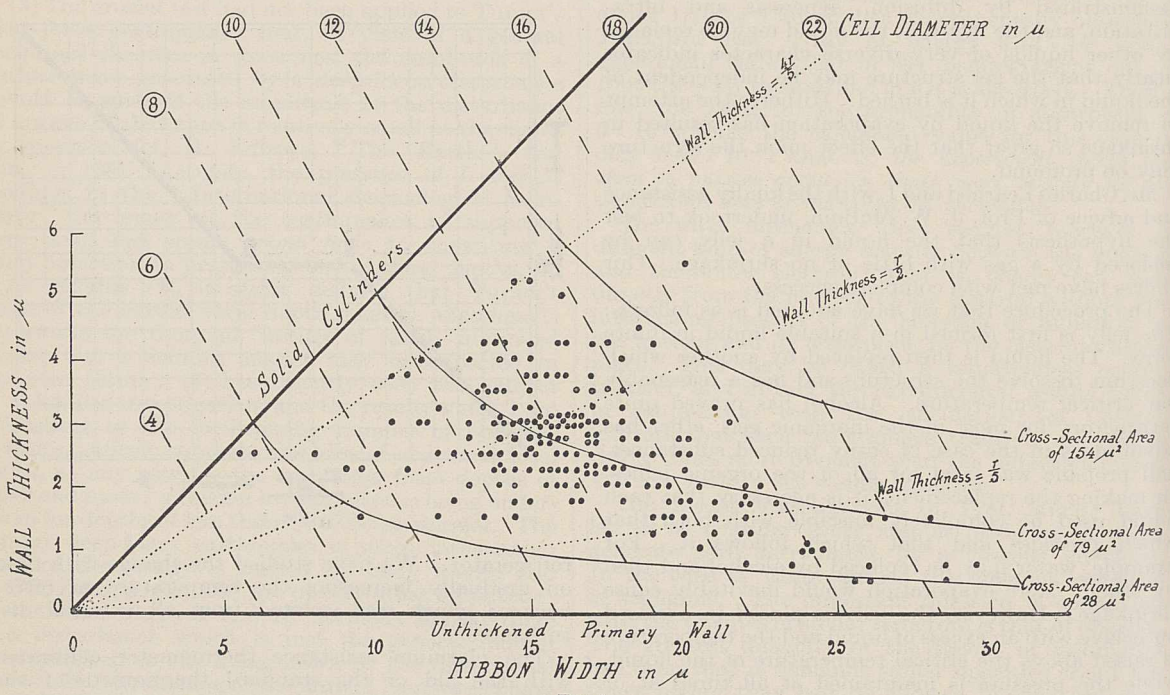

FIG. 1.

the two hundred cells measured has undergone the full sequence of growth-ring deposition; otherwise there should be thin walls among the small-diameter hairs.

The form of the upper boundary, showing that a lumen the radius of which is about one-fifth of the cell radius is normally left unfilled, is of physical interest, as will be seen presently.

A result of technological importance, both to cotton-spinner and cotton-grower, relates to the question of 'nep'. These hairs (which have walls so thin that they easily roll up into tangled bundles during their passage through the machines) are seen in this diagram to be predominant in the cells of big diameter, and to be absent among small diameter cells. Formerly one had imagined that they would be found in all diameters.

Lastly, we would point out that care should be taken in translating such data as these, drawn from the dead dry hair, into terms of growth and development. We have found that the frequency diagram of cell diameter undergoes remarkable modifications according to the condition of the hairs when measured. Living hairs measured from the green boll are much larger than the dead hairs, and these again are much larger than hairs 'swollen' with caustic soda to restore them to cylindricality, in Harland's method.[5] But, whereas the shape of the frequency distribution is unchanged between the living hair and the soda-treated hairs, the case is quite otherwise with the dry dead hairs; these have a far more compact distribution, and we have verified by direct search through our material that the thick-walled small hairs actually enlarge their diameter when the irreversible loss of water takes place at death; their centre is in compression when alive, presumably through convergence of the space-lattice columns of the fibrils towards the centre. This inference is cross-checked by Slater's unpublished observation, that the core of a cylindrical hair is more rigid than its periphery. In the thin-walled hairs, the removal of the water lost irreversibly after death allows the periphery to contract; the outer growth-rings, primary wall, and cuticle are thus in a state of tension, which accounts for the fact that most cross-sections of the dead cell have a crumpled appearance, unless the wall is more than half a radius in thickness. On softening with caustic soda, this tension relieves itself and the diameter decreases still further, even in the thick-walled small hairs.

It is remarkable that the physical properties of the cellulose wall should result in presenting to the cotton-spinner a much more uniform product than is produced on the plant, even though the plant has already done its best for him by making hairs of fairly uniform weight out of cells the diameter of which varies greatly. Thus, in the present diagram, the range of cell diameter from 5 to 19 microns (μ) might be expected to entail a range of cross-sectional area from 25 to 361 (being the squares of these diameters), whereas the actual area range is only from 25 μ^2 to 220 μ^2.

C. H. BROWN.
ABD EL GHAFFAR SELIM.
W. LAWRENCE BALLS.
Ministry of Agriculture,
Botanical and Plant Breeding Section,
Gîza, Mar. 22.

[1] W. L. Balls, "Development and Properties of Raw Cotton", London, 1915, p. 143.
[2] W. L. Balls, "Growth Fluctuations during the Development of Seed Cotton", *Tech. Bull.*, No. 101. Min. of Agric., Egypt.
[3] W. L. Balls, "Studies of Quality in Cotton", London, 1928, p. 154. Also Iyengar, R. L. N., and Turner, A. J., "The Weight per Inch of Fibres of different Lengths", Indian Cent. Cott. Comm., *Tech. Bull*, B, No. 7.
[4] Pierce, F. T., "Mechanism of Growth in the Cotton Hair", *Trans. Faraday Soc.*, No. 115, 26, part 12, 1930.
[5] Calvert, M., and Harland, S. C., "An Approximation to the Original Cell Diameter", *Shirley Inst. Memoirs*, vol. 2, No. 29.

Plankton Changes on the Coast of Ecuador.

I HOPE some oceanographer will be prompted to write at length some explanation (1) of the erratic behaviour of El Niño and (2) of the lenses of foul yellow water of which Mr. G. Sheppard writes in NATURE of April 25. May I make two suggestions?

The coolness and fertility of the Humboldt water is due to the upwelling of water from the depths to replace surface water blown westward by the prevailing off-shore winds of Peru and Chile. In *Yachting* of March and April, I read that the sailing yacht *Carlsark*, in six weeks of a voyage across the Atlantic last year, in the trade wind belt had only one day of north-east trades—and that, the first day out of Santa Cruz. Might not the cause of El Niño overcoming the Humboldt be due to a similar failure of the south-east trades over the Andes?

Winter gales pile up sea-wrack in the salens of Scotland's west coast. Several such inlets have the appropriate place-name of Brennfort (stinking port). With an off-shore wind and a high spring tide, I have seen huge areas of this putrid weed carried out into the sound in summer time. May I suggest, though unfamiliar with local physiography, that the prevailing in-shore wind of the Bay of Panama chokes up lagoons with rotting sea-ware, and that, concurrently with high tides, a reversal of the usual wind, for example, by the north-east trades crossing the Isthmus, might carry out the stagnant water to join El Niño?

I fear this is not a sufficient cause for the vast volume of putrid water that created such havoc among fish and birds off the Peruvian coast some six years ago. I have heard that boats painted with white lead turned quite black. That extensive miasma might have been due to volcanic action in the seas round the Galápagos.

WILLIAM SEMPLE.
Mile Ash, Dumfries,
April 27.

MR. G. SHEPPARD'S letter under this heading, in NATURE of April 25, directs attention to a matter which may be of serious importance. Apparently, the fœtid plankton accumulations described were dead material. Years ago, when oil began to be discharged upon the troubled waters of the oceans, some of us suggested *that the plankton might suffer*. Since then, multitudes of birds have been cast dead upon our shores enwrapped in oil. Occurring as these discoloured patches do, in the steamship lanes, they may be but a fulfilment of our prediction—one which sooner or later must come true: we cannot for ever sin against Nature. Has any attention been paid to such possibility by those who are studying the problem? Forced by modern sanitary practice to send our phosphates to sea, it will be strange if revenge be taken, through the oil wasters who are everywhere fouling the ways of life: through their interference with the recovery of phosphate by plankton.

HENRY E. ARMSTRONG.
55 Granville Park,
Lewisham, S.E.13.

The Mode of Action of Insulin.

IN a consideration of the mode of action of insulin it is of some importance to know the equivalent relationship between the amounts of hormone and dextrose, that is, the number of molecules of dextrose equivalent to one molecule of insulin. Up to a recent date this ratio was not known, on account of lack of knowledge of the molecular weight of insulin. A recent communication to NATURE [1] from Prof. The Svedberg has, however, provided the necessary information on this point. The molecular weight of 35,100 deduced

by Prof. Svedberg is in agreement with the physico-chemical behaviour of insulin, and is of the same order as those of ovalbumin and Bence Jones protein.

According to the extensive determinations of Culhane, Marks, Scott, and Trevan,[2] one international unit of insulin is equivalent to 1/24 mgm. of crystalline insulin. The weight of dextrose which this amount of insulin will remove from the blood is provided by data from the standardisation of insulin by the fall of blood-sugar in the rabbit. Assuming that the blood of a rabbit averages 1/13 of the total weight, the mean of the blood-sugar decrease in 174 rabbits (starved for 24 hr.), following injection of one unit of insulin, amounts to 100 mgm. of dextrose. In order to obtain this figure (for which I am indebted to the Pharmacological Department of these laboratories) the maximum drop of blood-sugar level has been taken. The true figure is probably higher, for although the decreased blood-sugar level inhibits the physiological production of insulin, the resulting liver-glycogenolysis would tend to prevent the minimum level being attained. This glycogenolysis is subnormal in rabbits starved for 24 hours.

The only other figure available in the literature is that due to Bouckaert *et al*,[3] who found that in order to maintain a normal blood-sugar level in rabbits receiving parenterally 1·26 gm. of dextrose per kgm. per hour, the injection of 6·8 units of insulin per kgm. per hour was necessary. This indicates that one unit of insulin is equivalent to 185 mgm. of dextrose. I have taken a mean value of 150 mgm. as the dextrose equivalent of one international unit of insulin. Hence it follows that 1 gm. of insulin will remove 3600 gm. of dextrose, or, using the value of 35,100 for the molecular weight of insulin, one molecule will remove $\frac{3600 \times 35100}{180}$, or approximately seven hundred thousand molecules of dextrose. Thus, there is no possibility that the action of insulin in removing dextrose from the organism is a stoichiometrical one depending on the presence of a number of certain active groups in the insulin molecule.

F. O. HOWITT.

Research Department,
Messrs. Boots Pure Drug Co., Ltd.,
Nottingham.

[1] Mar. 21, 1931, 438.
[2] *Biochem. J.*, **23**, 397; 1927
[3] *Arch. intern. physiol.*, **31**, 180; 1929.

Singlets of the Two-Electron Spectra B II, C III, N IV, and O V.

IN a recent analysis of C III the absolute term values of singlets and triplets could be independently determined from the D series in both systems. The difference $2\ ^1S_0 - 2\ ^3P_1$ was obtained as $52{,}380 \pm 200$ cm.$^{-1}$, which conclusively proves that λ2297, ν43524 cannot be the intercombination line, proposed by Bowen and Millikan.[1] Indeed, no such line has been found, in agreement with the improbability of a change of s in a spectrum with such small j separations.

The strong C III lines λ2297 and 1247 are identified with transitions to the normal $2s\ 2p\ ^1P_1$ from the two deep terms $^1D_2$ and $^1S_0$, arising from the configuration $2p\ 2p$. The terms thus obtained are checked by a large number of combinations with higher singlet levels.

In consequence of these identifications, the corresponding transitions in B II are taken as the lines λ3452 and 1842, previously thought[1] to be $2\ ^1S_0 - 2\ ^3P_1$ and $2\ ^1P_1 - 3\ ^1S_0$. Using the irregular doublet law, the combinations $2S - 2P$, $2P - 2D'$, and $2P - 2S'$ are then found for N IV and O V as shown in the accompanying tables. Three of the tabulated lines, B II $2P - 3D$, B II $2S - 2P$, and C III $2S - 2P$, were given their right assignment by Bowen and Millikan.[1] The terms are calculated from $2P - 3D$ on the assumption that

$$3D = Z^2 \times \frac{109{,}737 \cdot 1}{3^2},$$

which was very closely verified for C III by 5 members of the D series. The n^* for D' and S' are referred to the $2p$ state of C IV.

	$2P - 3D$.	$2s\ 2p\ ^1P_1$.	$2S - 2P$.	$2s\ 2s\ ^1S_0$.
B II	72,519 1378	121,291 1·90	73,396 1362	194,687 1·50
C III	174,131 574	283,868 1·86	102,351 977	386,219 1·60
N IV	298,525 335	493,613 1·89	130,687 765	624,300 1·68
O V	453,819 220	758,644 1·90	158,795 629	917,439 1·73

	$2P - 2D'$.	$2p\ 2p\ ^1D_2$.	$2P - 2S'$.	$2p\ 2p\ ^1S_0$.
B II	28,966 3452	92,325 1·77	54,264 1842	67,027 1·95
C III	43,524 2297	240,344 1·80	80,168 1247	203,700 1·92
N IV	58,189 1724	435,424 1·85	104,676 955	388,937 1·93
O V	72,924 1371	685,720 1·87	129,112 774	629,532 1·94

In the next table, $3P$ is determined from $2S - 3P$, and then, confirming the term system, strong lines are found in all the spectra at exactly the calculated position for $2D' - 3P$. In C III, $2S' - 3P$ was also found.

	$2S - 3P$.	$2s\ 3p\ ^1P_1$.	$2D' - 3P$ calc.	$2D' - 3P$ obs.
B II	144,105 693	50,582 2·95	41,743	41,740 2395
C III	258,941 386	127,278 2·79	113,056	113,056 884
N IV	404,524 247	219,776 2·83	215,648	215,652 463
O V	580,828 172	336,611 2·86	349,149	349,113 286

These transitions, $2p\ 2p\ ^1D_2 - 2s\ 3p\ ^1P_1$ and $2p\ 2p\ ^1S_0 - 2s\ 3p\ ^1P_1$, are in accord with the Heisenberg selection rule[2] for two-electron jumps, $\Delta l_1 = \pm 1$, $\Delta l_2 = 0$ or ± 2. However, no trace has been found of the corresponding transition in the triplet system, $2p\ 2p\ ^3P - 2s\ 3p\ ^3P$, agreeing with another form, $\Delta l_1 = \pm 1$, $\Delta l_2 = \pm 2$, given as the Heisenberg rule by Grotrian[3] and Pauling and Goudsmit.[4] It seems as if the observed data in C III could be represented by the addition to the selection rule that the transitions $\Delta l_1 = \pm 1$, $\Delta l_2 = 0$ are allowed only if $\Delta L = \pm 1$.

BENGT EDLÉN.

Physics Laboratory, University,
Uppsala, April 10.

[1] I. S. Bowen and R. A. Millikan, *Phys. Rev.*, **26**, 310; 1925.
[2] W. Heisenberg, *Zeit. f. Phys.*, **32**, 841; 1925.
[3] W. Grotrian, "Graphische Darstellung der Spektren, etc.", I., p. 204; 1928.
[4] L. Pauling and S. Goudsmit, "The Structure of Line Spectra", p. 93; 1930.

Modern Progress in Vertebrate Palæontology.*

By Sir ARTHUR SMITH WOODWARD, F.R.S.

IN a paper read to the Zoological Society in 1880, Huxley remarked that the astronomer who had determined three places of a new planet could calculate its place at any epoch, however remote; and if the law of evolution was to be depended upon, the zoologist who knew a certain length of the course of that evolution in any given case, might with equal justice reason backwards to the earlier but unknown stages. He accordingly surveyed the backboned or vertebrate animals, both living and extinct, so far as they had then been discovered, and he defined the successive stages through which they must have passed before they ended in the higher warm-blooded quadrupeds and birds which dominate the world of life to-day. He pointed out how, in the existing world, most of the earlier stages are represented only by animals with very special adaptations to their several modes of life, which give little idea of the variety displayed by animals of the same stage in former geological periods. He concluded that a multitude of extinct groups of each stage had still to be revealed, most of those groups being short-lived adaptations to the several spheres of life which were open to them at the time, and only a small proportion on the direct line of ancestry of the existing vertebrate animals. The actual links in the chain of life from the lowest to the highest rank must, therefore, have been comparatively few.

Even in Huxley's time there were already indications of several more extinct groups than those he dealt with in his researches, but the fossils by which they were known were too fragmentary to be satisfactorily interpreted. During more recent years, those early discoveries have been supplemented by numerous collections from various parts of the world; while the methods of preparing and studying even the most unpromising fossils have in all respects greatly improved. Much progress has, therefore, been made in understanding the relationships of the extinct forms of life, and in using them for discussing the problems of organic evolution. The vertebrates, especially, have proved remarkably interesting.

The earliest forerunners of the vertebrate animals (the Hypichthyes of Huxley) have not yet been found among fossils, probably because they had no hard parts capable of being preserved in ordinary circumstances in rock. They are still known only by their highly modified living representative, *Amphioxus*. Huxley's second stage, however, that of the Myzichthyes, represented by the lampreys and hag-fishes at the present day, has now been identified among fossils exactly where it might have been expected. It flourished especially in the latter part of the Silurian period, but ranged from the Ordovician to the Devonian. It included free-swimmers like the Anaspida, which have been found well preserved in the Upper Silurian (Downtonian) rocks of southern Norway and southern Scotland. They had an external skeleton enough to show that, while they agreed with the lampreys in the single narial opening and in the pouched gills, they had less degenerate jaws and possessed incipient paired pectoral fins. They also resembled the larva of the existing lamprey in having the end of the body turned downwards into the tail fin. They were accompanied by other Myzichthyes, like the Cephalaspidians, which were bottom-dwellers and had both an external skeleton and an internal head-skeleton so well ossified that in specimens discovered in Spitsbergen, Prof. Erik A. Stensiö, of Stockholm, has been able to recognise many of their lamprey-like characters. The surviving lampreys and hag-fishes, therefore, give no idea of the variety and adaptations of the Myzichthyes in their prime, when they dominated the world of life.

