NATURE

SATURDAY, NOVEMBER 11, 1933

No. 3341 Vol. 132

CONTENTS

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.
ST. MARTIN'S STREET, LONDON, W.C.2
Telephone Number: WHITEHALL 8831
Telegraphic Address: PHUSIS, LESQUARE, LONDON

Advertisements should be addressed to
T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4
Telephone Number: City 4211

Inland Water Survey of Britain

THE recent report to the British Association of the Committee appointed in September of last year to inquire into the position of inland water survey in the British Isles, and the possible organisation and control of such a survey by central authority, may be taken as a quasi-official verdict on the series of representations which have been put forward from time to time from various responsible quarters and have been supported in the columns of NATURE in the interests of efficient water administration. In our issue of November 5, 1932, commenting on the discussion on the subject at the York meeting of the Association, we pointed out that in dealing with a problem of serious national concern, such as flood prevention, it is in the highest degree essential to have accurate and unimpeachable records upon which preventive and remedial measures could effectively be based, but that, hitherto, there has been no authoritative body charged with the duty of supervising the collection of the necessary data. The British Association has equally appreciated this fact, together with other needs supported by cogent arguments, and, realising the pressing importance of a matter affecting the safety and welfare of a large section of the population, it appointed a Committee to consider the whole position in regard to water survey and to report.

The Committee, during the intervening months, has made a careful and painstaking investigation and has drawn up a statement reviewing the situation with thoroughness and impartiality. Commencing with a reference to the demands and suggestions for a survey of the water resources of the country which have been made in the past, one of the earliest of which dates back to the meeting of the British Association in Dublin in 1878, the report shows that these demands have increased and become more insistent of late years, and that the passing of the Reservoirs (Safety Provisions) Act, 1930, and the establishment of catchment boards under the Land Drainage Act of the same year, have invested the subject with fresh vitality and more urgent importance. The need for a properly organised survey is widely recognised and, indeed, has become imperative as a matter of national economy.

It is a significant coincidence that simultaneously with the presentation of the report, and quite independently of the researches of the British

Association Committee, the Institution of Mechanical Engineers, through a notification of an interim report by a committee of its own, and in the recent address from the chair of its new president, Mr. Alan Chorlton, M.P., has been the means of directing public attention to a matter of close collateral interest, namely, the desirability of establishing a national 'water-grid'. The idea of the grid is to provide the whole of Great Britain with adequate supplies of water through the agency of a network of trunk mains which would divert the surplus available in certain districts into others less frequently or less intensively visited by rainfall and with fewer natural storage supplies. The scheme adumbrated is ambitious and far-reaching in its effects, and it obviously presents a number of features which will require the most searching consideration before they can be considered as coming within the range of practical politics. They cannot be discussed here: the outstanding point is that, in this case also, there is direct emphasis on the need for a thorough investigation of the whole of the water supplies of Great Britain, since until a systematic and categorical survey is instituted and carried through, it would be impossible to consider any effective scheme of allocation and distribution of the resources of the country to the best advantage of its inhabitants and their industrial and commercial activities.

In order to be adequately comprehensive and to serve all the interests which are involved, a water survey must enlist several branches of science, notably meteorology, geology and topography, for the purpose of tracing the course of water from its first arrival in the shape of rain or dew to its final disappearance in the ocean. The foundations for a survey of this kind already exist, in part at any rate, in the work of certain Government departments, such as the maps prepared by the Ordnance Survey, the maps and memoirs of the Geological Survey and the records of the British Rainfall Organization. But, while these constitute admirable and reliable sources of information in regard to the special branches of science with which they deal, they are inadequate for the treatment of the matter as a whole, or even in its most important aspect from a utilitarian point of view.