The next stage, that of the Chondrichthyes, represented by the existing sharks, skates, and chimæroids, has also lately been recognised as dominant in its proper place in the geological record. Thanks especially to the researches of Stensiö, it now seems clear that during the latest part of the Silurian period and the Devonian period, when these fishes were in the forefront of progress, they developed true bone both externally and internally. They included the free-swimming Acanthodians, which are very shark-like, but have long been puzzling because, although their skeleton does not consist of typical bone, it is of more complex structure than the hard tissue of any modern shark or skate. The Chondrichthyes also included the heavily-armoured grovelling fishes like *Coccosteus* and *Dinichthys*, which are now generally known as *Arthrodira*. Quite lately, Prof. F. Broili has described a skate-shaped fish, *Gemuendina*, from the Lower Devonian of Germany, which seems to combine the characters of an Arthrodiran with those of a skate. Also, not long ago, Prof. P. Pruvost found, in the Lower Carboniferous of Belgium, part of a peculiar shark, *Cratoselache*, which retains the remnants of the bones of an Arthrodiran in the roof of its skull.

Huxley's next stage in the evolution of the vertebrates, that of the Herpetichthyes, or fishes which gave rise to the lung-breathers as well as to the typical modern fishes, proves to be represented among fossils not precisely as he supposed it to be. The Dipnoi, which he thought were the ancestral lung-breathers, seem now to be merely an offshoot which ended in the existing *Lepidosiren*, *Protopterus*, and *Ceratodus*. The real links between the Herpetichthyes and the earliest lung-breathers or Amphibia are the osteolepid fishes, which begin just where they might be expected, in the Middle Devonian rocks.

The Amphibian stage occupied the foremost place in the world of life of the Carboniferous period, and

* From the Huxley Lecture delivered in the Imperial College of Science on May 4.

Prof. D. M. S. Watson has shown that some of its representatives during this period, the early stegocephalians, are remarkable links between the osteolepid fishes and the later amphibians.

The next or Hypotherian stage, which flourished in the Permian and Triassic periods, included the ancestors of the mammals besides those of the reptiles and birds. Huxley did not recognise the former, but since 1880 the discoveries of Seeley, Watson, Haughton, and especially Broom, in South Africa, have revealed skeletons of cynodonts which can scarcely be distinguished from those of primitive mammals. In general appearance the skull always resembles that of a carnivorous mammal, and the teeth are arranged as if they were incisors, canines, premolars, and molars. The teeth also differ from those of ordinary reptiles in having scarcely any replacing teeth. Still more remarkable is the lower jaw, which consists almost entirely of the pair of dentary bones, as in a mammal, the other bones being reduced to a little cluster behind where they articulate in the reptilian way with the quadrate bone of the skull. In some of the little cynodonts which are no larger than rats (Ictidosauria), the quadrate bone is so small that it forms only part of the articulation for the lower jaw, the rest being formed by the squamosal bone, which extends to the whole of it in mammals. Through the cotylosaurian reptiles there are indications of every gradation between these cynodonts and the earlier amphibians, so that satisfactory links between the lowest and the highest land vertebrates will probably soon be forthcoming.

It is especially interesting to note that the nearest approach of the hypotherian stage to the next higher or prototherian stage is made by species of comparatively small size; for when undoubted Prototheria first appear later in the Jurassic rocks, scarcely any of them are larger than rats. When the first known representatives of the next higher mammalian stages of Metatheria and Eutheria follow them in the Upper Cretaceous rocks, the species are of equally small size. So far as palæontologists have experience at present, all links between the greater groups of vertebrate animals are to be found among the smallest, not the largest species.

Owing to the fragmentary nature of the fossils, little can be said about the Prototheria, which are represented in the existing world only by the monotremes of the Australian region. During the Jurassic and Cretaceous periods, they were overshadowed by the reptiles which flourished everywhere, and they seem always to have occupied a subordinate position. Very little is known also of the earliest Metatheria and Eutheria, which are represented at the present day by the marsupials and the higher (placental) mammals respectively. They appear together in the Upper Cretaceous formations of western North America, and skulls of small Eutherians have lately been found by an American expedition in corresponding rocks in Mongolia. It is clear, however, that by the beginning of the succeeding Tertiary period, which has well been named 'The Age of Mammals', the chief groups of Eutherians were already diverging into the several lines which have eventually become more clearly separated and even again subdivided. In certain paragraphs of his classic paper of 1880, Huxley distinctly recognised these facts and briefly stated them. It is, therefore, curious that he used parallel lines instead of diverging lines to represent the hypothetical pedigrees in his "Table of the Arrangement of the Mammalia", which has accordingly been criticised with some justification.

Huxley's interest in the subject was first roused by the numerous discoveries of ancestral mammals which were being made in the 'seventies in the Tertiary land deposits of western America, and especially by his visit to Prof. O. C. Marsh in 1876, when he examined the great collection of fossils in the Museum of Yale University at New Haven. At this time, Prof. Marsh had just arranged a series of specimens to show the genealogy of the horses, beginning with little four-toed swamp animals which had low intelligence and crushing teeth, and ending in the largest one-toed, plain-roaming animals, which had a much superior brain and grinding teeth. Subsequent more elaborate collecting and research in the same rocks by Prof. H. F. Osborn and his colleagues, of New York, have shown that the gradual evolution of the horses can sometimes be followed even in the most minute characters. At the same time, they have proved that the tracing of genealogies among the fossil mammals is not so easy as was at first supposed, even when the specimens are numerous and display well-preserved important features. It now appears that in each group there is no single line of advance, but there are several lines all changing in the same direction, only with slight differences and often at different rates. These are generally assemblages adapted for somewhat different modes of life. Such parallel developments have been observed in America among the fossil rhinoceroses, camels, cats, and other groups; and they are especially evident in the extinct hoofed animals known as the Titanotheres, which have lately been described by Prof. H. F. Osborn in the most exhaustive treatise ever devoted to a group of fossil vertebrates. There can, indeed, no longer be any doubt that each great group starts its career in geological time with certain innate potentialities which we do not understand, but which compel all its members, however varied may be their respective adaptations and modes of life, to follow the same course to the end.

In the Old World, we have had fewer opportunities of following the evolution of the Eutherian mammals, because the fossil record has so far proved much more incomplete. Among achievements during this century, however, must be specially mentioned the discovery by the late Dr. Charles W. Andrews of the pedigree of the elephants. Even in this case, we now realise that some remarkable changes occurred independently in more than one line. Among the later elephants, at any rate, there must have been several parallel series evolving in the same direction.

The Old World, nevertheless, has its compensations, for here we are able to study the most fascinat-

ing problem of all among mammals, the ancestry of man himself. There can now be no doubt that the man-like apes have always been restricted to the Old World, and that the ancestors of man must be sought among their ancestors. Hitherto, we have not made much progress, but the few discoveries that have rewarded our efforts during the present century are decidedly encouraging. In Huxley's time, the only fossil man known which exhibited more resemblances to the ape than any existing man, was that of the race first met with in 1856 in a cave in the Neanderthal, near Düsseldorf, Germany. His skull resembled that of the apes in its great bony brow-ridges; and his lower jaw lacked the usual prominence at the bottom of the bony chin. Among subsequent discoveries, the fragment of skull of *Pithecanthropus* from Java has still more prominent brow-ridges; and a human lower jaw from Heidelberg has a still more ape-like bony chin. On the other hand, the equally ancient skull of *Eoanthropus* from Piltdown, Sussex, has a good forehead without brow-ridges, and it approaches apes chiefly in its remarkable lower jaw and teeth. Now we welcome the recent discoveries of skulls and teeth of another fossil man, *Sinanthropus*, which have been made in a cave not far from Peking, in China. These fossils date back to a geological period at least as remote as those of *Pithecanthropus*, *Eoanthropus*, and the Heidelberg man, and it is not impossible that they are more ancient. They are, therefore, of extreme interest, and Dr. Davidson Black's preliminary descriptions and beautiful photographs of them show that they are specially important as displaying in combination several characters which in previous specimens have been separate and distinctive. In top view, for example, the skull of *Sinanthropus* looks astonishingly like that of *Pithecanthropus*, with the same bony brow-ridges; but the frontal region and parietal bosses are more tumid, and the bone is much thicker. The brain-case is as thick as that of *Eoanthropus*, and the bone has the remarkably fine spongy texture which has previously been observed only in the Piltdown fossil. The skull of *Sinanthropus* is also low and squat, with the same broad base and peculiarly-shaped occiput as in *Eoanthropus*. It also has the modern-looking deep sockets for the articulation of the lower jaw. The lower jaw and teeth of *Sinanthropus*, however, are more like those of Heidelberg man. This combination is indeed curious, and each new discovery makes it more clear that modern man is the sole and successful survivor of many and very varied former approaches to the unique position which he now holds.

In conclusion, the question arises as to whether such modern advances as have been described here, in the study of fossil vertebrate animals, are definitely leading to a better understanding of the general principles of our science. We may reply that the progress already achieved has, indeed, been helpful in this respect, and that it is now much easier to predict lineages and the course of discovery than it was in 1880, when Huxley ventured on his pioneer essay. We have made distinct progress in correlating changes in the world of life with alterations in surrounding conditions, and we can often trace gradual improvement in adaptation to controlling circumstances.

It seems possible to recognise now even that the few fundamental advances in the evolution of the vertebrates have all coincided with widely spread "revolutions of the globe", to adopt Cuvier's old expression, which we may now use in a new sense. The passage of the Myzichthyes into the Chondrichthyes seems to have occurred when fishes first ventured from the shallows into the open ocean. The Herpetichthyes probably began in adaptation to the conditions of the fresh-water lakes, in the deposits of which we first find them. During the Devonian period, when this adaptation was complete, the rocks show that there was widely-spread desiccation in many parts of the world. Conditions were, therefore, favourable for the origin of the amphibia, which seem to have appeared at about this time. In the Permo-Triassic period there were again most extensive deserts, and the speculation has been hazarded that the reptiles, which had then become established, were stimulated to activity and evolution by the need for long journeys in search of food. Some of the earliest reptiles, or Hypotheria, passed into the Prototherian mammals when genial conditions were advancing. The Metatherian and Eutherian mammals first began to spread and take the place of the vanished dominant reptiles at the end of the Cretaceous period, when there were world disturbances in mountain building and a cooling of the climate in large areas of the northern hemisphere. Finally, man emerged from the ape grade probably in the northern hemisphere during the hard circumstances at the beginning of the Great Ice Age in the Pleistocene period.

Direct competition between the representatives of one stage and the next seems rarely to have happened. The giant land reptiles, for example, which dominated the world during the Jurassic and Cretaceous periods, can scarcely have been exterminated by the competition of the mammals, which were all very small and scarcely came in contact with them. The mammals spread and flourished only when the lands had become practically vacant; and long after the reptiles had disappeared, even so late as the Lower Eocene period, there were still no land animals of any kind larger than a pig. Similarly, the great sea reptiles which lived until the end of the Cretaceous period, were not exterminated by the whales which eventually took their place. We now know that the whales originated only after the ichthyosaurs, plesiosaurs, and mosasaurs had vanished, and that even the comparatively small ancestors of the whales never entered into competition with these forerunners in their sphere in the oceans.

It is, indeed, probable that the procession of life which we observe has depended as much on the influence of surrounding conditions as on the inherent characters and tendencies of the various groups of organisms themselves. For a further understanding of the subject, therefore, geologists and biologists must still continue to co-operate.

Engineering Research in Great Britain.

JAMES FORREST, who died on March 2, 1917, at the age of ninety-one years, was connected with the Institution of Civil Engineers for fifty-four years, during forty of which he was assistant secretary or secretary. It was the ambition of his life to make the Institution the premier professional society in the world, and during his tenure of the secretaryship the names on the roll of the Institution rose from between 800 and 900 to 6900, and the annual income from £3000 to £20,000. He retired from office in 1896, but six years previously the Council, to mark its appreciation of his work, presented his portrait to the Institution, and a little later the members placed at his disposal a sum of £500. Forrest himself determined that this should be devoted to the establishment of a James Forrest lectureship, to be administered by the governing body of the Institution; and in 1893, Sir William Anderson was chosen to deliver the first lecture in accordance with the trust.

Anderson's lecture was on the "Interdependence of Abstract Science and Engineering". Another lecture, given in 1896, was by Sir Alexander Kennedy, whose subject was "Physical Experiment in Relation to Engineering".

While these subjects gave a wide field over which the lecturer could roam at will, other lectures have been devoted to some specific branch of engineering, as, for example, the lecture on "Unsolved Problems in Metallurgy", delivered by Sir Robert Hadfield in 1906, and that on "Unsolved Problems in the Design and Propulsion of Ships", given by Dr. Francis Elgar in 1907; but throughout the entire series of lectures, research has been given great prominence, and in the opening of the thirty-seventh James Forrest lecture, delivered at the Institution of Civil Engineers on May 5 of this year, Sir Thomas Stanton stated that his immediate object was "to trace the changes which have taken place in the nature of the subjects studied in engineering laboratories from the date of Sir Alexander Kennedy's lecture in 1896 to the present time".

Forty years ago almost all engineering laboratories were attached to educational establishments and were simply physical laboratories modified for engineering purposes. Problems of engineering research, however, became of a more 'physical' nature, and in consequence engineering laboratory methods had to some extent changed their character, while engineering laboratory research is becoming more and more detached from engineering education.

The matters discussed by Sir Alexander Kennedy were concerned almost entirely with the performance, economy, and efficiency of machines and prime movers, work admirably adapted to meet the urgent educational need of that time; but the scope of modern investigatory work in engineering can be illustrated by a review of problems of interest studied recently at the National Physical Laboratory. The work of the Engineering Department of the Laboratory can be divided into three groups: (*a*) Government research done for research committees and boards of the Department of Scientific and Industrial Research, for certain research associations, for the Air Ministry, the War Office, the Ministry of Transport, and other Government civil departments; (*b*) researches forming part of the general programme of the Laboratory Research Committee; and (*c*) special investigations for the general public. The latter work is undertaken at a scale of fees determined by the measure of publicity which clients are willing to allow to the Laboratory report. Under group (*b*) were included in 1929 investigations of the efficiency of power transmission by gears, of hardness tests of materials, of stress distribution in reinforced concrete columns due to shrinkage, of the properties of waves set up by wind blowing over water, of vortex rings discharged in the wake of a disc immersed in a stream of fluid, and of the variation of pressure in steel cylinders containing dissolved acetylene as the temperature is raised.

No fewer than twenty-four subjects were included in the Government research programme in 1929, among these being investigations on lubrication, the transmission of heat, the ignition of gases by sudden compression, the fatigue phenomena exhibited by single crystals of metals, the bearings of aircraft engines, the endurance of laminated springs as found in motor vehicles, the mechanical properties of materials at high temperature, the resistance of projectiles, the pin joints of caterpillar tractor track-shoes, the efficiency of motor lorry gear boxes, the distribution of wind-pressure on roofs, the mixing and laying of concrete roads, and the friction of road surfaces. Special investigations carried out in 1929 dealt with ceiling fans, steam-pipe coverings, safety glass, brake linings, ball and roller bearings, the vibration of buildings, and the action between white metal alloys and lubricants.

One piece of work of a novel and interesting character has arisen out of a visit to Paris in 1918 by the British Ballistic Mission, who saw there apparatus in which a model projectile was exposed to a momentary jet of air at high speed. At the National Physical Laboratory it was found that the construction of a continuously flowing current of air up to twice the speed of sound presents far fewer difficulties than those experienced with the momentary jet; and a three-inch diameter wind channel has been developed in which the head resistance of model projectiles can be measured at speeds up to three times that of sound, and relative values due to changes in the design of the head and base of the projectile can be determined.

One of the most striking developments of recent years is the increase in the application of the method of scale model testing to the solution of engineer-

ing problems. The method was foreshadowed by Newton in the "Principia", and the theory was extended by Stokes, Helmholtz, Froude, James Thomson, and Osborne Reynolds. The foundations of the method were laid by these pioneers, and the last forty years has witnessed the continued growth of its application to a wide range of problems. Sir Thomas Stanton stated that he did not intend to put forward arguments for their extension; he believed that what is wanted is a somewhat more critical review than has hitherto been attempted of the implications of the method, and of the extent to which engineers may rely on the predictions to full scale made from them. He dealt with the principle involved in scale model testing, and illustrated it by reference to the prediction of the resistance of a ship, the hydraulic resistance of pipe lines, and the prediction of the wind resistance of roofs and bridges.

The concluding part of the lecture contained a review of the present position of engineering research in Great Britain. Sir Richard Glazebrook, in his James Forrest Lecture in 1923, reviewed then the conditions, and the most notable step taken since has been the formation of an important Research Department of the Ministry of Transport under the Roads Improvement Act, 1925, and the inauguration in 1930 of a research station at Harmondsworth. This will probably be the largest engineering research laboratory in Great Britain. There remains the important consideration of whether the financial provision for engineering research is adequate. A comparison of Great Britain with other European countries is difficult on account of the lack of definite information, but a comparison with the expenditure on research in the United States shows that the sum we spend is of very modest proportions. Research, however, is being encouraged in various ways, and, Sir Thomas Stanton said, "taking into consideration the sympathetic attitude of the Research Department, we may, I think, conclude that, apart perhaps from research in aeronautics and metallurgy, the existing provision for general engineering work is adequate, and that should further provision be considered advisable for investigations of national importance, the Department may be relied upon to give all the help that can be made available".

The Royal Institution.

THE president, Lord Eustace Percy, and Managers of the Royal Institution went direct to the core of old English custom when they invited the members and other visitors, representative of the diplomatic and public services, science, arts, literature, and medicine, to a "House Warming" in Albemarle Street. It was held on May 6, and was largely attended. Fleetwood, in an epistolary of 1577, says, "The shoemakers of London having builded a newe Hall, made a royall feast for theire friends, which they call theire house warming". Then, Evelyn chronicles, under date Nov. 28, 1661, "I dined at Chiffinch's housewarming in St. James's Park"; and in a number of the *Spectator* for 1712, the following occurs: "I must make the present entertainment like a treat at an housewarming, out of such presents as have been sent me by my guests".

The primary object of the house warming was, of course, to demonstrate the realisation in material form of the reconstruction effected in the Royal Institution. It has long been recognised that rebuilding and a readjustment of certain parts to modern needs was a real necessity. This applied particularly to the Lecture Theatre, which remained much as it was since completion in 1802, an auditorium, moreover, constructed entirely of timber. We think that the Managers are to be congratulated on preserving so much of the old-time atmosphere of this historic room, the scene of the early experiments of Davy and Faraday and their successors. The scientific equipment of the theatre has now been considerably extended; a cinematograph projector and an epidiascope have been installed, together with many technical desiderata essential for the proper and convenient elucidation of lecture subjects.

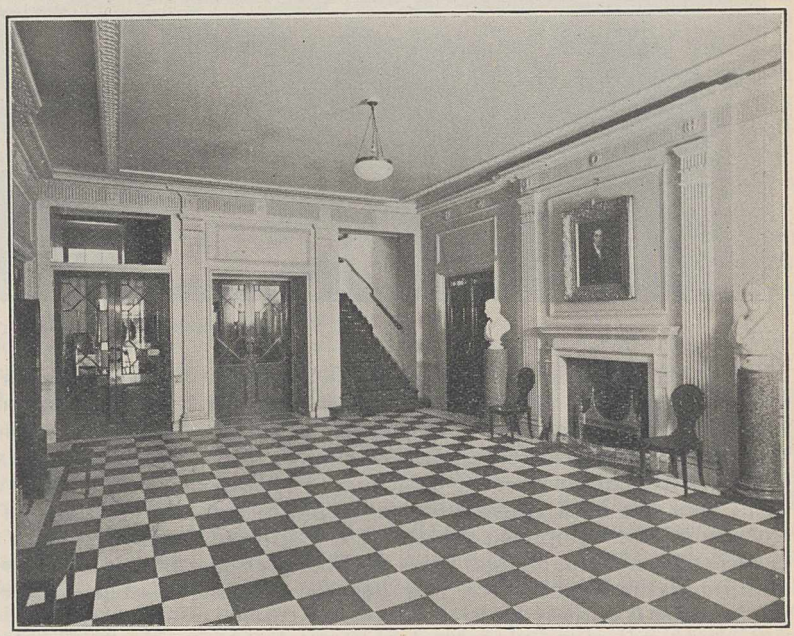

FIG. 1.—New Entrance Hall, Royal Institution.

The rebuilding of the Lecture Theatre has

naturally involved the replanning and reconstruction of a large adjacent part of the building. The ante-room on the first floor has been enlarged and redecorated in excellent taste. Opening from this is the ambulatory, around which, beneath the seating of the theatre, well-lighted showcases for historic apparatus in the possession of the Institution have been arranged. Opening from the opposite side of the ante-room is a long corridor giving access to the Far Library and also to the Davy Faraday Research Laboratory.

A new entrance hall has been constructed, and this is supplementary to the fine old entrance hall, and staircase, adjacent, which was in existence in 1799 at the foundation and occupancy of the building. A large new chemical laboratory has been built on the ground floor, and some of the rooms replanned, to enable an exit from the Lecture Theatre direct to the street to be made. The basement area has been rearranged, and contains the workshops, the equipment for the distribution of electric power throughout all parts, and the heating and ventilation plant. The new heating system in operation is entirely electric.

An interesting programme was arranged for the house warming. All parts of the Institution were open to guests, including the director's flat on the second floor, which contains Faraday's study. Sir William Bragg gave demonstrations in the Lecture Theatre, comprehended in the title "Classical Experiments of the Royal Institution". He showed Davy's experiments on the decomposition by electrolysis of potash to obtain metallic potassium. Faraday's experiment on the induction of electric currents in a coil by the movement of a magnet into and out of it was shown; his 'great cube' experiment, to show that electricity resides on the outside of a conductor, was also demonstrated, for which purpose a small wire cage was erected in the Lecture Theatre. This experiment must have been described in hundreds of text-books, but there are probably not many who have seen a person sitting unharmed inside an electrified cage while sparks are drawn from the outside. Rayleigh's experiment on the production of a sound shadow was also shown; the sound waves from a bird-call were obstructed by a glass disc, on the other side of which a sensitive flame gave a response only when on the axis of the disc, due to a diffraction effect of the sound waves. In relation to Sir James Dewar's low temperature work, a diamond was heated in a crucible and thrown into a dish of liquid air, where it burnt, deriving oxygen for combustion from the liquid air. The historical apparatus in the keeping of the Institution was displayed and supplied with full descriptive particulars. In addition, there were exhibits and experiments in the Davy Faraday Research Laboratory illustrating the latest developments in the technique of X-ray crystal analysis; these included a demonstration of the rotating cathode X-ray tube developed by Dr. A. Muller.

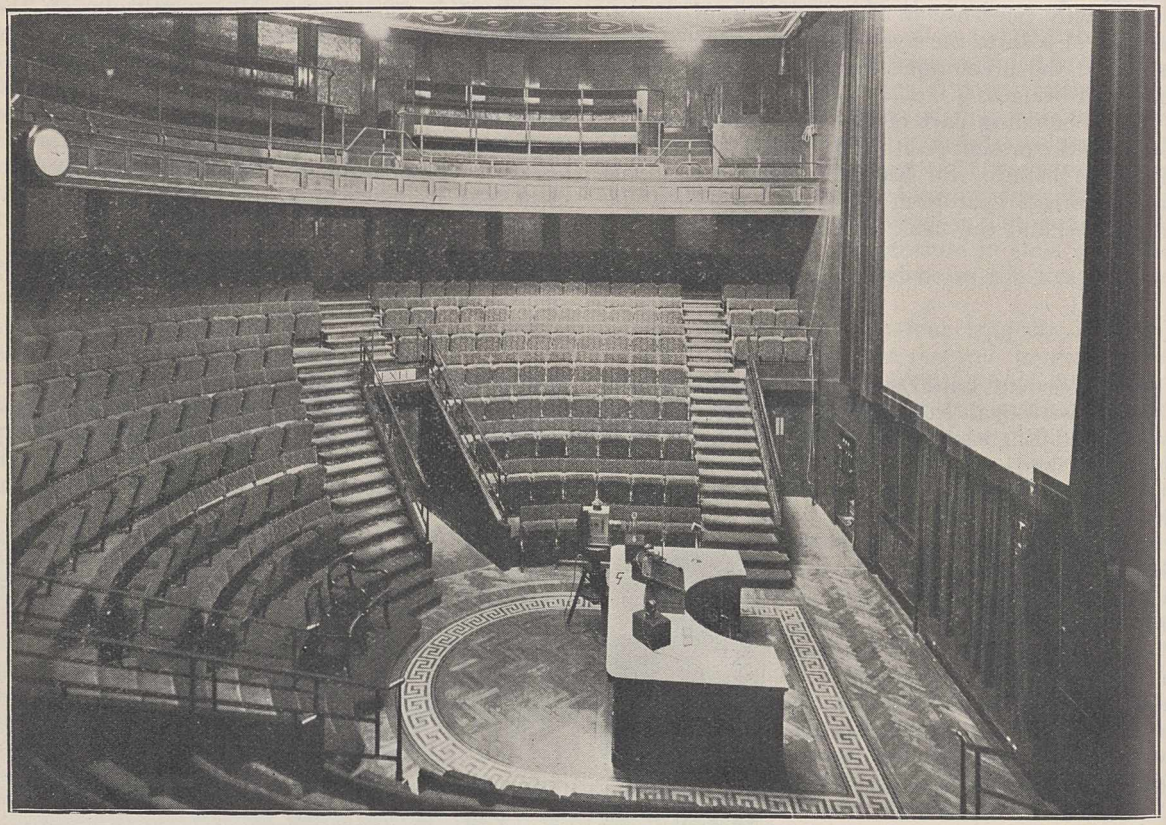

FIG. 2.—Lecture Theatre, Royal Institution.

Obituary.

PROF. A. A. MICHELSON, FOR.MEM.R.S.

WE much regret to announce the death, which occurred on May 9, of Prof. A. A. Michelson, the distinguished physicist of the University of Chicago. Prof. Michelson was probably best known for his wonderful experimental work to detect any effect of the earth's rotation on the velocity of light. At the end of 1929, he resigned his position at the University of Chicago and went to Pasadena, where he proposed to carry out further work on this subject, and it is reported that preliminary measurements have already been made. Prof. Michelson had worked previously at Mount Wilson Observatory, Pasadena, and a brief account of repetitions of the famous Michelson-Morley experiment, as it is generally called, with a diagram of the apparatus, was contributed to NATURE of Jan. 19, 1929, by him and his collaborators. The results then obtained showed no displacement of the interferometer fringes so great as one-fifteenth of that to be expected on the supposition of an effect due to a motion of the solar system of three hundred kilometres per second through the ether. Since then, Prof. Michelson has been awarded the Duddell Medal for 1929 of the Physical Society of London for his work on interferometry.

In NATURE of Jan. 2, 1926, we were fortunate in being able to publish, as one of our series of "Scientific Worthies", an appreciation of Prof. Michelson and his work by Sir Oliver Lodge. We print below extracts from that article.

"Albert Abraham Michelson was born in Strelno, Poland, on Dec. 19, 1852. In 1854 his parents migrated to the United States. After emerging from High School in San Francisco, young Michelson was appointed to the Naval Academy, from which he graduated in 1873, and two years later became instructor in physics and chemistry under Admiral Sampson, continuing this work until 1879. After a year in the Nautical Almanac Office at Washington, Michelson, now an ensign, went abroad for further study at the Universities of Berlin and Heidelberg, and at the Collège de France and the École Polytechnique in Paris. Upon his return to the United States in 1883 he became professor of physics in the Case School of Applied Science, Cleveland, Ohio; whence, after six years, he was called to Clark University, where he remained as professor until 1892, when the University of Chicago opened its doors. Prof. Michelson went to this new institution as professor of physics and head of the department. In June 1925 he was honoured by being appointed to the first of the Distinguished Service Professorships made possible by the new development programme of the University.

"It was while he was at Cleveland that Prof. Michelson collaborated with Prof. Morley in their joint experiment; and it may have been for the purpose of that experiment that he invented his particular form of interferometer, with the to-and-fro beams at right angles. Later, he applied it in Paris to the determination of the metre, with an estimated accuracy of about one part in two million.

"During the War, Prof. Michelson re-entered the Naval Service with the rank of Lieutenant-Commander, giving his entire time to seeking new devices for naval use, especially a range-finder, which became part of the U.S. Navy Equipment.

"A Nobel Prize was awarded to Prof. Michelson in 1907, the first American to get one for science; and the Copley Medal, the most distinguished honour of the Royal Society of London, was awarded him in the same year.

"The gold medal of the Royal Astronomical Society was presented to Prof. Michelson on Feb. 9, 1923; and the compact exposition of the reasons for that award, by the president, Prof. Eddington, on that occasion will be found in NATURE, vol. 111, p. 240.

"Michelson touched on many departments of physics, but in optics, the highest optics, he excelled. In this subject he can be regarded as the most fertile and brilliant disciple of the late Lord Rayleigh, for his inventions are based on a thorough assimilation of the principles of diffraction, interference, and resolving power; and his great practical achievements are the outcome of this knowledge. Michelson seemed to have a special instinct for all phenomena connected with the interference of light, with a taste for exact measurement surpassed by none in this particular region. The interferometer with which he began became in his hands much more than an interferometer. He applied it to the determination of the standard metre in terms of the wave-length of light, with exact results which will enable remote posterity millions of years hence to reconstruct, if they want to, the standard measures in vogue at this day. He applied it also to analyse the complex structure of spectrum lines, and with remarkable completeness to determine the shape and size of invisible objects, such as to ordinary vision, however much aided by telescopic power, will probably remain mere points of light.

"In a magnificent paper in the *Phil. Mag.* of July 1890, Michelson suggested the application of interference methods to astronomy. He knew well that the resolving power of a telescope depended on the diameter of its aperture, and that the formation of an image was essentially an interference phenomenon; the minuteness of a point image, and therefore the clearness of definition, depending on the size of the object-glass. But he pointed out that if the aperture was limited to slits at opposite edges—so that no actual image anything like the object would be formed, but only the interference bands which the beams from the two slits could produce—a study of those bands would enable us to infer about the source of light very much more than we could get by looking at its image. For example, suppose it was a close double star, and suppose the slits over the object-glass were movable,

so that they could be approached nearer together, or separated the whole distance of the aperture apart. A gradual separation of the slits would now cause the fringes to go through periods of visibility and invisibility; and the first disappearance of the fringes would tell us that the distance apart of the two components of the star (multiplied by the distance between the slits and divided by the distance of the star) would equal half a wave-length of light. The two components might be far too near together ever to be seen separately, and yet we could infer that the star was a double one; and by further attention to the visibility curve we could infer the relative brightness of the two components and their position relative to our line of sight.

"Furthermore, if, instead of looking at a star, we turned the slit-provided telescope on a planet with a disc too small for ordinary measurement, the size of that disc could be estimated from the behaviour of the interference fringes produced by its light in a suitable interferometer, or by the telescope converted into one.

"In view of the great interest aroused by the application of this method by Michelson himself, with the aid of collaborators at Mount Wilson Observatory, Pasadena, California, and with the hundred-inch telescope established there, it may be interesting to quote here part of the conclusion of his paper of date 1890:

"'(1) Interference phenomena produced under appropriate conditions from light emanating from a source of finite magnitude become indistinct as the size increases, finally vanishing when the angle subtended by the source is equal to the smallest angle which an equivalent telescope can resolve, multiplied by a constant factor depending on the shape and distribution of light in the source and on the order of the disappearance.

"'(2) The vanishing of the fringes can ordinarily be determined with such accuracy that single readings give results from fifty to one hundred times as accurate as can be obtained with a telescope of equal aperture.'

"'If among the nearer fixed stars there is any as large as our sun, it would subtend an angle of about one hundredth of a second of arc; and the corresponding distance required to observe this small angle is ten metres, a distance which, while utterly out of question as regards the diameter of a telescope-objective, is still perfectly feasible with a refractometer. There is, however, no inherent improbability of stars presenting a much larger angle than this; and the possibility of gaining some positive knowledge of the real size of these distant luminaries would more than repay the time, care, and patience which it would be necessary to bestow on such a work.'

"There seemed little hope at that time, and certainly no reasoned expectation, that any stars, except perhaps some of the very nearest, could have discs big enough for perception and measurement even by this virtual telescope of thirty feet aperture. The possibility of giant stars came, however, above our mental horizon; and Eddington made the notable prediction that a star like Betelgeuse must be in a highly rarefied state at a tremendously high temperature, and that it would be swollen out by the pressure of light to a size almost comparable with the dimensions of a solar system, although it could not contain very much more matter than, say, two or five times our sun. His argument, in brief, is that the spectrum of a young red star like Betelgeuse shows that it cannot be radiating furiously. Why then is it so conspicuous an object to our vision? It can only be because it is of enormous size, its density perhaps a thousand times less than atmospheric air. By utilisation of the data available in the light of his theory of stellar constitution, Eddington made an estimate of the diameter of the star.

"So with great skill Michelson and his collaborators got the interferometer to work. After many preliminary adjustments, on Dec. 13, 1920, Dr. F. G. Pease at Mount Wilson, with Michelson's apparatus, measured the diameter of a star for the first time, using Betelgeuse for the purpose. The interference-fringes formed by the star were observed, the object mirrors were gradually separated, and it must have been a joyful moment when, as they grew farther and farther and farther apart, the fringes at the eye end became less distinct and ultimately disappeared. The distance apart of the mirrors now, multiplied by the proper fraction, gave the angular dimensions of the star—a thing which had never before been observed in the history of the world. An estimate of the star's distance gave its actual diameter, and confirmed Eddington's prediction!

"Other stars have since been measured, and the giant stars well deserve their name. Moreover, an instrument has been put in the hands of posterity to the power of which we can scarcely set a limit in investigating utterly invisible details, both about the heavenly bodies and about atoms, by the new and powerful method of analysing the radiation which they emit.

"The form of instrument adapted to the heavens is, however, not applicable to the atoms. The spectrum of atomic radiation is formed by a grating; and Rayleigh showed that the power of a prism spectroscope is expressed approximately by the number of centimetres of available thickness of glass, which is one form of saying that, to get high definition or separating power, we must use interference depending on a great number of wave-lengths retardation. Michelson perceived that the retardation principle might be employed so as to make a grating which combined with its own effect the resolving power of a prism. A slab of glass, a centimetre or more thick, might be used to give the necessary lag in phase of many thousand wave-lengths, and thereby secure a definition and resolving power unthought of before. So Michelson designed the Echelon spectroscope, consisting of thick slabs of glass, each protruding a millimetre or so beyond the other—a staircase spectroscope—which is now a regular instrument in the examination of the minute structure of spectrum lines.

"What, however, is popularly the best-known

work of Michelson is the application of his interferometer to determine if possible the motion of the earth through the ether. The speed expected was of the order one-ten-thousandth of the velocity of light; but since the journey of the light in the instrument is a to-and-fro journey—one half-beam going as nearly as possible with and against the hypothetical stream of ether, while the other half-beam goes at right angles to that direction—the amount to be measured was not one-ten-thousandth but the square of that quantity; that is to say, the observer had to measure one part in a hundred million—no easy matter. The interferometer was mounted on a stone slab floating in mercury, and the whole observation conducted with great care. The result was zero; and that zero was used afterwards as the corner-stone of the great and beautiful edifice of relativity."

WE regret to announce the following deaths:

Mr. St. George Littledale, who was awarded the Patron's Medal of the Royal Geographical Society in 1896 for three important journeys in the Pamirs and central Asia, on April 16, aged seventy-nine years.

Sir Charles Lucas, lately chairman of the Royal Empire Society (formerly the Royal Colonial Institute), distinguished as a historian of British colonial development, on May 7, aged seventy-seven years.

Mr. Emil Torday, a distinguished authority on the anthropology of Africa, on May 9, aged fifty-six years.

News and Views.

THE question of the introduction of twenty-four hour reckoning for railway time-tables has recently been discussed in Parliament. The subject is a well-worn one. It is nearly half a century since the late Sir William Christie made efforts in this direction. He suggested that, if it were done, astronomers might meet the public by reckoning astronomical time from midnight, a change that was actually made in 1925. A few years ago a committee appointed by the Council of the Royal Astronomical Society interviewed the railway authorities, endeavouring to persuade them to adopt the 24-hour system in time-tables, pointing out that the method was already in use in many countries. The companies, however, refused to make the change unless clear evidence was submitted to them that the public desired it. It is, however, fairly obvious that the public is inarticulate in matters of this kind. There was little enthusiasm for the summer-time scheme until it came about as a war-time economy; but once it was tried, it was welcomed with enthusiasm by all except a small minority. If the 24-hour scheme were adopted there would be no need to have new clock dials; the addition of 12 hours is an easy mental operation: moreover, the use of the new time for time-tables and public announcements would entail no obligation to use it in private life.