There is no existing department or central organisation to deal with direct hydrological measurements of the amount of water derived from rainfall, in spite of the fact that exact information as to the quantities of flow in streams and rivers, and the available resources of storage in catchment basins, is continuously in requisition for the purposes of numerous public undertakings. In round figures, there are in Great Britain more than 800 local authorities and joint boards for water supply; some 300 water companies and more than 1,000 private proprietors; 46 catchment boards, so far established; and more than 500 electricity stations needing feed and condenser water for steam plant, besides various other interests such as canal authorities, pollution boards, fishery boards and hydro-electric undertakings. Some of these bodies take measurements and keep records for their own use, but so far as it has been possible to ascertain, they form a small minority and, in general, there is an entire absence of co-ordination and of any organisation for the efficient and methodical recording of data.

The Committee has had no hesitation in affirming that, as regards the first part of its terms of reference, the position of inland water survey in the British Isles is far from satisfactory, and it states that a systematic survey of the water resources of Great Britain is urgently required.

The second part of the inquiry, as to the possibility of arranging a central organisation for the control of a survey, has presented certain difficulties. An examination of the organisations established in other countries demonstrates considerable diversity of practice. The report mentions, and an appendix (Main Memorandum B) describes, the systems in vogue in the United States of America, the Dominion of Canada, Switzerland and Italy. The report then goes on to point out that the conditions prevailing in Great Britain are different in many respects from those in other countries, and that these varying conditions are of significance in influencing the trend of organisation. Irrigation, which is of vital importance in arid regions, is of minor importance in districts of adequate rainfall; hydro-electric development is an attractive enterprise in territories where fuel supplies are scanty or non-existent, but is of less account where coal is plentiful; the floods on British rivers do not compare in magnitude with those experienced in some parts of America; and so on. In Great Britain, the predominant interest is the ever-increasing need of public water supply for domestic and trade purposes. After that, come the problems of drainage, floods, motive power, navigation and fishing.

Two important principles are stated to stand out

in the experience of foreign countries, particularly in the case of the United States, where it has been found desirable that (1) the investigational activities of a survey should be segregated from those relating to construction and administration and (2) records should be collected entirely by the State; those collected by other agencies, however meritorious and serviceable in themselves, being liable to lack of continuity, to restricted accessibility by the public and to suspicion of unreliability. It is the judgment of the Committee that these principles are of fundamental importance, and it follows that the organisation of a water survey should be a national undertaking. "The ideal to be aimed at for Great Britain is a Government department (or section of a department) working as a central hydrometric authority in the closest co-operation with the Rainfall Organization and the Geological and Ordnance Surveys, and independent of any interest concerned with the use or control of water." At the same time the Committee realises that it is scarcely feasible under present conditions to move for the immediate establishment of an organisation to be financed by public funds. It has sought various avenues of escape from what might appear to be a financial impasse, and as the outcome of negotiations, it suggests the reference of the matter to the Institution of Civil Engineers, which it has reason to believe will be prepared to investigate the feasibility of carrying out the objects outlined in the report on a self-supporting basis, with the aid of subscriptions from individuals and bodies interested.

The matter having been carried this far, it is much to be hoped that the Committee's recommendation will be acted upon, so that a commencement, at any rate, may be made in a utilitarian work of high scientific importance, in which Great Britain lags behind the enterprise and example of other nations. Ultimately, of course, as implied in the statement of principle above, absorption by a Government department is contemplated, as in the case of the British Rainfall Organization. Despite the present unfavourable outlook, the Committee does not despair of the eventual attainment of this goal, "in view of the very different attitude now adopted by the Government towards scientific research compared with that of fifty years ago, provided the need is made sufficiently clear and the demand adequately supported by those directly concerned". *Magna est spes—et prevaleat!*

Indian Woods of Commerce

Commercial Timbers of India: their Distribution, Supplies, Anatomical Structure, Physical and Mechanical Properties and Uses. By R. S. Pearson and Dr. H. P. Brown. Vol. 1. Pp. xlv+548+182 plates. Vol. 2. Pp. ix+549–1150+plates 183–320. (Calcutta: Government of India Central Publication Branch; London: High Commissioner for India, 1932.) £5.

THIS work, consisting of two large volumes, is in some respect a successor to Gamble's "Manual of Indian Timbers". Since the establishment of the Forest Research Institute at Dehra Dun in 1906, much new information has been accumulated regarding the characteristics and uses of Indian timbers and the supplies available, and in recent years the need for a comprehensive work making this information available has been increasingly felt.

There is one essential difference between the scope of Gamble's manual and that of the present work: whereas the former contains macroscopic descriptions of every wood of which material was available, and thus covers a considerable portion of the Indian woody flora, the latter deals with only 320 selected timbers, described in much greater detail than in the case of Gamble's manual. The joint authorship represents the combined labours of a practical man of wide Indian experience and a scientific specialist. Mr. (now Sir Ralph) Pearson, for many years head of the forest utilisation branch at Dehra Dun, was specially qualified to put together the masses of information accumulated in the files of the Research Institute, and he is to be congratulated on the results of his industry. From the scientific point of view, however, the outstanding feature of the book is the detailed descriptive work of Dr. H. P. Brown, the value of which is enhanced by a beautiful series of low-power (× 10) and high-power (× 110) photomicrographs taken by himself. The chief criticism of Dr. Brown's work lies in the fact that the descriptions are based on such a small number of specimens, namely, one each in the case of nearly half the species and seldom more than two each in the case of the remainder. Considering the variability in the dimensions of wood elements, this may render some of the identification keys difficult to apply. The great majority of the specimens used were from Gamble's collection.

The work begins with an introduction containing a brief account of the forests of India and a general

description of the structural characteristics and properties of wood ; the various individual species, grouped into families, are then dealt with, the sequence following in the main that of Brandis's "Indian Trees". Under each family heading is given certain general information relating to the family and the trees and woods contained in it. Under each genus there is a description of the characteristic features of the woods of that genus, followed by keys of macroscopic and microscopic characters to the commercial species. More detailed information by species is then given under a standard set of headings. In addition to the photomicrographs already referred to, there are small skeleton maps showing the distribution of each species ; these maps are useful, though not free from mistakes, the distribution as shown in the map differing in several cases from that given in the description or from actual fact. There are also certain inaccuracies in the description of the forests of India, which appears in the introduction ; for example, the inclusion among the species of the *in* forests of Burma of *Carallia lucida*, a tree of the moist forests, and the omission of *Shorea obtusa*, one of the most important species of the *in* forests. It is misleading, also, to include among the associates of the *sal* those trees of the riverain and swamp forests which do not normally enter the *sal* forests ; instead of these, such important companions of the *sal* as *Lagerstrœmia parviflora*, *Ougeinia dalbergioides*, *Stereospermum* and others might have been included.

There is an extensive and useful bibliography cited under each family, genus and species. As this bibliography is repeated in the form of an appendix, it would have been sufficient to enter reference numbers in the body of the text, thereby saving much repetition of titles, some of considerable length. The bibliography of *Tectona grandis* alone, for example, runs to more than a page, and this is all repeated in the appendix. The sum total of these repetitions must add appreciably to the bulk of the two volumes. The printing and the production of the work have been admirably carried out by the Oxford University Press, and the photomicrographs are beautifully reproduced. It would have facilitated reference if the genus had been entered as the page heading on the right side, the family being entered on the left side only, instead of on both sides.