FOR some little time the attention of the public has been specially directed to eastern affairs in such a way as to emphasise the need for appreciation of the distinctive features in Oriental culture as a basis of understanding. More recently, however, the success of the exhibition of Persian art has given undue stress to the æsthetic side, which scarcely comes within the scope of NATURE. It is for this reason that we have refrained from comment on the various suggestions for the foundation of a museum for Oriental or Asiatic art which have appeared in the correspondence columns of the daily press. A proposal of a more comprehensive and scientific character is now put forward by the Royal Anthropological Institute. At a recent meeting of the Institute's Joint Committee on Teaching and Research, which includes representatives from all the universities and institutions interested in anthropological and archæological studies, it was strongly urged that a central institute is needed to serve and guide the study of Indian and Oriental cultures as an expression of the thought and life of the people; and that such an institute should include, as recommended by the Royal Commission on the National Collections, provision for the study and exhibition of the national collections from the scientific and technological as well as from the æsthetic point of view. It was added that provision should be made in the Institute for the endowment of advanced teaching and research, and that its constitution should be on a federal basis, to permit the closest co-operation with existing institutions devoted to such studies.

THE bearing of the last suggestion is elaborated in a memorandum by Prof. J. L. Myres which was circulated to the Committee and is published in *Man* for April. It is there pointed out that the provision of a chair of Indian cultural studies, which has been suggested, is scarcely practicable, in view of the wide range of studies to be covered; while a series of chairs "in some British University" would not necessarily stand in the desired relation to the national collections. On the other hand, there are in other university cities, as well as in London, long-established and well-supported centres of Oriental study, such as the Indian Institute at Oxford. This institute, as founded by Monier-Williams, did indeed, on a small scale, anticipate the combination of library, museum, and provision for teaching and research such as is now contemplated and could alone cover adequately the study of art and technology, illustrate the thought and social structure of the people, and in the literature provide the interpretation of their culture. A national institution of the type suggested might then be linked federally to all existing establishments by the structure of its directorate and the composition of its staff.

THE Patent Office has recently made changes in the method of publishing its abridgments of specifications which should be noted by all who have to search through British patent literature. Hitherto, the weekly official journal has always contained, in numerical sequence, the week's series of abridgments, the whole from year to year forming a complete numerical set for immediate reference purposes. In addition, the abridgments allotted to each of the 271 classes into which the subject matter of inventions

is divided by the Patent Office have been collected together in five-year periods and issued in class volumes with name and subject indexes. Under the new arrangement, which came into force this year with specification No. 340,001, the publication of the abridgments in the official journal has been discontinued, and they will now be issued only in separate weekly instalments divided into 40 groups, each of which comprises a carefully selected number of the old subject classes; when the whole series includes 20,000 abridgments (that is, roughly, every year), the abridgments of each group will be issued in volume form with their appropriate name and subject indexes. The official journal contains each week a numerical list of the accepted specifications showing the groups in which the respective abridgments will appear.

IT is too early to say whether the change which has been made in the method of publication of patent specifications will be appreciated by searchers. The old arrangement provided a very ready reference to individual cases and a useful continuous record for libraries and others who had no space for the series of full specifications. But, on the other hand, it was not particularly handy for a current subject search, and the old volumes of class abridgments lost a good deal of their usefulness by appearing so late. The new group volumes will be considerably larger than the old ones, but the sheets will appear within a few weeks of the acceptance of the specifications and should thus prove of greater value for current search purposes (especially if the 'opposition' period is extended as is suggested by the recent Departmental Committee), and their separate subject indexes will replace the present annual consolidated subject index. The annual accumulation of the group allotment lists which are printed in the journal each week will continue the numerical sequence of the earlier series of abridgments.

THE annual report of the Council of the Institution of Professional Civil Servants again records a large increase in the membership of the Institution, which during 1930 rose from 6560 to 8452. It is noteworthy that, quite apart from 'observer' and 'technical assistant' staffs, the latter figure includes 1243 members of full scientific status employed in the various scientific branches of the Civil Service. The outstanding feature of the year's activities was the submission to the Royal Commission on the Civil Service, which is now sitting, of a comprehensive statement of evidence embodying the Institution's case for a far-reaching reorganisation of the scientific and technical services of the State. It was urged that the existing multiplicity of professional, scientific, and technical grades should be rationalised and replaced by a simplified graded technical service. As regards the relationships between administrative and technical staffs, it was proposed (1) that the respective functions of the technical and the non-technical officers of the service should be redistributed in a manner which would give the expert wider powers of administration in his own department and enlarge the limits of his authority in regard to expenditure and the handling of staff; and (2) that arrangements should be made to ensure that the parliamentary head of a department is always fully aware of the views of his technical advisers. In cases where the board system is not in operation, right of access to the Minister on all important questions involving technical considerations should be unconditionally vested in the heads of professional, scientific, or technical hierarchies. In a friendly reference to the work of the Association of Scientific Workers, the Council expresses the hope that all eligible members of the Institution will become members of the Association, which, it states, is "the only body actively bringing the claims of the scientist to the notice of the public". Emphasis is laid on the essential unity of the scientific and technical services of the State.

THE measurement of noise was the subject of the discourse given at the Royal Institution on May 8, by Dr. G. W. C. Kaye, superintendent of the Physics Department, National Physical Laboratory. The 'yardstick' or 'degree' by which we measure noise is the decibel, a simple power-ratio or logarithmic unit (NATURE, Jan. 10, p. 75). Although the measurement of noise is of considerable complexity, being bound up in part with physiology and psychology, the physics of acoustical measurement has made great strides both in facility and exactitude. This is largely owing to the development of electrical methods based on the invention of the electronic valve. By such means, noises can be analysed into spectra showing their frequency components, and their loudness can be measured physically by the microphone. A convenient 'noise thermometer' ranges from 0 to 100 decibels, an upper level which is unlikely to be exceeded in everyday experience. Conversational level is at about the half-way point, 50 db. The value for a quiet suburban street is 30 db., for a tube-train 80 db. Loudness levels of everyday noises have been determined by the National Physical Laboratory and by the Bell Telephone Laboratories and others in the United States. New York traffic noises, both in the street and in the Underground, appear to be about 10 decibels louder than in London. A modern car is quieter than a horse-vehicle on a paved street. Among the loudest things one is likely to encounter are the noises of rivetting, pneumatic road drilling, steamship sirens, and printing-presses; but the arch offender of all is the aeroplane engine at close quarters (110 db.). The noise in the cabins of aeroplanes in flight ranges between 80 db. and 110 db., according to the type of machine. There are, however, good prospects that the noise in aeroplane cabins will presently be substantially reduced (possibly to that of a railway train) by using propellers with lower tip speeds, providing more effective silencers on the exhausts, reducing engine clatter by enclosing the engines, and constructing cabins of double walls containing a suitable filler. The question of protection from noise is being investigated at the National Physical Laboratory, and new sound-laboratories are to be erected in the near future.

IN *Engineering* for April 24, a description is given of a clock that apparently can go on continuously until any part wears out. It was made by T. Dieden, of Carlslund, Sweden, and has already been going for fourteen years. Although a self-winding clock, it is a very near approach to perpetual motion. In its main features it is very similar to an ordinary clock, having a driving weight, a train of wheels driving the hands, and a torsion pendulum consisting of a heavy metal disc suspended by a thin steel ribbon. The unique feature of the clock lies in the method employed for winding up the driving weight. The power is obtained by the ordinary variations of the atmospheric pressure and temperature. The case of the clock contains seven closed elastic metallic boxes of the type used in an aneroid barometer. The lower box is attached to the case, but the column of boxes is otherwise free. The total expansion or contraction of all the boxes due to changes in the temperature or pressure is communicated to the top box. This is connected to two pawls working in opposite directions. When the column of boxes either increases or diminishes in height, the spindle carrying the ratchet wheels always rotates in the same direction and the driving weight is wound up. Fixed pawls prevent the ratchet wheels from running back. When the weight reaches its topmost position they are thrown out of action. With its weight fully wound up, the clock can run for eighteen months without stopping, and it would be exceedingly unlikely for the temperature and pressure to remain constant over such a long interval. The pendulum has a period of $7\frac{1}{2}$ seconds, so that the length of the equivalent simple pendulum is about 185 ft.

THE Annual Report of the Zoological Society of London records a successful year: the number of fellows has increased (from 8344 last year to 8430), the subscriptions of fellows have increased; the number of visitors to the garden in Regent's Park has increased, very considerably exceeding the two million mark; gate money has increased, and with it all the expenditure for the year has fallen, so that a favourable balance of £1479 is carried forward. The health of the stock has been satisfactory, and the death-rate is still moving, although almost imperceptibly, in the right direction. Its decline should be hastened by the formation of an isolation ward, where epidemic diseases may be checked at the outset. Chance injuries and accidents account for most of the deaths, 230, or 18·9 per cent. Then follow diseases of the respiratory system, which, even when tuberculous and mycotic infections are excluded, account for 177 deaths, or 14·6 per cent; diseases of the digestive system follow with 166, or 13·7 per cent. In addition to the isolation hospital, there have been created several new buildings, of which the parrot house and bird-diving house, in the old refreshment-room building, and the butterfly cage appeal most to the inhabitants and to visitors.

PERHAPS readers will turn most eagerly to discover how the zoological park at Whipsnade is progressing. Much has been accomplished since the last Report of the Zoological Society. Hall Farm has been transformed into a restaurant, and the old fellows' pavilion has been transported from Regent's Park to the Downs. More than three miles of internal roads have been made; four chalk-pits, ultimately to become carnivore dens, have been excavated for road metal; much planting has been done, and already enclosures and paddocks are well stocked with a considerable variety of the larger birds and mammals. As has already been announced, Whipsnade Zoological Park will be opened to the public on Saturday, May 23, the previous day being set aside as a private day for fellows of the Society and official guests. Capt. W. P. B. Beal, late Principal Veterinary Officer of the Gold Coast, has been appointed Superintendent of the Park for one year.

AT a special meeting of the Council of the Ray Society on April 30, the following resolution was adopted: "The Council of the Ray Society desire to place on record the profound grief felt by them on hearing of the death of their President, Professor W. C. M'Intosh, F.R.S., on April 1st last. Professor M'Intosh had belonged to the Society since 1863 and had been President since 1913. He had not only shown his practical interest in its success by his exceptionally long period of membership, but he had given the most devoted service to the Society by his frequent journeys from St. Andrews to London, in order to attend the meetings of the Council, at which he nearly always presided. The Council direct that this record of their appreciation of the value of their late President's work be sent to Dr. R. T. Gunther, his nearest surviving relative, with the expression of their sincerest sympathy." Sir Sidney F. Harmer, the treasurer of the Society, was elected president *ad interim* in succession to the late Prof. M'Intosh.

RECENT Norwegian work in the Antarctic region has resulted in several new discoveries of coast-line. Several years ago, Mr. L. Christensen detailed one of his ships, the *Norvegia*, for exploratory purposes. New land was discovered to the west of Enderby Land, called Queen Maud Land, and to the north-east of Coats Land, called Princess Martha Land. News now comes of further discoveries in the southern summer that has just ended. The *Times* recently recorded the discovery by Capt. Riiser Larsen, flying from the *Norvegia*, of a further stretch of coast-line between the two already mentioned. This is Ragnhild's Land and extends from lat. 68° 40′ S., long. 33° 30′ E., to lat. 70° 30′ S., long. 24° 15′ E. The *Geographical Journal* for April contains news from Mr. Christensen of the sighting of more land, this time apparently to the east of Enderby Land and MacRobertson Land which Sir Douglas Mawson discovered. The new coast-line lies in lat. 68° S. and extends from long. 65° E. to 71° E. Thus there appears to be a considerable bight in the coast of Antarctica between MacRobertson and Wilhelm Lands. The *Norvegia* concluded the season's work by circumnavigating Antarctica and confirming the non-existence of various doubtful islands.

THE production of books seems to maintain its very high standard, especially in Great Britain and the United States, in spite of trade depression. This is due probably to the large number who are

now taking advantage of the opportunities offered for advanced education; for, in spite of the great number of publications in fiction (by far the greatest of all), children's books, religion, biography and travel, and other books of a general character, which reach the same percentage in Great Britain and the United States, a good proportion of books is in the specific sciences. With the great advances made in aeronautics, there is a corresponding increase in the number of British publications, which, according to the *Publisher and Bookseller*, reached the total, in 1930, of 133. Only 26 books on wireless appeared in 1930; topography and folk-lore show a total of 205, while botany, horticulture, and agriculture stand at 176, anthropology 35, chemistry and physics 116, astronomy and meteorology 50, engineering sciences 115, geology 53, mathematics 37, medicine 456, zoology 163, and psychology 64. The total number of British books published in 1930 was 15,494, of which 3638 were new editions. It is gratifying to the man of science to note that the 209 limited editions still remain in the letters groups, there being practically no such publications in science. According to the list of publications in the United States in 1930, which appears in the *Publisher's Weekly*, the number of American books produced last year reached 10,027, of which 1893 were new editions. These figures are much below the corresponding figures for Great Britain.

IN the first of a new series of *Tyneside Papers*, issued by the Tyneside Council of Social Service, the trend of population in that area is compared with the results of an earlier survey published in March 1926. It was then pointed out that population was growing more rapidly than industry was expanding, and that a new equilibrium would be brought about slowly through (1) a further decline in the birth-rate, (2) further migration, (3) a partial recovery in the old staple industries, and (4) the expansion of minor industries and the starting of new industries. So far, the staple industries have not recovered, and, apart from the electrical industry, there has been little expansion of other industries. The situation, however, has entirely changed in regard to the birth-rate and migration. The average yearly natural increase in population for the years 1926–29 was only two-thirds of what it was in the earlier period 1921–26. In the second period, the annual outward balance of migration from Tyneside was about six times as much as that in the first period, and, if this exodus should continue, it would do much to reduce unemployment. Many would naturally wish that the situation could be readjusted by revival of local industries rather than by loss of population, and the question suggests itself whether some of the industries presumably absorbing the inflowing population in the south could not be established on Tyneside.

THE thirty-sixth annual congress of the South-Eastern Union of Scientific Societies will be held at Winchester on June 10–13, under the presidency of Sir J. Arthur Thomson. The presidential address on "Some Natural History Problems of the Countryside", will be delivered in the Guildhall on June 10. The various sections will open their sessions on the following days. Mr. James Groves, president of the Botanical Section, will discuss ancient and modern stoneworts, in his presidential address. In the Archæological Section, the president, Dr. W. E. St. L. Finny, will take as his subject the kings of Wessex, from Egbert to Athelstan. The president of the Geological Section is Prof. H. L. Hawkins, who will discuss the nature, deposition, and palæontological implications of the Chalk. Mr. J. F. Marshall, as president of the Zoological Section, will describe some stereoscopic photomicrographs of fossil insects to be exhibited by him in the Congress museum. Archæological surveys will form the topic of the presidential address of Mr. H. J. E. Peake, before the Regional Survey Section. Several useful and interesting excursions have been arranged in connexion with the Congress. On June 13, the preservation of the countryside and the various parliamentary bills concerned with it will be discussed, Sir Lawrence Chubb and Sir Edgar Bonham Carter taking part in the discussion.

MESSRS. Adam Hilger, Ltd., the well-known optical instrument manufacturers, have issued a pamphlet giving a general account of the products and aims of the firm and outlining the scope of its activities. The high quality of the Hilger products is generally recognised, and the pamphlet reveals that the total value of the instruments exported by the firm during the last five years is three times that of the instruments supplied to the home market. The selected list of purchasers given at the end includes institutions from all parts of the civilised world. There is probably justification for the surmise that "most of the research of the world in certain fields of prime importance in modern physics is being done with Hilger instruments". Particular attention is given in the pamphlet to the industrial applications of scientific manufactures, and there is an account of work of this kind connected with the metallurgical and chemical industries, mineralogical survey and the utilisation of ores, engineering design, the colour industries (paints, textiles, artificial silk, etc.), the manufacture of glassware, and the manufacture of optical instruments (cameras, microscopes, telescopes, binoculars, etc.). The publication is an interesting one, and the only point which calls for criticism is the retention of the accents and the capital initial letter in the word 'angstrom' used as a unit of wave-length. It is time that the name of this unit took its place with 'ampere', 'henry', 'ohm', and many others of similar origin, as a common noun.

THE first of this year's Royal Society conversaziones will be held in the Society's rooms at Burlington House on Wednesday, May 20, at 8.30 P.M.

SIR JAMES FRAZER, the distinguished anthropologist and author of "The Golden Bough", has been elected an Honorary Master of the Bench of the Middle Temple.

SIR ARTHUR KEITH, Hunterian professor and Curator of the Royal College of Surgeons, has been elected a foreign member of the American Philosophical Society, Philadelphia.

THE following appointments in the Colonial Agricultural Service have recently been made by the Secretary of State for the Colonies:—Mr. B. J. Weston, to be horticulturist, Cyprus; Mr. J. S. Norman, to be field instructor, Federated Malay States.

THE sixteenth of the public lectures on "Physics in Industry" arranged by the Institute of Physics will be delivered on May 19 at 4.30 P.M., at the Institution of Electrical Engineers, by Mr. Alan E. L. Chorlton, who will take as his subject "Physics in Relation to the Development of the Internal Combustion Engine".

IN NATURE for May 9, p. 714, it is stated with reference to the Lancashire earth-shake of May 3 that tremors were not registered at the Liverpool Observatory and Tidal Institute. Mr. H. J. Bigelstone, principal assistant at the Observatory, informs us that this is incorrect. Tremors were recorded on the Milne-Shaw seismograph there, commencing at 9 h. 23 m. 0 s. and lasting 40 sec. The maximum amplitude recorded was 1·5 mm.

IT is reported in *Science* that Dr. Werner Heisenberg, professor of theoretical physics at the University of Leipzig, has been awarded the Barnard Medal of Columbia University. Every five years the National Academy of Sciences recommends to the trustees of Columbia University a nominee for the Barnard Medal "for discoveries in physical or astronomical science or novel application of science to purposes beneficial to the human race". The previous recipients of the medal have been Lord Rutherford, 1909; Sir William Bragg, 1914; Prof. A. Einstein, 1921; and Prof. Niels Bohr, 1925.