Looking at the contents of the two volumes as a whole, one cannot suppress the feeling that it might have been better to publish the detailed microscopic descriptions and keys quite separately from the more general information. The latter is of interest to the practical and commercial man, who does not ordinarily possess the scientific knowledge of wood anatomy necessary to make use of the microscopic descriptions, which are of interest rather to the specialist engaged on the structural examination and identification of woods. The endeavour to cater for both classes of readers in one work has resulted in the production of two volumes of unwieldy size in which the contents appear somewhat unbalanced. It also introduces a serious difficulty when we endeavour to run down a given wood sample to its proper species. From the commercial point of view a limit has rightly been placed on the number of species dealt with. But from a systematic point of view the aim should be to cover as wide a range of species as possible. With the aid of the book we cannot, for example, identify specimens of such important or interesting woods as *Artocarpus integrifolia*, *Betula utilis*, or any of the eastern Himalayan conifers ; these, and many others, are omitted from the book, and we still have to turn to Gamble for enlightenment in regard to them.

In spite of these criticisms, the work should prove of great assistance to those who are interested in the commercial timbers of India. The chief regret is that its price may place it out of the reach of many who would like to possess it.

Homage to Lamarck

The Lamarck Manuscripts at Harvard. Edited by William Morton Wheeler and Thomas Barbour. Pp. xxxi+202+4 plates. (Cambridge, Mass. : Harvard University Press ; London : Oxford University Press, 1933.) 12*s*. 6*d*. net.

IN this book are reproduced in the original French and in an English translation six manuscripts of Lamarck which are a valued possession of the Museum of Comparative Zoology at Harvard. The first is an unpublished lecture dealing with the phrenological system of Gall, and illustrates Lamarck's interest in physiological and pathological questions. He is known to have spent some years in medical studies. The second comprises two articles on psychology, published in the "Nouveau Dictionnaire d'Histoire naturelle de Deterville" (1817). The third is a preliminary sketch for his book "Système analytique des Connaissances humaines" (1820). The fourth,

entitled "Questions zoologiques", although short, is perhaps the most important of the lot, and gives a clear insight into Lamarck's views about sensation and volition.

As is clearly shown in this paper, Lamarck held that only the highest animals perform acts of volition, and that rarely; most animal actions "originate in the powers of their *internal feeling*, and the emotions of this feeling are the immediate source of their actions. It is not correct, therefore, to say that all animals are intelligent beings, that they exhibit judgments, acts of volition and voluntary movements. It would be one of the greatest absurdities to say that the *Monad* [*Amœba*] thinks, judges, wills and directs by its volition all the contractions and other movements which we observe" (p. 191). This fundamental point of Lamarck's doctrine is sometimes overlooked by popular writers.

Attached to the brief fifth MS. are nineteen plates prepared for, but not included in, the "Histoire des Animaux sans Vertèbres". Two of these plates are reproduced, together with a little-known portrait of Lamarck and a facsimile of his rather beautiful writing. The sixth MS. records the botanical results of an excursion with the Paris Natural History Society in 1797.

The editors have completed their pious task by contributing a vividly written introduction. As they rightly point out, Lamarck's theory of evolution, unclear as it is and lacking in solid proof, has shown remarkable vitality and persistence, indicating that it must contain some core of essential truth. "Its vitality has been so great that despite repeated and apparently devastating onslaughts it still survives, with such emendations, of course, as the extraordinary advance in biology has necessitated. Probably most living biologists, psychologists and sociologists, with the exception of the extreme geneticists, are more or less convinced of the adequacy of many of Lamarck's contentions. Few, indeed, can succeed in persuading themselves that all the actual appetitive behavior, adaptations and experiences of living organisms throughout the eons of geological time count for nothing in heredity".

As a man, Lamarck deserves our greatest admiration. Frail and sickly, overworked and worried, stricken with blindness in his later years, he yet had the courage to publish, and the tenacity to uphold, a subversive and unpopular theory which the world was not ready to receive.

E. S. R.

Biology in Education

Biology in Education: a Handbook based on the Proceedings of the National Conference on the Place of Biology in Education, organised by the British Social Hygiene Council. Edited and with Introductions by J. G. Crowther. Pp. x+204+60. (London: William Heinemann, Ltd., 1933.) 7*s.* 6*d.* net.

THE papers read at the National Conference on the Place of Biology in Education held last year have now been published in book form under the above title. The presentation is in attractive form and there is a useful index and bibliography. It is a book which should be in the hands of all those—fortunately an increasing number—who are interested in giving biology a more prominent place in the schools. The contributors are both eminent and experienced, and it is unlikely that the contents of the work will go out of date for many years.

To readers who are convinced already of the value of biology in education, the contents are at once a source of optimism and pessimism—optimism because those who have elected to throw in their lot with the teaching of biology are so fully convinced of its value, pessimism because there are still very considerable numbers of people, entrenched in key positions, who still are not prepared to make the necessary concessions which would lead them from a traditional curriculum.

Summarised briefly, the position appears to be as follows. The suggestion that the schools are not sending forward a sufficient number of pupils prepared to adopt biology as a career has been somewhat over-emphasised. The number of posts available to the professional biologist can never be very numerous, and, as the late Viscount Chelmsford pointed out (p. 8), the normal requirements of the Colonial Office have been much reduced as a result of financial stringency. In general, those who take up applied biology as a career fall into two categories, first, those who by instinct are naturalists—an instinct which is quite distinct from a mere general competence in science; secondly, the biochemist, who may be completely devoid of the instincts of the naturalist, but must have a very sound fundamental training in chemistry and physics.

The first type can be sorted out from those who take the type of science course traditionally associated with Cambridge. Their numbers would be increased if, as Prof. A. V. Hill suggests (p. 137),

no candidate for Part I of the Tripos could obtain first class honours unless he took at least one physical and one biological subject. The second type might well be recruited from the 'first class' man who has followed physics and chemistry as his main subjects until comparatively late in his education. This again follows a suggestion of Prof. Hill, who states that several of his best pupils have been of this type.

The argument for the inclusion of biology in the school curriculum does not lie here, but from the needs of an understanding of the part played by biology in the changing order of civilisation. The common conscience is not yet convinced that an education without science, including biology, limits vision of an advancing world. The position is most serious in respect of the leaders. A very large proportion of administrators pass through the preparatory and public schools. The abler they are as scholars the greater their chance of missing science during their education (Section II). Mr. Savage, chief inspector of the Board of Education, points out (p. 58) that in some respect the position has made very little advance since 1918. It may be that some fault is in the traditional methods of the teaching of science. An able boy in the public schools has a considerably higher mental age and outlook than that of most boys of his years. He is often taking an interest in some form of general philosophy, and to put him merely as a watcher in a laboratory whilst tedious experiments take their course will be a very different and unwelcome experience in contrast with his periods of classics and history demanding from him a constant alertness of mind. For these boys there might be provided more frequently short courses of the type recommended by the Prime Minister's committee on natural science in education, based more particularly on the history of science.

There remains the very large class of ordinary boys, especially those who have little mathematical sense. With those surely it would be better to substitute some of the romance of science for the equation.

The problem is even more urgent in respect of those who will choose leaders. Education in the elementary schools at the present time is being profoundly transformed, and now is the opportunity to ensure that biology shall take its place in a curriculum of general elementary science. The body of opinion in the papers is in favour of this. Excellent accounts of such possibilities are given in the paper contributed by Mr. Ellis, secretary to the Education Committee of the National Union of Teachers, and by the teachers in elementary schools who gave the conference their experiences. The Board of Education, through short courses given throughout the country to the staffs of elementary schools, is encouraging the teaching of general elementary science in a very material way. The progress made in the teaching of biology in the training colleges, also strenuously backed by the Board's inspectors, is well known. Section V of the report gives a very encouraging account of this.

Quite rightly the organisers of the Conference decided not to stress sex education, and the part allotted to such education both in the papers and in the discussion, whilst very valuable, keeps it well subordinate and in place.