THE Council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane Prize, for the period 1926–30, to Dr. Nellie B. Eales, Zoology Department, University of Reading, for her papers "On the Anatomy of a Fœtal African Elephant" published in the *Transactions* of the Society. The Bruce-Preller Lecture, to be delivered on July 6 by Prof. Horace Lamb, will be devoted to a commemoration of the centenary of the birth of James Clerk Maxwell. On June 15, Prof. A. H. R. Buller, professor of botany in the University of Manitoba, will address the Society on "Recent Advances in our Knowledge of the Higher Fungi".

THE International Institute of African Languages and Cultures has issued invitations to a congress to be held in Paris on Oct. 16–19, when the Exposition Coloniale-Internationale will still be open. The Congress will deal with important linguistic and anthropological problems of the Africa of to-day. Prof. Antoine Meillet, president of the Institut d'Ethnologie, will act as president of the Congress, and Prof. Henri Labouret as vice-president. The Congress will be opened by Maréchal Lyautey, and Lord Lugard will speak on the aims of the Institute. The meetings will be held at Vincennes. An interesting feature of the programme is a lecture by Dr. Chauvet on African music, which will be illustrated by songs and dances by African performers. Visits to the appropriate museums and collections are being arranged.

THE Gold Medal of the Institution of Mining and Metallurgy has been awarded to Dr. Charles Camsell, deputy Minister of Mines and Industries of the Dominion of Canada, "in recognition of his untiring zeal and great ability in promoting the development of the natural resources of the Dominion and in furthering the general interests of the mineral industry". The following awards have also been made: The Consolidated Gold Fields of South Africa, Ltd., Gold Medal to Mr. C. W. B. Jeppe, for his researches on mine ventilation at great depths, and for his paper on "Ventilation at the Crown Mines, Witwatersrand"; the Consolidated Gold Fields Premium of forty guineas to Mr. E. G. Lawford, for his "Notes on Some Stoping Problems in Mexico"; and the William Frecheville Student's Prize of ten guineas to Mr. W. H. Wilson, for his paper on "Bottom Slicing applied to Mining a large Irregular Replacement Deposit in Limestone".

IN a 4-page pamphlet, Mr. P. J. Harwood, of "Corona", Ovingdean, Brighton, puts forward a theory of the Michelson and Morley experiment based on his definition of motion as "a process of extending a body in a particular direction" which "confers . . . super-extension on the body" and it acquires "a length longer than its static length". According to Mr. Harwood, the increase of thickness of the mirrors in the line of motion compensates for the increase of the path of the light in that line. He does not mention the increase of length of the support of the mirrors in the line of motion, which his theory of motion requires, and his readers are left in the dark as to why the super-extension is limited to the mirrors. We have been unable to verify the author's statement that Sir James Jeans "says that the sun, instead of sending us light waves, sends us nothing more substantial than mathematical equations".

MESSRS. Bowes and Bowes, Cambridge, in catalogue No. 457 offer upwards of 400 books in new condition at greatly reduced prices. The list is one of general interest, but in it are several works of a scientific character, particularly in the departments of archæology, travel, and natural history.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An organiser of agricultural education under the Middlesex County Council—The Secretary, Middlesex Education Committee, 10 Great George Street, S.W.1. An assistant in the department of radium therapy and research of the Middlesex Hospital—The Secretary-Superintendent, Middlesex Hospital, W.1 (May 20). A resident lecturer in mathematics, with physics, at the Borough Road Training College, Isleworth—The Principal, Borough Road Training College, Isleworth (May 23). A head of the department of continuative education of Loughborough College—The Registrar, Loughborough College, Leicestershire (May 23). An assistant lecturer in economics at University College of the South-West of England—The Registrar, University College of the South-West of England, Exeter (May 25). A graduate teacher of electrical engineering subjects for the Junior and Technical Day School and Evening Classes of the Wandsworth

Technical Institute—The Secretary, Technical Institute, Wandsworth, S.W.18 (May 30). An assistant lecturer in chemistry at Brighton Technical College—The Secretary, Brighton Technical College, 54 Old Steine, Brighton (May 30). An assistant in textile research, for research work relating to the knitting industry, in the department of textiles of University College, Nottingham — The Registrar, University College, Nottingham (June 1). An inspector of explosives under the Home Office—The Private Secretary, Home Office, Whitehall, S.W.1 (June 5). An assistant lecturer in physics in the University of Manchester—The Registrar, University, Manchester (June 6). A lecturer in metallurgy, an assistant lecturer in civil engineering, an assistant lecturer in electrical engineering, and an assistant lecturer in mathematics, each in the faculty of engineering of the University of Bristol — The Secretary and Acting Registrar, University, Bristol (June 9). A lecturer in agricultural chemistry and physics at Swanley Horticultural College for Women—The Principal, Swanley Horticultural College for Women, Swanley, Kent (July 6). A science mistress for physiology at the Bedford Physical Training College—Miss Stansfeld, Bedford Physical Training College, 37 Lansdowne Road, Bedford. Two assistant organisers for help in the development of the Young Farmers' Club movement in the north and west of England respectively—The National Association of Young Farmers' Clubs, 26 Bedford Square, W.C.1.

Our Astronomical Column.

Pluto.—*Popular Astronomy* for April contains Prof. V. M. Slipher's report on the Lowell Observatory, in which there are some more details about Pluto. It was not until Feb. 18, 1930, that Mr. Tombaugh discovered the images on plates taken on Jan. 23 and 29, and afterwards that on the plate of Jan. 21. It was examined visually with the 24-inch refractor. "No certain evidence of disk could be made out, although on a few occasions its image seemed not quite like those of equally faint stars." "Later tests . . . indicated that with Pluto's faintness his disk, if as much as 0·6″, could escape detection under good observing conditions." This would imply a diameter of 11,000 miles. It was found that Pluto was brighter visually than photographically, so a yellowish colour was inferred.

The report also states that "the search of the ecliptic with the efficient 13-inch telescope is being continued by Mr. Tombaugh. A band of considerably greater width is being carried round the sky, and the reach in magnitude of stars included has been increased."

Rech. Instit. Circ. 425 contains the following observations of Pluto made at Simeis by S. Beljawsky:

1931.	U.T.	R.A. 1931·0.	N.Decl. 1931·0.
Mar.	22^d 18^h 22·8^m	7^h 21^m 9·91^s	22° 20′ 39·4″
,,	23 18 12·0	7 21 8·99	22 20 45·6

The magnitude was 14·5. Prof. M. Wolf gave it as 14 on Feb. 8.

The above *Circular* also contains the following revised orbit of 1931 *FE*, which is the interesting minor planet discovered by Drs. Schwassmann and Wachmann in March. It is by A. Kahrstedt.

Epoch 1931 April 7·0 U.T.

M	31·20°	
ω	129·62	1931·0
Ω	1·20	
i	24·26	
log q	0·2439	
Period	3·713 years.	

The perihelion distance is 1·754, the eccentricity 0·2687.

Spectroscopic Parallaxes of *B*-type Stars.—The Commonwealth Solar Observatory at Canberra has recently published *Memoir* No. 2, containing an investigation of southern *B*-type stars by B. W. Rimmer for determining spectroscopic parallaxes. The method used by Rimmer is essentially the same as that of Edwards, who amplified an earlier method of Adams and Joy. It consists in (*a*) accurately classifying the spectral types of the stars on the basis of the Harvard classification but with additional sub-types interpolated, and (*b*) dividing each sub-type into groups according to the sharpness of the spectral lines. Both type and line sharpness are correlated with absolute magnitude, and the final results give reasonably good values of the parallaxes. Struve has recently shown such methods to have a sound physical basis; also his parallaxes (derived from interstellar calcium lines) show a good correlation with the results obtained by them, though indicating that the dispersion of absolute magnitudes is probably too restricted. Rimmer's method differs from that of Edwards in the formation of two extra groups, for bright line stars and peculiar stars; also, the instrument used gives spectra double the length of those obtained at the Norman Lockyer Observatory, Sidmouth, by Edwards. For those stars, however, which are common to the two observers (170 in number) the parallaxes are in fairly good agreement. A full discussion is given both of the instrumental equipment and the method used in deducing parallaxes. The final results for 350 stars form a useful addition to our knowledge of stellar distances; being in numerous instances the only available source of information for southern *B*-type stars. This is the first volume of a purely astronomical character to be issued from Canberra, and it will be welcomed by astronomers.

The Eighth Satellite of Jupiter.—*Yale Astron. Transactions*, vol. 6, part 4, contains a new theory of this satellite by Prof. E. W. Brown. As is well known, the theory of this satellite is extremely difficult, owing to its great inclination and eccentricity and the very large solar perturbations. Prof. Brown has diminished these difficulties by the use of a doubly periodic intermediate orbit: the two periods are that of the elliptic terms and that of the Variation. The work was carried out before the recent recovery of the satellite, so the constants were derived from the observations of the first six or seven years. The ratio of the mean motions (Sun to J. VIII) is −0·171171, giving 741·613 days for the sidereal period; the mean inclination, 31° 13′. The eccentricity is at present taken as exactly 0·4. The mean motion of the perijove is $-0{\cdot}00163\ n$, where n is the mean motion of J. VIII. The perijove therefore takes more than 1200 years to make one revolution. The fact of the motion being in the reverse direction to the satellite was unexpected; it arises from the second order terms exceeding those of the first order. The mean motion of the node is $-0{\cdot}02193\ n$, hence the node goes round in about ninety years. The coefficients of the inequalities are given in the article.

Research Items.

Stone Implements of Types new to Southern India.—Six stone implements of types not hitherto recorded in India are figured and described by K. Sripada Rao in the *Journal of the Mysore University*, vol. 4, pt. 2, July 1930. They are selected from among four hundred and fifty implements collected on geological excursions of the Central College, Bangalore. It is suggested that of the six types, four, from Reddipalle, Cuddapah District, of Cuddapah quartzite, represent an advance on the Lower Palæolithic (Acheulean) culture of Biligere, Mysore, while the last two, from Trichinopoly and Ranganathpur, Mysore, belong to the Middle Palæolithic. The first implement is triangular with incurved sides. One surface is concave and shows no sign of working; the other has a small central triangular platform of which the sides are parallel to the sides of the implement, giving it the appearance of a truncated triangular pyramid. Similar specimens were collected from widely separated areas such as Satyavedu, Alicoor Hills, and Kibbanhalli (Mysore). The nearest parallel is a 'tribrach' from the Isle of Wight, described by Sir John Evans, and compared by him to specimens from Yucatan and Russia. The second implement is roughly triangular with rounded angles and has one surface chipped in three broad triangular faces longitudinally disposed. It closely resembles the Stellenbosch 'cleaver'. The third implement is horseshoe shaped. The worked surface is covered by six broad flaked faces, the three big ones forming, with the back, the three straight cutting edges, of which the main one is opposite the curved edge of the horseshoe. The fourth implement is roughly rectangular. The worked surface (one side only) shows four big flakings, of which the one longitudinally disposed forms the cutting edge. Of the two remaining implements, the one from Trichinopoly, of yellow cherty material, is crescent shaped. The convex edge, $8\frac{3}{4}$ in. in length, is thin and sharp, the concave edge is also sharp. One end is pointed, the other has a ridge, and it is suggested that this was inserted in a handle to enable both edges to be used. The sixth implement, from Ranganathpur, is of white and greasy-looking quartz reef, stained red by iron oxides. It is of the shape of an ox-head with ledge-like notches in the place of the ears. These make the implement probably unique in India and perhaps indeed elsewhere. It is suggested that the rounded and sharp-edged butt, which affords no hand-hold, was intended to fit in a slotted handle.

Pneumoconiosis caused by Talc.—Although talc powder finds a number of industrial applications, comparatively few instances of pulmonary affections traceable thereto have been recorded. In the *Rendiconti* of the Reale Istituto Lombardo di Scienze e Lettere for 1930, Dr. Arturo Zanelli describes the case of a workman employed in a pneumatic tyre factory to inject powdered talc into the interior of the tyres and to apply the same material to the outer surfaces of the tyres by means of a cloth. During this work, the air contained a dense dust, but no masks were provided for the employés and no other means was adopted for their protection from the dust. The man developed grave digestive troubles, and X-ray examination of the lungs revealed the presence of the nodular formations typical of pneumoconiosis. Although talc has been regarded as a mineral forming a dust which only rarely has pathogenetic qualities, one of its properties seems to render it particularly dangerous. It forms extremely minute particles which do not irritate the sensitive nerve endings of the mucus on which they are deposited, so that such important means of defence as sneezing, coughing, and increased secretion are not brought into operation. In the case considered, indeed, the patient exhibited, during working hours, a weakening of the olfactory sense, the layer of dust on the mucus preventing the transmission of the olfactory stimuli to the nerve endings.

Respiration in Insects.—In *Biological Reviews* of the Cambridge Philosophical Society, vol. 6, No. 2, 1931, pp. 181-220, Dr. V. B. Wigglesworth gives an admirable summary of our present-day knowledge of respiration in insects. A very extensive literature has grown round the subject during the last twenty years or so, and, in sifting this mass of information, the author has undertaken a task of considerable difficulty. His review covers the ground of external and internal respiration in insects: the histology of the tracheal system is fully described, while the supply of air to the tracheoles, the respiratory movements, the elimination of carbon dioxide, and the respiratory function of the blood all come under review. The respiration of aquatic insects is also very fully discussed, and there is a brief account of the same process in parasites. The ultimate endings of the tracheæ are capillary tubes, or tracheoles, often less than 1μ in diameter. The problem as to whether these fine tubuli contain fluid or air, a subject which Dr. Wigglesworth has specially studied, is discussed from its biophysical aspect. The exchange of gases in the tracheal system, as a whole, is effected primarily by diffusion, which is modified by the opening and closing of the spiracles. The relative importance of the spiracles and the integument with regard to the elimination of carbon dioxide is another important aspect of the subject, and it is evident that we know little as yet with regard to the rôle played by the skin. While there is indirect evidence that the blood acts as a carrier of oxygen to the tissues, it is still a very moot point whether it contains a respiratory protein analogous to hæmocyanin or hæmoglobin. It is only in certain very special cases that hæmoglobin is present in insects and functions as an oxygen carrier; but in the vast majority of these creatures no carrier has been identified. At the end of Dr. Wigglesworth's paper there is a bibliography, of about three hundred references, which will be found of service to all interested in the subject.

Indian Forest Plants.—In *Indian Forest Records* (Botany Series), vol. 16, pt. 1 (1931), Mr. R. N. Parker, forest botanist at the Research Institute, Dehra Dun, India, continues his illustrations of Indian forest plants with plates and notes of five more species of the genus *Dipterocarpus*. The first part of this work appeared in vol. 13, pt. 1 (1927), of *Indian Forest Records*, and was mentioned in NATURE, five species of this genus then being dealt with. The species here treated of are: *D. Baudii*, *grandiflorus*, *obtusifolius*, *Dyeri* and *Kerrii*. Excellent plates depict the species. Mr. Parker has an interesting note on the hybridisation of different species. He writes: "I am of opinion that the various species of Dipterocarpus hybridise freely in nature. The hybrids most often met with appear to be between the *ins* (rough-barked dipterocarps), *D. obtusifolius* and *tuberculatus*, and one of the *kanyins* (smooth-barked dipterocarps)." The hybrids *D. costatus* × *obtusifolius* and *D. tuberculatus* × *turbinatus* seem to be of frequent occurrence. Other hybrids also appear to occur, though the evidence for them is not always very satisfactory. Dr. Kerr, a botanist

keenly interested in the Malayan flora, was the first to detect and describe a hybrid *Dipterocarpus*.

New Arctic Islands.—The Arctic seas between Franz Josef Land and Northern or Nicholas Land have seldom been penetrated, owing to congestion of heavy ice. The *Italia* airship passed over the region in 1928 but made no discoveries. In the summer of 1930, the Russian Arctic expedition under Prof. O. Schmidt, in the icebreaker *Sedov*, after relieving the meteorological station at Hooker Island, Franz Josef Land, made an attempt to reach Northern Land, of which the western side is unknown. In spite of heavy ice, the expedition had a great measure of success and made several discoveries of importance. An account of the voyage by Prof. R. Samoilovitch, with a map of the discoveries, appears in *Petermanns Mitteilungen*, Hefte 3/4, 1931. A low, flat island of Palæozoic sandstone (Wiesse Island) was found in lat. 79° 27′ N., 76° 40′ E. A second island, Issatschenko Island, was found fifty miles south-east of the island known as Einsamkeit or Lonely Island, which, however, was not seen. A third island, called Voronin Island, was found in lat. 78° N., long. 93° 30′ E. (approximately). Farther north, a number of small islands of Palæozoic limestone were discovered about fifteen miles from the west coast of Northern Land. On one of these islands of the Kamenev Group, in lat. 79° 6′ N., long. 90° 33′ E., a new meteorological station was established and provisioned for three years. The party of four men is provided with dogs and could retreat to the Siberian coast if relief by ship were impossible. Finally, the expedition discovered another island, Schmidt Island, in lat. 81° 5′ N., long. 89° 40′ E. This island is completely ice-covered.

The Idu (Japan) Earthquake of Nov. 26, 1929.—A preliminary report on this earthquake by Prof. A. Imamura (*Tokyo Imp. Acad. Proc.*, vol. 6, pp. 419-422; 1930) shows that it presented phenomena of much interest. The shock was destructive in two areas, the centres of which are about 14 miles apart. Of the faults that appeared with the earthquake, three are especially noteworthy. One, about 6½ miles long, runs north and south along the neck of the Idu peninsula. The dislocation along this fault in a railway tunnel shows that, at a depth of 500 feet, the crust on the west side had shifted 7 ft. 10 in. southwards and 2 ft. downwards with reference to the other. At the surface, the dislocation was much less apparent. The other two faults may be continuations of this fault, that at the south end being 11 miles long and trending S. 30° W. The crust on its west side was shifted relatively 4 ft. 3 in. to the south, with an upthrow of 1 ft. 8 in. The fault at the north end is much smaller and trends to the north-west. The seismographic evidence shows that the first movement came from near Ukihasi (lat. 35° 2′ N., long. 139° 0′ E.). The block-movement thus seems to have started near the central point of the fault-system, passed quietly over the middle fault, and increased greatly along the two oblique terminal faults. Round these faults are situated the two meizoseismal areas, in which 259 persons were killed and 2142 houses destroyed. About 4½ miles to the east of the southern area lies the small town of Ito, at and near which were felt the numerous slight shocks of the previous spring (NATURE, vol. 126, pp. 326, 971; 1930). About the time of the Idu earthquake, the Military Land Survey was engaged in relevelling the district. One section was levelled the day before the earthquake and in the opposite direction the day after. A comparison of the two series showed that practically no change had occurred in this portion of the peninsula. The relevelling and retriangulation of the whole area are now in progress and seismographs have been erected at four stations around the epicentres (*Tokyo Imp. Acad. Proc.*, vol. 6, pp. 399-400; 1930).