Precision Weighing

Feine Waagen, Wägungen und Gewichte. Von Dr. W. Felgentraeger. Zweite vermehrte und umgearbeitete Auflage von "Theorie, Konstruktion und Gebrauch der feineren Hebelwaage". Pp. vii+308. (Berlin: Julius Springer, 1932.) 26 gold marks.

THE knife-edge balance used for precision weighing is capable of giving an accuracy of an exceedingly high order in comparison with that offered by fine instruments in other classes of measurement. High precision in balance technique was attained some decades ago, but nevertheless it remains true that success in precision weighing is dependent on the close observance of a large number of precautions in the design and construction of the balance and in the technique of its use.

Dr. Felgentraeger has given a very detailed account of the knife-edge balance as an instrument for precision weighing. The book commences with a discussion of the theory of the balance, which is dealt with fully for the general case and allows of deductions being made for simpler cases. A large portion of the book is devoted to a discussion of the design and functioning of the component parts of the balance. Careful attention is given to the requirements for the construction of the beam; also to the methods of preparing the knives and their bearing planes, and of attaching the knives to the beam. A useful comparison of the properties of agate and steel for the construction of knives and bearing planes is also given.

A chapter is devoted to the description, illustration and critical discussion of a great variety of balances of widely different makes, ranging from micro-balances to 20 kgm. balances, and from ordinary balances to those of special precision in which the loads are compared, by Gauss's method of exchange, without opening the balance case during a series of weighings.

A small section of the book is devoted to air-damped balances, for which there has been an increased demand in recent years. The technique of weighing is explained clearly and concisely, and the book concludes with a useful chapter on weights—a new feature of this edition.

The information made available by Dr. Felgentraeger is of such a wide character that there appear to be but few branches of the subject which are not discussed in detail. Imperfections in the construction or in the mounting of different parts of a balance occur sometimes although the greatest care is taken, and it is not always easy to locate faults without spending an excessive amount of time in testing the balance. An outline of the methods to be adopted for locating and eliminating the less obvious faults in balances would have been of great assistance to makers and users.

The book is well arranged and fully illustrated; in some instances clearer illustration would have been advantageous for the better appreciation of the details of the various designs of balances which are discussed. Nevertheless, it is a valuable work of reference and is welcome for the helpful information which it offers to users of balances generally. F. A. GOULD.

Short Reviews

(1) *The Story of a Billion Years.* By W. O. Hotchkiss. Pp. x+137+4 plates. (2) *Our Mineral Civilization.* By Prof. Thomas T. Read. Pp. x+165. (A Century of Progress Series.) (Baltimore, Md.: The Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1932.) 5*s*. 6*d*. each.

THESE two small books are units in the series issued in connexion with the Century of Progress Exhibition at Chicago. Both are entertaining and stimulating summaries of their subjects and fulfil their object, in that they present "the essential features of those fundamental sciences which are the foundation stones of modern industry".

(1) Mr. Hotchkiss provides a good account of the principles of geology, the subjects treated including the evolution of surface features, origin and age of the earth, the palæontological and stratigraphical record, and the Great Ice Age. As befits a book connected with the Chicago Exposition, the planetesimal theory of the origin of the solar system is regarded as generally accepted. The last chapters examine the question of the geological factors that may affect the future evolution of mankind. The variation in the distribution of land areas and in climate are believed to be of such slowness as to be overcome. It is significant in these times that the book closes with an appeal for the advancement of social science so that the fruits of this century of progress in the physical sciences may be properly enjoyed.

(2) In the second volume, the place of minerals in the foundations of this present civilisation is discussed. The history of the exploitation and the modern applications of coal and oil, iron and steel, and the multitudinous minor metals are dealt with in a very attractive manner. When we consider how dull a book on this subject might have been, we realise the achievement of the author in presenting so much sound knowledge in so charming a way. The introduction of 'Mutt and Jeff', 'Harpo Marx', 'King David' and other popular characters does no harm to the argument and cheers the reader. This volume, like the first, ends with an appeal for social planning. Here the position of the expert in any new scheme of society is discussed.