High-Speed Wind Channels.—A paper by Sir Thomas Stanton in the March number of the *Proceedings of the Royal Society* contains a history of recent progress in the development of high-speed wind channels for research in external ballistics. The fundamental idea of the work is to measure the forces and couples to which a projectile is subject, by means of scale models in which the body is held stationary in a current of air moving at high speed. The earlier work was done with the momentary blasts of air which were produced by the release of a volume held at high pressure; this proved unsatisfactory, partly because of the difficulty experienced in obtaining speeds greater than that of sound, but more particularly because it was found that complicated systems of stationary waves formed in the jets, so that it would be almost impossible to know the exact conditions to which the model was subjected. The later work has been carried out in a continuous air current, and it has now been found possible to devise systems in which the air current is reasonably uniform over a sufficiently large region to contain a small model, and in which the forces on the model can be measured with relative ease. A considerable amount of investigation has been done on these lines, but it has been found that the conditions in the channels are extremely sensitive to quite small changes in the entering air. This rather limits the usefulness of the method, and it is suggested that the next stage in the work should consist in bringing such conditions under better control.

Stark and Zeeman Effects.—Two papers in the March number of the *Proceedings of the Royal Society*, by Prof. J. S. Foster, on the effects of electric and magnetic fields on the helium spectrum, and by J. K. L. MacDonald, on the Stark effect in molecular hydrogen in the range 4100-4770 A. add considerably to knowledge of these phenomena. Prof. Foster's contribution is largely concerned with the combined effects of magnetic and electric fields, a subject which has played an important part in the development of quantum theory, but for which few data are available. Amongst the numerous results may be noted the appearance of lines in crossed fields for which the change in the magnetic quantum number (Δm) appears to be more than one unit. Mr. MacDonald's paper deals only with the pure electric resolution of the band lines, extending and partly checking earlier work by Kiuti. This investigation of molecular hydrogen is of considerable difficulty, both experimentally and in its theoretical interpretation. In addition to the use of Lo Surdo tubes of rather curious design, with restriction of the path of the discharge in front of the cathode, it was also found necessary to employ streaming gas, admitted from below the cathode, and, in order to obtain details of the line structures, to sacrifice field strength to obtain a steady and bright source. The scale of the resolution of the lines, compared with the splitting of the lines of atomic hydrogen, appears clearly on a plate accompanying the paper.

Structure of the Atomic Nucleus.—Latimer, in the March number of the *Journal of the American Chemical Society*, points out that the abundance curve for lighter elements, the atomic weights of which are approximately integral multiples of four, shows maxima for 4, 7, 10, 12, and 14 alpha particles, which suggests that the alpha particles are arranged in a tetrahedral pattern. He proposes an arrangement of 4 alpha particles in a tetrahedron with a certain coupling of proton spins and, by continuing the

pattern to 10 alpha particles, finds a point in the lattice about which four protons converge in the same manner as in the alpha particle. The entrance of a pair of electrons at this point explains the first pair of extra electrons found in argon (40), and an extension of the principle appears to give a complete explanation of the numbers of extra electrons required in the heavier elements. With the addition of the extra electrons, the proposed nuclear structure becomes a diamond-shaped lattice of electron pairs joined by protons. The model may be interpreted as the pattern determined by the directions of the proton spin vectors, the angle between any two proton vectors being that formed by lines from two corners of a tetrahedron to its centre. This is the angle at which two elementary spin vectors add to give a resultant of two units. The quantity $\frac{1}{2}\sqrt{n(n+2)}$ is the magnitude of the vector representing n units of spin, and only resultants with integral values of n are permitted. The geometry of the tetrahedron is thus clearly seen to be that demanded by quantum mechanics for the combination of two unit spin vectors. The paper is illustrated by representations of models, which add considerably to the clearness of the ideas put forward in it.

Atomic Weight of Iodine.—In an investigation of Baxter and Tilley in 1909, the ratio of silver to iodine pentoxide was found to be 0·646225, whereas the values Ag = 107·880 and I = 126·932 give 0·646251 (isotopic oxygen mixture = 16·000). It is now shown by Baxter and Butler, in the March number of the *Journal of the American Chemical Society*, that the ratio Ag/I_2O_5 is affected by two sources of error: (1) the adsorption of air by very porous iodine pentoxide, and (2) the fact that iodine pentoxide produced by the dehydration of iodic acid appears to contain less iodine and more oxygen than corresponds to the formula I_2O_5. Whilst the modern value for the atomic weight of iodine rests on several well-established ratios to silver and to the other halogens, it would be necessary, in order to reconcile the experimental values of the ratios of silver and iodine to iodine pentoxide with the theoretical values, to increase the atomic weight of iodine by 0·005 unit in the former case and decrease it by 0·03 unit in the latter. Great care was taken in the purification of the iodine pentoxide, which was then decomposed by heating at about 400° in a weighed quartz reaction vessel which contained hot silver to prevent escape of iodine, and finally the weight of the iodine was determined. Water retained by the pentoxide was collected in a weighed absorption tube and correction of 0·001 per cent for adsorbed air was made. The ratios I/O and I_2/I_2O_5 were found to be 3·17262 and 0·760342, which would correspond with I = 126·905, which is considered to indicate an excess of oxygen of 0·005 per cent in the pentoxide above the theoretical value. Iodine pentoxide of normal composition has not been prepared.

Hydrogen Ion Concentration in Unbuffered Solutions.—A platinised electrode in a hydrogen atmosphere adsorbs the cation or base from a salt or base solution, thus yielding a more acid solution in the cell than before treatment with hydrogen. This forms a serious objection to the use of the ordinary type of platinised platinum electrode in unbuffered solutions. Again, since acid-base indicators are weak acids or bases, large errors may be caused in their use in measuring the *p*H of pure water or extremely dilute solutions of acids or bases. These problems are discussed in three papers in the March number of the *Journal of the American Chemical Society* by Kolthoff and Kameda. In the first, it is shown that acid adsorbed by platinum can be removed by washing with water in a hydrogen atmosphere. An electrode coated with a bright layer of platinum was used, which gave satisfactory results in unbuffered or slightly buffered solutions. The electrode, after platinisation, is treated with hydrogen bubbled through water, and the cell then washed out and solution admitted. The electrodes are easily poisoned and are replated after each set of measurements. In the second paper, the use of mixtures of two forms of an indicator in different ratios is described, the indicator being isohydric with the solution. The colour in the unbuffered solution is compared with that in an ordinary buffer solution with the same indicator mixture, a correction for the difference of ionic strength of the two solutions being applied. In the third paper, the hydrolysis of zinc sulphate solutions was investigated. The second paper emphasises the importance of using pure indicators, the commercial products not always being satisfactory in this respect.

Corrosion of Copper.—The green patina produced on copper by more or less prolonged exposure to moist air is generally stated to be a basic carbonate. In two papers in the *Journal of the Institute of Metals*, (vol. 42, p. 181; 1929: vol. 44, p. 389; 1931), Vernon and Whitby have reported analyses of the deposit formed in different localities in England, and these show that in the particular samples examined the main constituent is a basic sulphate of copper, with very little carbonate. In some specimens from coastal towns there was chloride; in specimens from Lowestoft there was a considerable amount. In only one specimen was there no carbonate. London samples contained copper sulphide, sometimes to the extent of more than 10 per cent, and the action of hydrogen sulphide is considered to play an important part in the corrosion. In the second paper, it is shown that the compositions of the materials of the patina more than seventy years old correspond with the natural minerals — brochantite, $CuSO_4$, $3Cu(OH)_2$; atacamite, $CuCl_2$, $3Cu(OH)_2$; and malachite, $CuCO_3$, $Cu(OH)_2$. There is an interesting general discussion at the end of the second paper.

Solid Polyiodides of Potassium.—Although solid polyiodides of cæsium, rubidium, and ammonium have been shown definitely to exist at ordinary temperatures, whilst no solid polyiodides of sodium and lithium are reported, the solid polyiodides of potassium have been the object of several researches which have led to conflicting conclusions. Up to the present, four investigators have considered that they have prepared KI_3, although only one reports analyses supporting his results, whilst two have obtained evidence for its existence. At least four investigators have failed to obtain it, or have given evidence against its existence. There is a similar conflict of evidence in the case of KI_7. In the March number of the *Journal of the Chemical Society*, N. S. Grace has shown that the solid polyiodides obtained from aqueous solutions contain water of crystallisation, the two compounds KI_3, H_2O and KI_7, H_2O, stable at 25°, being isolated. Previous work of Abegg and Hamburger, which had been interpreted as indicating the existence of KI_7, is shown to be substantially accurate, but the polyiodide was shown to contain two molecules of combined benzene, KI_7, $2C_6H_6$. Evidence is given that no unsolvated polyiodides of potassium exist at 25°. Results of Parsons and Whitmore, which have been regarded as disproving the existence of solid polyiodides, are shown to be too incomplete to provide any such evidence.

Agricultural Science in Palestine.

WHEN the Zionist organisation began to develop its programme for the colonisation of Palestine, it realised the need for scientific research into agriculture and horticulture and set up an experimental station at Tel-Aviv under the directorship first of Dr. Warburg, and now of Dr. Elazari Volcani. Laboratories were equipped and arrangements made for field experiments in the various parts of the country being colonised under Zionist auspices. As might be expected, the scientific work has been well done and a number of interesting results have already accrued, opening up many possibilities for the future. The Zionists are not the only Jewish investigators in Palestine: the French organisation, known as P.I.C.A., has its school and experimental farm at Mikveh, where good work is done, and there is, of course, the Palestinian Government Department with its headquarters at Jerusalem.

The agricultural problems are those of a dry region of smallholders — a usual type of holding where irrigation can be widely practised but less common otherwise. The smallholdings are necessitated by the circumstance that Palestine is only a small country, already carrying a considerable population of Arabs who have been there for many years and regard themselves as having a good claim to the land; while the number of Jews who wish to colonise it is considerable. To meet the difficulty, the method was early adopted of working out schemes of husbandry suitable for small farmers of intelligence but not much capital. In the Plain of Sharon, the best prospects are for fruit, flowers for scent, and, near the towns, dairy products and vegetables. In the Emek these are less suitable though dairying is being seriously attempted: the simple obvious products are cereals, but these are not easy to sell profitably.

The Tel-Aviv work is based on a sufficiently comprehensive programme and it covers practically all subjects bearing upon the colonists' problems. Throughout, the purpose is to intensify agriculture in order to provide a higher standard of living for a larger rural population. This involves the more intensive production of existing crops, the introduction of new ones, and the improvement of the native breeds of live-stock. At the same time, the Division of Rural Economics is making a careful survey of the conditions of production of the existing crops and live-stock products with the view of further development. Possibilities of disposal of the increased output are being explored; the home market is not particularly large, but Egypt and the near parts of Europe offer some prospects for an export trade.

Dairy farming, in particular, seems to offer many advantages. It gives a higher output per man and per acre than the traditional agriculture, and thus lends itself to a denser agricultural settlement. The resulting animal manure raises the fertility of the soil for other systems of farming. The investigation has been assisted by the Empire Marketing Board, which arranged that Mr. J. Crichton, of the Rowett Institute, should study the subject on the spot. The technical problems are well on the way to solution. The grading up of the dairy cattle has been started, and also the initial improvement of the soil to a point at which it will begin to carry the new system, and the elaboration of a suitable cropping scheme. The Palestinian demand for dairy produce being insufficient, it is proposed to build up a control organisation strong enough to maintain such a standard of quality as will secure the products in the overseas markets.[1] The possibility of the development of a sugar industry is being examined.[2] The most hopeful solution appears to be the combined cultivation of cane and beet, thus spreading the work at the factory over a longer season and broadening the scheme of cropping. Sugar-cane, although little grown, is not a new crop in Palestine. Beet, however, presents certain difficulties in the dry regions, but these can be overcome by irrigation at critical periods.

Among the indigenous plants are eight species of wild flax, and the growing of flax for seed, carried out in Bible days, is being exploited once more. So far no serious diseases or pests have affected this crop, though it is anticipated that dodder is likely to put in an appearance at some future date.

Palestine, however, is always liable to plant diseases and pests, and steps were taken from the outset to cope with them. Dr. Reichert, who is in charge of the Division of Plant Pathology, and is ably assisted by Miss Hellinger, has confined his attention principally to the banana, citrus, and wheat crops. 'Internal decline', a physiological disease of citrus fruits well known in other regions, has now been recorded in Palestine. Diplodia stem-end rot is widespread, and in 1929 cost the Palestine orange industry some £25,000. It is, however, practically eliminated by debuttoning the fruit by colouring it. A third trouble, due to *Sclerotinia sclerotiorum*, is common to citrus, banana, and various other crops. The banana is particularly susceptible, and there seems considerable danger of the spread of the fungus thence to the citrus groves. The wheat studies, commenced in 1923 and still in progress, have been chiefly concerned with the relative susceptibility of different varieties to bunt, and it is of considerable interest that the wild emmer (*Triticum dicoccoides*) has been found to be highly susceptible.

Dr. Oppenheim, of the Division of Horticultural Breeding, is working principally upon the sugar content and the acidity of the orange fruit during its development, and upon breeding methods for improving the citrus crop. He emphasises the importance of bud selection and suggests the establishment of a national organisation for the selection of stock and of bud-wood from trees already existing in the groves.

Of the insects giving trouble to the grower, locusts are the best known, and the Government has set up a good locust service to observe and deal with the insects as soon as they appear. Other insects, however, are also harmful. Dr. F. S. Bodenheimer, in his bulletin on the Coccidæ or scale insects of Palestine, enumerates some 65 species, of which eight are new to science. Even this list by no means exhausts the Coccid fauna and he has since issued supplementary notes. He has studied also the Wood Leopard moth (*Zeuzera pyrina*), an insect which causes great damage, particularly to olive and apple trees, by its larva tunnelling in the wood. The use of paradichlorbenzine or calcium cyanide is recommended as a remedy easy to handle and to apply. Among other entomological papers, the report by H. Haupt on *Homoptera Palestinæ* I.[3] and that of F. S. Bodenheimer on tobacco pests may be mentioned. Some of the latter originally affected wild Solanaceæ and other plants, but are now passing over to the newly planted tobacco and cause considerable injury.

Spraying naturally comes in for a good deal of study: one interesting paper deserves mention.[4] Assuming varied standards of mortality by spraying, and a 95 per cent natural mortality in each generation of the larvæ from the eggs surviving spraying, it is shown that insects with 10 or 20 eggs per female cannot maintain their existence under such control measures, but that the Red Scale (*Chrysomphalus*

aurantic), which has 100 eggs per female, can only be controlled by a spray giving at least 90 per cent mortality, and that one, or at most two, sprayings per year are then sufficient. The control measures should be applied at the time of population minimum; the numbers cannot be materially reduced if dealt with at the time of population maximum. Similar considerations are applied to field mice control.

The publications of the Tel-Aviv Institute are not confined to agriculture and horticulture. A systematic survey of the flora of Palestine is now being carried out by A. Eig. Two bulletins on the systematic side and one from the ecological aspect give an excellent bird's-eye view of the flora of Palestine. The flora is in process of active transformation owing to the effect of modern methods of land cultivation. Marsh species are tending to disappear owing to increased drainage, while certain dry land species are vanishing with the spread of irrigation.

The attempt to fix the shifting sand dunes will probably affect the dune flora. These imminent changes render it desirable for the botanical surveys to be pushed forward as rapidly as possible, but the work is handicapped by the fact that most plants are short-lived, appearing in the spring only, so that only relatively small areas can be investigated each year. The flora is much affected by physical factors, especially by the distribution of rainfall, as the period of greatest heat synchronises with that of absence of rain. Steps are already being taken to preserve the native flora, to guard the reserves, and to plant woods of forest trees.

One of the publications makes an especially wide appeal: Dr. Volcani's pamphlet, "The Fellah's Farm", which, apart from its special agricultural matter, is of general interest because of its many references to survivals of ancient Jewish and fellah folklore. Here, for example, is a summary of the rites still performed by the local peasantry when the rain has failed to appear:

"Each district has its local rites. There may be a procession of girls in the twilight after the evening meal, beating empty petrol tins containing pebbles, in order to make even more noise. They knock at the doors of the houses, and are sprinkled with water. An old woman marches before them, a handmill on her head, on top of which a rooster shut in a basket crows lustily to call forth divine compassion. A pitcher of water occasionally replaces the handmill. A white cock and a black hen are carried along and beaten at intervals so that they may cry all the louder. Grain and flour sifters are carried on the head to symbolise the famine threatening man and beast. Sometimes an old woman, riding a donkey backwards and carrying an infant, grinds an empty handmill. These figures are meant to personify innocence. The old woman can no longer do wrong, while the infant has not yet tasted sin. The rooster represents the domestic animals."

The workers at Tel-Aviv, and the Zionist Organisation supporting them, are to be heartily congratulated on the volume and quality of the work they have already done under conditions which have sometimes been both difficult and trying. With the setting up of the new experimental field at Rehovat, we may expect an even more extensive study of Palestinian problems. A good beginning has been made: we wish the workers all success.

THE STAFF OF ROTHAMSTED EXPERIMENTAL STATION.

[1] Preliminary Report on the Agricultural Aspect of a Sugar Industry in Palestine, *Tel-Aviv Bull.*, 3, 1924.
[2] The Dairy Industry as a Basis for Colonisation in Palestine, *Pub. Palestine Econ. Soc.*, 1928. The Transition to a Dairy Industry in Palestine, *Tel-Aviv Bull.*, 11, 1930.
[3] Homoptera Palestinæ, 1, *Tel-Aviv Bull.*, 8, 1927.
[4] Theoretical Considerations on the Evaluation of Control Measures, by Dr. F. S. Bodenheimer. *Hadar*, vol. 3, No. 12, December 1930.

The Satellites of Jupiter.