The Fourier Integral: and certain of its Applications. By Prof. Norbert Wiener. Pp. xi+201. (Cambridge: At the University Press, 1933.) 15*s*. net.

THIS book is based upon a course of lectures given by the author at Cambridge during the Lent term of 1932. The introduction contains a condensed but useful account of Lebesgue integration, leading to the Riesz-Fischer theorem, which embodies the definition of mean convergence. Chap. i introduces the Fourier transforms:

$$(1) \qquad g(x) = \lim_{A\to\infty} \frac{1}{\sqrt{2\pi}} \int_{-A}^{+A} f(y)\, e^{-ixy}\, dy,$$

$$(2) \qquad f(x) = \lim_{A\to\infty} \frac{1}{\sqrt{2\pi}} \int_{-A}^{+A} g(y)\, e^{ixy}\, dy;$$

culminating in Plancherel's theorem, which proves that if $f(x)$ belongs to the class L^2, then (1) and (2) continue to hold, if we replace the symbol 'lim' by 'l.i.m.' (limit in the mean). Chap. ii discusses the general Tauberian theorem, which is concerned with the asymptotic behaviour, for large x, of certain integrals of the form

$$\int_{-\infty}^{+\infty} K(x-y)\, f(y)\, dy.$$

Chap. iii considers special Tauberian theorems with particular application to the distribution of the prime numbers, an extremely interesting application of the general theory. Chap. iv treats of the 'spectrum' of a function which measures the 'energy-distribution' in the generalised harmonic analysis of the function. This chapter also contains some original applications to almost periodic functions.

Prof. Wiener's many contributions to this field of research are well known and his lucid exposition will make the book indispensable to all who wish to take a serious interest in this fascinating subject.

The Elements of Switchgear Design. By Dr. Fritz Kesselring. Translated from the German by S. R. Mellonie and J. Solomon. Pp. vii+182. (London: Sir Isaac Pitman and Sons, Ltd., 1932.) 7*s.* 6*d.* net.

THERE is much in Dr. Kesselring's little book to be commended, but the translators would have been well advised to alter his notation and his units so as to make it more easily understood by English readers. They say that they have left the original notation and units untouched so as to make the book "more instructive to the student". We are afraid that it will frighten him from reading the book altogether. When he comes to the formulæ for Coulomb's law and for the capacities of conductors, and finds them 4π times too much or too little as the case may be, he needs instruction. The translators recognise this, as they give a reference on p. 63 to Hague's treatise. Again, the force (K) of attraction between two linear currents is given in Joule/cm. units, and although we are told more than once that a Joule/cm. = 10·21 kgm., it all tends to puzzle the English engineer. Once (p. 69) the force is measured in kgm./10^3 amp.^{2}/ degree units.

No proofs are given of the formulæ; references ought therefore to have been given. The formula for the mutual inductance of two current rings is stated to be very complicated and so graphs, unfortunately on much too small a scale, are given in its place. It would have been better to show that the formula becomes simple in special cases. The discussion of flash-over and puncture is good.

The Vitamins in Health and Disease. By Prof. Barnett Sure. Pp. xiv+206. (London: Baillière, Tindall and Cox, 1933.) 11*s.* 6*d.*

PROF. SURE'S book is a simple and readable exposition of the history of vitamin work to date, and of its bearing on practical problems of medicine and nutrition. It takes, implicitly and explicitly, the strictly orthodox view that direct vitamin administration has the object of making good, by prophylaxis or cure, dietary deficiencies. Consequently there is no collation, or critical examination, of the stimulating suggestions, to be found scattered in biochemical literature and in the *obiter dicta* of clinical investigators, that the vitamins may have specific pharmacodynamic actions of much wider clinical potentialities.