PROF. DE SITTER, Director of Leyden Observatory, delivered the George Darwin Lecture of the Royal Astronomical Society on May 8, taking as his subject "The Satellites of Jupiter". The lecture began with a sketch of the progress of our knowledge of the system. Galileo attempted to make tables of their motion. Romer deduced from them the finite velocity of light. Wargentin devoted a large part of his life to the study of their motions. Bradley made careful observations. La Grange improved the mathematical theory. Delambre and Damoiseau made tables, which remained in use until recent times. Forty years ago, Sir David Gill carried out a series of observations with the Cape heliometer; he compared the satellites with each other, not with Jupiter itself, finding that this increased the accuracy of observation very notably. The positions of certain stars had been found with great accuracy in connexion with the determination of the solar parallax from observations of the planets Iris, Victoria, and Sappho. These stars were now used to check the scale of the heliometer, and this was considered to be known to one part in 100,000. Prof. de Sitter took a large part in reducing these observations; he found from a combination of all determinations that the mass of the Jovian system is 1/1047·40 of the sun, with a probable error of 0·03 in the denominator.

Prof. de Sitter then gave an outline of the different classes of perturbations, which he divided into four groups: (1) Those with periods of less than 17 days; (2) periods of 400–500 days; (3) the small libration of satellites I, II, III about their equilibrium position—he found that the period of this is close to six years; (4) those exceeding Jupiter's period of revolution. The inequalities of short period exceed in magnitude the oscillations arising from the eccentricities of the orbits; he therefore used intermediary orbits based on these inequalities, instead of using ellipses.

The values given by Prof. de Sitter of the masses of I, II, III, IV were 381, 248, 817, and 509, expressed in units of the seventh decimal of Jupiter's mass. Those of II and III are the best known, the different determinations of these being very accordant. He made a comparison between the Jovian system and (1) the four interior planets, (2) the four giant planets. He noted that 33 years in the satellites corresponded to 17 centuries in the terrestrial planets and to 1200 centuries in the outer planets. Consequently, progressive changes take place much more rapidly in the satellite system, which adds interest to the study of them.

Prof. de Sitter also alluded to his studies of the variations in the rate of the earth's rotation as shown by the fluctuations in the motions of the moon, the inner planets, and Jupiter's satellites. Certain discrepancies between the results from Jupiter's satellites and those from the other sources suggest the possibility that the Jovian system might have fluctuations of its own. He showed from a diagram that the fluctuations were small during the nineteenth century, so that it was not until the present century that their reality could be affirmed with some confidence.

Newcomb had, however, suggested many years before the possibility that the lunar fluctuation might arise from changes in the earth's rate of rotation.

Prof. de Sitter stated that his work had been assisted by excellent series of photographs of the satellites obtained at many observatories. He made a comparison between the accuracy of heliometer and photographic positions; the probable error of one position with the former was 0·075″, while that from a plate with six images, measured in two positions, was 0·02″–0·03″.

Weather and Health.

AN interesting report, prepared by Dr. Ellsworth Huntington with the advice of a strong committee, based on the daily meteorological and mortality records of the city of New York from April 15, 1882, to Mar. 24, 1888, appears as *Bulletin* No. 75 of the National Research Council (National Academy of Sciences, Washington). Gross mortalities at ages under five years and over five years are considered separately, also mortalities in these age periods from causes other than pneumonia and influenza. Mortality from pneumonia and influenza (all ages) forms a separate group. The data are expressed as percentages of the daily average of the particular year, and, when necessary, corrections for seasonal trend are introduced. For sufficient reasons, graphical methods are chiefly used, in particular climographs: that is, a third variable, daily deaths, is shown by contour lines on a bivariate diagram, for example, of temperature and relative humidity. It is contended that the method leads to clearer results than the use of correlation coefficients and massed averages.

The principal conclusions reached are these. Judging by the data of deaths from all causes except pneumonia and influenza among persons over five years of age, the optimum temperature is close to 65° F. Among children under five years the optimum is about 10° lower. Among extremely young infants, however, there is evidence that the optimum is higher. So far as influenza and pneumonia are concerned, it appears that the chances of contracting the disease are at a maximum with the lowest and a minimum with the highest temperatures, but that the chances of death after the disease has been acquired are subject to the influence of the normal temperature optimum. It appears that at the optimum temperatures, low atmospheric humidity is harmful but, among young children, plays only a minor part. Above the optimum temperature, the best humidity appears to be progressively lower as the temperature rises.

Much stress is put upon the relation between interdiurnal variability of temperature and mortality. "No matter whether a drop of temperature causes the mean temperature to be better or worse, it tends to produce a stimulating effect which induces a relatively low death-rate both on the day in question and the next day. In similar fashion, no matter whether a rise of temperature brings a favourable or unfavourable mean temperature, its effect for two days is to raise the death-rate." Still more interesting is the apparent fact that a moderately high degree of variability of temperature from day to day is more favourable than low variability. In this respect there is a similarity between the experience of New York and of Stockholm, which suggests that there is a definite optimum variability independent of temperature.

The author asks whether "the apparent difference from season to season" may not "merely represent the fact that in cold weather we are protected from changes of temperature". He finds that ideal weather in New York would be characterised by an average temperature of about 65° and a relative humidity of nearly 90 per cent. The preceding ten days should have been characterised by fairly strong changes of temperature, averaging 4°, and should culminate in a fall of 10° or 12°. It seems that south-east England, outside the smoke-laden area of London, approaches as near to the ideal as we may hope to come, but the author points out that many other variables remain to be considered.

University and Educational Intelligence.

CAMBRIDGE.—The Sadleirian professorship of pure mathematics will be vacant on Sept. 30, 1931, by the resignation of Dr. E. W. Hobson.

The Appointments Committee of the faculty of mathematics has reappointed Mr. S. W. P. Steen, of Christ's College, and Mr. T. G. Room, of St. John's College, to be University lecturers in the faculty, and Mr. E. C. Bullard, of Clare College, to be University demonstrator in geodesy.

A report has been received from the managers on the regulations for the Quick professorship of biology. In October, Prof. G. H. F. Nuttall retires from the chair, after having held it for twenty-five years. By the terms of Mr. Quick's will, the benefaction must always be used to promote "study and research in the sciences of vegetable and animal biology". Authority is given to the managers, however, to propose to the University changes in the particular field of biology with which the chair shall be associated. From 1906 until 1919 this field was defined as protozoology; in 1919 parasitology replaced protozoology. The managers now recommend to the University that the next tenure of the Quick professorship should be associated with the field of research which they define as the study of the "Biology of the Cell". If this recommendation is approved, they intend to offer the chair to Mr. D. Keilin, who has for some years been carrying on research work of this type in the Molteno Institute.

The University has conferred the honorary degree of M.A. on Mr. E. Everett, on his retirement, after more than forty years' service, from the post of assistant to Sir J. J. Thomson at the Cavendish Laboratory.

DURHAM.—The Council of Armstrong College has appointed Dr. E. G. Richardson to be lecturer in physics. Dr. Richardson is at present lecturer in physics at University College, London, and is engaged on research in connexion with the propagation of high frequency radiation in gases.

LONDON.—The London School of Economics and Political Science has been granted the sum of £142,000 by the Rockefeller Foundation. This sum has been allocated as follows: £60,000 for reconstructing and extending the library; £10,000 for the purchase of additional books; £30,000 towards the purchase of land for new school buildings; and £42,000, in annual grants of £6000, for providing increased facilities for post-graduate teaching and research.

The late Mr. Clifford B. Edgar has bequeathed £4000 to the London School of Hygiene and Tropical Medicine for the promotion of research. Mr. Edgar was a graduate of the University, and intimately connected with its work for many years, having acted as chairman of the Finance Committee from 1910 until 1920.

The Court of Common Council has renewed for 1931

its grant of £105 in aid of the University's extension work, and the Drapers' Company has renewed for the year 1932 its grant of £500 for the Department of Applied Statistics at University College. The Civil Service Commission has notified the University of the renewal for 1931–32 of the present subvention of £2250 from Indian revenues towards the cost of probationary instruction of selected candidates for the Indian Civil Service.

OXFORD.—At Rhodes House, on May 9, Prof. A. Einstein delivered in German the first of his three Rhodes Lectures on "The Theory of Relativity—its Formal Content and Present Problems". He gave a general exposition of the special and general theories of relativity, emphasising the need of "logically satisfying" assumptions and explaining the methods of advance from the Euclidean to a pseudo-Euclidean metric and hence to the Riemann metric. The general theory could not, however, provide a logical explanation of the electromagnetic field. In his second lecture, on May 16, Prof. Einstein will discuss the problem of the finite universe. In his last lecture, on May 23, he proposes to give an account of his attempt to derive both the gravitational and electromagnetic fields by the introduction of a directional spatial structure.

THE following courses of free public lectures in metallurgy have been arranged by the Armourers and Brasiers' Company:—At 8 o'clock on May 21 and 28 and June 4, at the Royal School of Mines, "Thin Films on Metals", by U. R. Evans, and at 5.30 on May 27 and June 3 and 10, at King's College, Strand, "Some Impurities in Metals and the Production of Metals of High Purity", by Dr. W. Rosenhain. No tickets are required.

Birthdays and Research Centres.

May 18, 1873.—Dr. H. ELTRINGHAM, F.R.S., president of the Entomological Society of London (1931).

Is more or less continuously engaged in the histological structure of insects, more especially that of special glands and organs. At present investigating the structure of the abdominal organs in the smaller caddis flies, the action of 'diaphanol' on chitinous and other structures, and the structure of the eye in Aleurodes.

At all times prepared to undertake histological investigations into the finer structure of insects, and should be glad to have unusual material for this purpose from anyone who has the opportunity of obtaining same in a proper state of preservation. Would be glad to furnish suitable preservative fluids to anyone who can obtain material suitable for investigations of this character.

May 19, 1876.—Prof. W. K. GREGORY, curator of the Department of Ichthyology, American Museum of Natural History.

My chief investigation now in progress is the study of the skulls of fish of many orders and families. Each skull is considered from two points of view: first, as a natural mechanism (the inert part of a machine that serves in the complex turnover of energy taken in and paid out by the organism as a whole); secondly, as a morphological pattern, which has acquired its various characters at different stages of its phylogenetic history.

I should welcome researches bearing upon the hypotheses that triradiate sutures arise through the equal growth away from each other of three centres of ossification and that the semicircular canals arose in a similar manner. A functional analysis of parts of the neurocranium (cranial vault, interorbital bridge, ethmo-vomer block, keel-bone or parasphenoid) leads to interesting results.

May 23, 1850.—Dr. G. C. DRUCE, F.R.S., Fielding curator in the University of Oxford.

I am at present engaged in an investigation of the flora of Cyprus.

May 23, 1864.—Sir ARTHUR SMITH WOODWARD, F.R.S., lately Keeper of the Department of Geology, British Museum (Natural History).

I have accumulated many fossil fishes on which I hope soon to continue research, but I have been occupied for a long time in preparing (and largely rewriting) a second English edition of Zittel's "Palæontology", vol. 2 (Fishes, Amphibians, Reptiles, and Birds), which is now in type and nearly completed. A new edition of my "Outlines of Vertebrate Palæontology" will probably follow. I think that one who has had long experience of any sphere of research can do good service to science by attempting, from time to time, to digest and correlate the results of the multitude of technical papers and memoirs which now appear in more rapid succession than ever.

Societies and Academies.

LONDON.

Royal Society, April 30.[1]—**J. A. Todd**: On twisted cubic curves which satisfy twelve conditions. The paper deals with the problem of determining the number of twisted cubic curves in space which satisfy the joint condition of meeting r lines in one point, s lines in two points, and of passing through t fixed points where $r+s+2t=12$, so that the condition determines a finite number of curves. The simpler cases are treated by a variety of elementary methods; for the more complicated cases the principle of special position is employed, in which the given lines and points are made to assume particular positions in such a manner that the curves which are required fall into various classes, of which the number of curves in each is determined by simpler considerations.—**H. T. Flint**: A metrical theory and its relation to the charges and masses of the electron and proton. This paper points out the analogy existing between the equations of the quantum theory and the electromagnetic equations of Maxwell, pointing to the existence of a definite natural metric in a five-dimensional continuum. Parallel displacements along the world lines in this continuum are associated with no change in length, but in the four-dimensional world the change of length is a periodic function, with a frequency proportional to the mass associated with the world line. This view leads at once to the interpretation of the ratio of the masses of the electron proton as a metrical ratio, and makes a unitary physical theory possible.—**A. M. Mosharrafa**: Material and radiational waves. The Maxwellian equations of electromagnetic and electron theory are derived from one set of basic relations in a manner which throws some light on the relationship between material and radiational waves, and accounts for the existence of exactly three types of physical entities, namely: positive electricity, negative electricity, and radiation. It is shown that a physical entity may be associated with the propagation of a vector A in a direction n. If A and n are in the same direction, the entity is recognised

[1] Continued from p. 726.

as positive electricity, if in opposite directions as negative electricity, and if mutually perpendicular, then as radiation. In the general case, A will have both a longitudinal and a transverse component, corresponding to the co-existence of matter and radiation.—J. Guild: The colorimetric properties of the spectrum. The paper describes an investigation carried out at the National Physical Laboratory to determine the colorimetric properties of a group of seven subjects as obtained from direct measurements of the trichromatic coefficients of the spectrum on a trichromatic colorimeter. A proposal is made for the adoption of a set of standard data, to represent a normal eye for technical colorimetric purposes, based on the results of this investigation and those recently published by W. D. Wright.—C. Robinson and H. A. T. Mills: The colloid chemistry of dyes. The aqueous solutions of benzopurpurine 4*B* and its isomer prepared from *m*-tolidine (1, 2). Although benzopurpurine 4*B* is a well-known cotton substantive dye, its isomer prepared from *m*-tolidine has not sufficient affinity for cotton for it to be of practical use as a dyestuff. An investigation of the solutions of these dyestuffs has been carried out in order to see if correspondingly great differences could be found in their colloidal properties. The viscosity of their solutions (if not super-saturated) are the same and are of the order to be expected in an unhydrated colloid. The viscosity does not vary with rate of shear, and the conductivities are of the same order. On the other hand, ultra-filtration, flocculation by electrolytes, and ultramicroscopic examination show marked differences between the two dyes, which may be explained if it is assumed that benzopurpurine 4*B* forms larger aggregates than the meta isomer. The osmotic pressures of the two dyes are almost the same; this can be accounted for in spite of the difference in particle size shown by experiments described. It is concluded that these dyes exist in solution as totally dissociated colloidal electrolytes, hydrolysis being negligible.—G. B Deodhar: X-ray nondiagram lines. In the K and L series, nondiagram lines pairs are found which show approximately constant $\sqrt{\nu/R}$ differences. These seem to resemble the usual screening doublets.—T. E. Stern: The chemical constant of chlorine vapour and the entropy of crystalline chlorine. By statistical mechanics the molecular composition of chlorine gas is calculated, assuming that the ratio between the numbers of atoms of the two isotopes 35 and 37 is known. It is found in this calculation that the angular momenta of nuclei are without effect upon the constitution of chlorine gas. The vapour pressure of chlorine crystals is also calculated and, finally, the entropy of chlorine per mole in the crystalline form at the absolute zero.—I. E. Knaggs: The molecular symmetry of hexa-aminobenzene in the crystalline state and certain other properties of the substance. An examination of crystals of hexa-aminobenzene by the powder X-ray photographic method has shown the crystal symmetry to be that of the holohedral cubic class, the space-group being O_h^2. There are 16 molecules in the unit cell of side 15·14 A., and the molecules possess a threefold axis of symmetry.—H. W. Melville and E. B. Ludlam: The effect of foreign gases on the lower critical oxidation limit of phosphorus vapour. The experiments were carried out to test the equation originally proposed by Semenoff. In the present approximate state of the theory, the differences obtained are explained on the variation of the diffusion coefficient of the chain propagators into the foreign gas. The results show no correlation with those obtained for foreign gases at the upper critical oxidation limit.—L. Rosenhead: The lift on a flat plate between parallel walls. The effect of the walls is to increase the lift-coefficient, and curves and tables are given showing this increase for various values of the angle of attack and the ratio of chord of aerofoil to width of channel.—J. A. V. Butler and A. D. Lees: The behaviour of electrolytes in mixed solvents (3). The molecular refractivities and partial molar volumes of lithium chloride have been determined in a series of mixed water-alcohol solvents. It is found that the molecular refractivity is constant in each solvent over the range of concentrations investigated. Its value is scarcely affected by the presence of alcohol until the molar fraction of the latter is more than 20 per cent, and then falls off steadily to the value for pure alcohol. The effect of lithium chloride on the density of the solutions varies greatly with the composition of the solvent.—T. C. Marwick: An X-ray study of mannitol, dulcitol, and mannose. The relationship is traced between the structures of mannitol and dulcitol, and between the structures of mannose and other saccharides. (See also NATURE, Jan. 3, 1931, p. 11.)—G. I. Finch and J. C. Stimpson: The electrical condition of hot surfaces during the adsorption of gases. The electrical conditions of a carbon rod and a copper sheet have been studied at temperatures up to 850° C. *in vacuo*, and in contact with various gases. The results of these experiments suggest that 'normalisation' of the carbon involves the evolution of occluded gases accompanied by structural changes in the surface, but that in the case of copper it involves a process of sintering.—A. B. D. Cassie and C. R. Bailey: Investigations in the infra-red region of the spectrum (3, 4). The absorption spectrum of carbon disulphide is described between the limits of 1 μ and 22 μ, and the results compared with those of Coblentz for the liquid. The molecule possesses a rectilinear structure, with probably a single linkage between the carbon and sulphur atoms. The Raman spectrum has been coordinated with the infra-red spectrum, and an explanation is offered for the appearance in both of the characteristic doublet associated with the inactive frequency.—D. R. M'Rae: Asymmetry observed in the stark component of H_α. A special grating having a very intense first-order spectrum on one side has been used to resolve the Stark components of H_α. Asymmetry is observed in the displacements of the components, and also in the relative intensities of the components. Altering the number of atoms in the initial states does not explain completely the asymmetry of intensities.—F. D. Miles: The apparent hemihedrism of crystals of lead chloride and some other salts. Lead chloride, which normally shows holohedral orthorhombic symmetry, can, under certain specified conditions, be obtained from hot solutions containing dextrine in microscopic crystals consisting of a single form (a bisphenoid), which can have only axial symmetry. By reducing the concentration of dextrine this form can be gradually repressed. Normal crystals of lead chloride were grown and investigated by X-ray methods. The difficulty of X-ray work with crystals impervious to the radiation is emphasised, and a simple method is given for finding whether any given reflection will emerge from any crystal face. The structure contains two glide planes of symmetry. The symmetry is, therefore, in all probability holohedral. The idea that crystal faces lying opposite to each other across a plane of symmetry may behave differently to an optically-active reagent is supported. The cases described appear to be the first to demonstrate that the presence of optically-active material may induce the *growth* of a hemihedral crystal of a substance, the normal symmetry of which is certainly higher.—C. E. Wynn-Williams: The use of thyratrons for high speed automatic counting of physical phenomena. The thyratron may be regarded as a triode valve which

contains a trace of mercury vapour or inert gas at low pressure. Under appropriate conditions, a positive voltage impulse of only a few micro-seconds' duration applied to the grid will cause an arc to strike between the anode and cathode (or filament). The arc then continues independently of further grid potential changes until the anode circuit is momentarily interrupted. In this respect the thyratron behaves as a very delicate, inertialess relay, capable of controlling considerable currents. Some circuits are described for utilising to the greatest advantage the 'inertialess relay' characteristic of the thyratron, for high-speed automatic counting of voltage impulses set up by physical phenomena. Two impulses separated by as little as 1/500th second can be separately recorded.

PARIS.

Academy of Sciences, Mar. 30.—Camille Matignon: Some properties of commercial calcium nitrates. These have been regarded by some people as liable to spontaneous combustion, and some insurance companies have enforced special premiums on this account. It is shown experimentally that these views are erroneous.—**Gabriel Bertrand and V. Ciurea:** Tin in the animal organism. Previous work on this subject is criticised on the ground that the method employed did not differentiate tin from silica. The authors, using a more exact method, have found in the organs of the ox, horse, and sheep quantities of tin varying between 0·4 and 26 parts per million, the largest proportions being found in the tongue: no tin was found in the peritoneum.—**André Blondel:** The limitations of photometry.—**Léon Guillet and Jean Cournot:** Remarks relating to the influence of occluded gases on the mechanical properties of metallurgical products. Criticisms of the conclusions of Guichard, Clausmann, Billon, and Lanthony on the effect of occluded gases on the hardness of electrolytic iron.—**D. Wolkowitsch:** The representation of the results of a series of experiments by an approximate formula with two parameters.—**Paul Delens:** Congruences of curves and figuration of invariants.—**D. Pompeiu:** The property of holomorph functions.—**A. Magnan and A. Sainte-Laguë:** The distribution of aerodynamic velocities round an aeroplane in flight.—**L. Joly:** A method of measuring the heat conductivity coefficient of materials.—**Guy Emschwiller:** The chemical action of ultra-violet light on the alkyl iodides. From a study of the action of ultra-violet light on liquid alkyl iodides, it is concluded that the primary action is removal of a molecule of hydrogen iodide; this can react with another molecule of the iodide, giving a saturated hydrocarbon and iodine. The other secondary products found can also be explained on this hypothesis.—**Ch. Bedel:** The electrical resistance of silicon. It has been found possible to secure good electrical contacts with pure silicon, and obtain consistent figures. The presence of small proportions of iron in the silicon has a marked effect on the resistance.—**R. Gibrat:** The optics of uniaxial heterogeneous structures.—**H. Le Breton:** The age of the recent marine terraces of Xu-Nghé in North Annam (French Indo-China).—**D. Chalonge and E. Dubois:** The distribution of ozone in the atmosphere. From the study of absorption spectra it is concluded that ozone is distributed in the atmosphere in a much less discontinuous manner than has hitherto been supposed; there are appreciable quantities at relatively low altitudes.—**Mme. F. Bayard-Duclaux:** The electrical conductivity of the air at Paris.—**Pierre Lesne:** Organic adaptation in xylophage insects of the family of the Bostrychidae. Commensalism of Lyctoderma.—**Mme. Lucie Randoin and René Fabre:** Comparative researches on the proportion of SH derivatives in striated muscle, liver, and blood in the normal rat, in the underfed rat, and in the rat deprived of the B vitamins.—**J. Lefèvre and A. Auguet:** The problem of the relationship between the heats of work and repose. The solution and laws. Why work is more economical at low temperatures.—**Ch. Hruska:** Vaccination against anthrax with non-attenuated virus. Saponin is added to the virus and this is injected. The local swelling is cured in 15–20 days, and the animal is resistant to infection. The mixture of the virus and saponin is unaltered after keeping for fifteen months.

Official Publications Received.

BRITISH.

Scientific Reports of the Imperial Institute of Agricultural Research, Pusa, (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), 1929–30. Pp. vi+165. (Calcutta: Government of India Central Publication Branch.) 3.8 rupees; 6*s*.

The Indian Forest Records. Chemistry Series, Vol. 16, Part 2: Indian Ephedras. By Dr. S. Krishna and T. P. Ghose. Pp. iii+32+5 plates. (Calcutta: Government of India Central Publication Branch.) 1.14 rupees; 3*s*. 3*d*.

Agriculture and Live-stock in India. Vol. 1, Part 1, January. Pp. xii+108+6 plates. (Calcutta: Government of India Central Publication Branch.) 1.8 rupees; 2*s*. 6*d*.

The Indian Journal of Agricultural Science. Vol. 1, Part 1, February. Pp. vi+156+15 plates. (Calcutta: Government of India Central Publication Branch.) 2.8 rupees; 4*s*. 6*d*.

Report of the Kodaikanal Observatory for the Year 1930. Pp. ii+4. (Calcutta: Government of India Central Publication Branch.) 6 annas.

Government of India: Department of Industries and Labour. Functions and Organisation of the India Meteorological Department (1931). Pp. 18. (Delhi: Government of India Press.)

Proceedings of the West Indian Conference of Agricultural Officers, 1930, held at the Imperial College of Tropical Agriculture, Trinidad, B.W.I., on the 23rd January 1930 and following Days. Pp. 56. (Trinidad: Government Printing Office.) 2*s*. net.

Mysore Geological Department. Bulletin No. 11: Review of Mineral Production of Mysore for 1915 to 1929. By A. M. Sen. Pp. xiv+203+4 plates. (Bangalore: Government Press.) 3 rupees.

Silvicultural Research Manual for use in India. Vol. 2: Statistical Research (The Statistical Code). By H. G. Champion and I. D. Mahendru. Pp. viii+264+10 plates. (Calcutta: Government of India Central Publication Branch.) 12.10 rupees; 20*s*. 6*d*.

Journal of the Royal Microscopical Society. Series 3, Vol. 51, Part 1, March. Pp. xvi+108. (London.) 10*s*. net.

Madras Fisheries Department. Fish Statistics for 1926–27. (Supplement to the Administration Report for 1927–28.) Edited by Dr. B. Sundara Raj. (Report No. 2 of 1929, Madras Fisheries Bulletin, Vol. 23.) Pp. 87-151. (Madras: Government Press.) 10 annas.

FOREIGN.

Memorie del R. Istituto Lombardo di Scienze e Lettere. Vol. 24, Fascicolo 2: Pier Candido Decembrio, contributo alla Storia dell' Umanesimo Italiano. Memoria di Ernst Ditt. Pp. 21-108. (Milano: Ulrico Hoepli.) 22 lire.

Rendiconti del Seminario Matematico e Fisico di Milano. Vol. 4 (1930-VIII). Pp. xi+236. (Milano.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 97: The Kamia of Imperial Valley. By E. W. Gifford. Pp. vii+94+2 plates. (Washington, D.C.: Government Printing Office.) 25 cents.

The World Calendar. By Elisabeth Achelis. Second edition. Pp. 26. (New York City: The World Calendar Association, Inc.)

Pubblicazioni del R. Osservatorio Astronomico di Merate (Como) succursale del R. Osservatorio di Brera (Milano). N. 4: Ricerche sulla frequenza delle grandezze assolute delle stelle delle diverse classi spettrali. Per Gino Cecchini. Parte 1: Catalogo generale de parallassi stellari. Pp. 152. (Milano: Ulrico Hoepli.) 30 lire.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin trimestriel des résultats acquis pendant les croisières périodiques et dans les périodes intermédiaires. Publié par le Bureau du Conseil avec l'assistance de C. H. Ostenfeld. Résumé des observations sur le plankton des mers explorées par le Conseil pendant les années 1902–1908. Quatrième partie: Sommaire général des parties 1 à 3. Pp. 601-672. (Copenhague: Andr. Fred. Høst et fils.)

Proceedings of the United States National Museum. Vol. 78, Art. 21: Description of a New Species of Amidostomine Worm of the Genus Epomidiostomum from the Gizzard of Anserine Birds. By Rudolf Wetzel. (No. 2864.) Pp. 10+2 plates. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Nickel Alloy Steels: a Summary of their Properties and Applications. (Nickel, A7.) Pp. 12. (London: The Mond Nickel Co., Ltd.)

Spectrometric Apparatus (Spectrographs). Pp. 16. (London: Bellingham and Stanley, Ltd.)

New Books at Reduced Prices in various Subjects. (No. 457.) Pp. 44. (Cambridge: Bowes and Bowes.)

New Models. (Catalogue No. T.L 20.) Pp. 19. (London: The Medical Supply Association, Ltd.)

Fungi, Plant Pathology, etc.: Catalogue of the Library of the late Dr. N. Patouillard. (Catalogue No. 185.) Pp. 52. (London: Dulau and Co., Ltd.)

Diary of Societies.

FRIDAY, MAY 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4.—Sir Arthur Keith: Human Monsters and Malformations (6): A Consideration of the Commoner Malformations to ascertain how far they can be explained by regarding them as Atavistic States or as due to Parental Influences.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—F. S. Grimston: The Indian Ordnance Factories and their Influence on Industry.

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.

PHYSICAL SOCIETY (at Science Museum, South Kensington), at 5.15.—Sir Richard T. Glazebrook: Standards of Measurement: their History and Development (Guthrie Lecture).

INSTITUTE OF CHEMISTRY (Belfast and District Section) (at Royal Belfast Academical Institution), at 7.30.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section) (Annual General Meeting), at 8.—The Relative Value of the Induction of Premature Labour, Test Labour, and Cæsarean Section in the Treatment of Minor Degrees of Contracted Pelvis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. C. Philip: Experimental Aspects of Hydrogen-Ion Concentration.

SATURDAY, MAY 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District Meeting) (at Cheltenham), at 10.30 A.M.

BIOCHEMICAL SOCIETY (in Department of Biochemistry, Oxford), at 2.30.—Dr. I. S. Maclean and M. S. B. Pearce: Oxidation of Oleic Acid *in vitro* and their Bearing on the Biological Oxidation of Oleic Acid.—J. A. Lovern and R. A. Morton: Pigmentation in the Livers of Monk Fish.—J. A. Lovern, R. H. Creed, and R. A. Morton: The Mittelmann Process for Treating Fish Livers.—A. E. Gillam and R. A. Morton: The Antimony Trichloride Colour Test and the Ultra-violet Absorption of Liver Oils and Concentrates.—Prof. I. M. Heilbron, A. E. Gillam, and R. A. Morton: Specificity in Tests for Vitamin A. A New Conception of the Chromogenic Constituents of Fresh and Aged Liver Oils.—K. H. Coward, K. M. Key, B. Morgan, F. Dyer, and R. A. Morton: Biological, Chemical, and Physical Measurements of Vitamin A.—A. L. Bacharach, E. Allchorne, and V. Hazley: The Effect of Adding Vitamin A to a Rachitogenic Diet.—Prof. J. C. Drummond and B. Ahmad: Observations on the Relations between Carotene and Vitamin A.—T. W. B. Osborn: Influence of Various Factors on the Concentration of Complement in Blood.—C. L. Cope: Creatinine Excretion in Man.—R. B. Fisher: Relation of Lactic Acid Metabolism to Avian Polyneuritis.—N. Gavrilescu and R. A. Peters: Tissue Respiration in Vitamin B Deficiency.—Prof. R. A. Peters: Tension Buffering.—H. W. Kinnersley and Prof. R. A. Peters: Observations on the Thermolability of Vitamin B_3.—A. S. Foot, J. Golding, and S. K. Kon: Note on the Requirements of the Pig for the Vitamin B Complex.—R. Cook and Prof. J. B. S. Haldane: The Respiration of Bacterium Coli.—D. C. Harrison: Glucose Dehydrogenase: a New Oxidising Enzyme from Animal Tissues.—O. Rosenheim and W. W. Starling: Note on the Purification and the Optical Activity of Carotene.—H. J. Phelps and R. B. Vallender: Further Observations on the Equilibria set up at a Charcoal-Water Interface.—Demonstration:—T. W. B. Osborn: Method of Estimating the Blood Complement.

MONDAY, MAY 18.

VICTORIA INSTITUTE (at Central Buildings, S.W.1), at 4.30.—Dr. C. E. P. Brooks: Climatic Changes since the Ice Age.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Col. R. McCarrison: Experimental Research at the Pasteur Institute, Coonoor, S. India (1).

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons), at 8.—Dr. E. W. Fish: An International Nomenclature of the so-called Pyorrhœa Group of Diseases.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—B. Thomas: The First Crossing of the Rub 'Al Khali.

TUESDAY, MAY 19.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. A. D. Peacock and Dr. R. A. R. Gresson: Male Haploidy and Female Diploidy in *Sirex cyaneus*, F. (Hymen).—Miss J. A. R. Wilson: Some New Facts about the Structure of the Russian Paper-Coal Cuticles, and their Bearing on the Systematic Position of some Fossil Lycopodiales: with a Note on the Absence of Eligulate Heterosporous Lycopodiales in the Fossil-record, by Prof. J. Walton.—A. H. R. Goldie: The Electric Field in Terrestrial Magnetic Storms.—Prof. T. M. MacRobert: Fourier Integrals.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Dr. E. C. Rhodes: Labour and Output in the Coal-Mining Industry in Great Britain.

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

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Institute of Hygiene), at 6.30.—T. G. Rose: Higher Control (Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Dr. S. K. Hutton: The Labrador Eskimos, Past and Present.

WEDNESDAY, MAY 20.

SOCIETY OF GLASS TECHNOLOGY (in London), at 2.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Gilbert Walker: Recent Work by S. Mal on the Forms of Stratified Clouds.—C. K. M. Douglas: A Problem of the General Circulation.—G. S. P. Heywood: Wind Structure near the Ground, and its Relation to Temperature Gradient.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Col. R. McCarrison: Experimental Research at the Pasteur Institute, Coonoor, S. India (2).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. A. A. Fitch: The Geology of the Country between Ivybridge and Buckfastleigh, Devon.—Exhibition of a Series of Specimens illustrating the Contact-metamorphic Effects of a 'Diabase' Sill, at New Hope, Bucks County, Pennsylvania.

ROYAL MICROSCOPICAL SOCIETY (at B.M.A. House), at 5.30.—Dr. C. A. Hoare: Transmission of Trypanosomes by Insects.—Prof. D. L. Mackinnon: Lancaster's 'Gregarine' from the Eggs of *Thalassema neptuni*.—Dr. F. Davies: The Conducting System of the Heart.—Prof. R. Ruggles Gates: A Double Zygospore in Spirogyra.

FOLK-LORE SOCIETY (at University College), at 8.—Prof. R. A. Nicholson Some Notes on Persian and Arabian Folklore.

THURSDAY, MAY 21.

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

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—Annual General Meeting.

CHEMICAL SOCIETY, at 8.—G. M. Bennett and F. S. Statham: (*a* Stereoisomerism of Disulphoxides and Related Substances. Part VII. Some Further Pairs of Isomeric Dioxides; (*b*) Part VIII. Isomeric Tetrabromides of a Disulphide.—G. M. Bennett and W. B. Waddington: Studies in the Penthian Series. Part IV. The Four Stereoisomeric Oxides of Benzoylaminobenzpenthiene.—G. M. Bennett and A. N. Mosses: Derivatives of the Aliphatic Glycols. Part III. Chlorohydrins of some Higher Glycols.—G. M. Bennett and A. N. Mosses: The Influence of the Sulphur Atom on the Reactivity of Adjacent Atoms or Groups. Part V. Comparative Reactivities of Nine Homologous Phenyl ω-hydroxyalkyl Sulphides with Hydrobromic Acid.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.1), at 8.15.—Dr. G. W. M. Findlay: Infectious Jaundice.

COKE OVEN MANAGERS' ASSOCIATION (Northern Section) (at Armstrong College, Newcastle-upon-Tyne).—Dr. J. H. Jones: Reactivity of Coke.

FRIDAY, MAY 22.

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

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

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

PUBLIC LECTURES.

FRIDAY, MAY 15.

LONDON SCHOOL OF ECONOMICS, at 5.—Lord Lugard of Abinger: British Rule in Tropical Africa. (Succeeding Lectures on May 18 and 19.)

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

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—Dr. H. de Böckh: Selected Chapters of Regional Geology and Tectonics. (Succeeding Lectures on May 19 and 21.)

KING'S COLLEGE, LONDON, at 5.30.—Col. the Master of Sempill: Air Communications of the British Empire.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Prof. E. L. Collis: The Coal-Miner: His Health and Occupational Diseases (1): Environment of Work (Chadwick Lecture.)

MONDAY, MAY 18.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Prof. E. L. Collis: The Coal-Miner: His Health and Occupational Diseases (2): Welfare—the Fund (Chadwick Lecture).

TUESDAY, MAY 19.

INSTITUTE OF PHYSICS (at Institution of Electrical Engineers), at 4.30.—A. E. L. Chorlton: Physics in Relation to the Development of the Internal Combustion Engine (Public Lecture on Physics in Industry).

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Prof. J. Mellanby: Recent Work on Blood Coagulation.

WEDNESDAY, MAY 20.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (Public Health Division), at 5.—Dr. B. Hart: Mental Hygiene.

THURSDAY, MAY 21.

UNIVERSITY COLLEGE, LONDON, at 2.30.—Sir Flinders Petrie: The City of the Shepherd Kings.

ROYAL SCHOOL OF MINES, at 8.—U. R. Evans: Thin Films on Metals (Armourers and Brasiers' Company Lectures). (Succeeding Lectures on May 28 and June 4.)

FRIDAY, MAY 22.

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

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

CONGRESS.

MAY 19 TO MAY 24.

ROYAL INSTITUTE OF PUBLIC HEALTH (at Frankfort-on-Main).—In Six Sections as follow:

(1) State Medicine and Municipal Hygiene.
(2) Architecture, Housing, and Town-planning.
(3) Industrial Hygiene.
(4) Women and Children and the Public Health.
(5) Tuberculosis.
(6) Pathology, Bacteriology, and Biochemistry.