In a book meant as a practical guide, it seems unfortunate that there is no mention of international agreement about units, though this question is absolutely fundamental to a useful international exchange of practical experience in vitamin therapy. Yet the agreed report of the Permanent Commission on Biological Standardisation was issued in October 1931, and the United States was well represented on the Committee. Apart from this major fault, and a certain number of minor oversights, little else can be said in criticism of what is a useful addition to the small but growing library of books on vitamins.

A. L. B.

Modern Physics: a Second Course in College Physics. By Prof. G. E. M. Jauncey. Pp. xvii+568. (London: Chapman and Hall, Ltd., 1933.) 22*s.* net.

PROF. JAUNCEY'S interesting manual for students interprets the term 'modern physics' very liberally—he certainly does not restrict it to 'atomic' physics. His liberality of interpretation leads, on occasion, to some odd results in the matter of balance—for example, one whole page is devoted to an elementary deduction of the expression for the capacity of a parallel plate condenser, and less than two pages to the subject of cosmic rays. A good deal of space is wisely given to the elementary theory of alternating currents, but it seems to be an error of judgment, in a work which embraces so many topics, to devote 28 pages to "useful mathematics".

It is pleasant to note that the volume opens with a short historical sketch. It introduces the reader to a wide range of subjects, and should prove to be a useful handbook for a student of general honours standard.

A. F.

The Distribution of Prime Numbers. By A. E. Ingham. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 30.) Pp. vi+114. (Cambridge: At the University Press, 1932.) 7*s.* 6*d.* net.

THIS interesting "Cambridge Tract" is concerned mainly with the behaviour, for large values of x, of the function $\pi(x)$, which denotes the number of primes not exceeding x. The first chapter gives some elementary theorems concerning $\pi(x)$, that is to say, theorems which can be proved without the use of the complex variable. In the second chapter the prime number theorem, namely $\pi(x) \sim x/\log x$, is proved with the aid of the Riemann zeta-function. The remaining three chapters deal with more precise relations.

The treatment is complete in itself and the author states that the book is not exclusively for specialists, but aims rather at making the subject accessible to a wider circle of mathematical readers. The attractive style and clarity of exposition fully justify this claim.

Infra-Red Photography

By DR. S. O. RAWLING

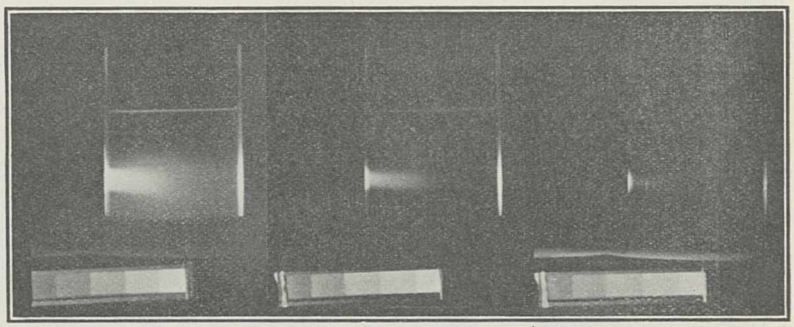
IT is only within the past two years that the general public has become familiar with infra-red photography. Yet Abney, so long ago as 1880[1], photographed the solar spectrum as far as 9867 A. It may well be asked why half a century should pass before so remarkable an extension of photographic technique could gain recognition among photographers generally. The main reason was that until recently no photographic material possessed more than a very slight degree of sensitivity in the infra-red region of the spectrum, and many of those which had even this were very prone to chemical fog, especially on keeping. With very few exceptions, the materials were used for spectrography, a subject which has no direct appeal to the public. Abney, it is true, is reported to have photographed a kettle filled with boiling water, the only source of radiation being the kettle itself, but nobody repeated the experiment and it was not until the opening decade of the present century that infra-red picture-making began to be practised at all seriously.

In 1910 Prof. R. W. Wood[2] delivered a Traill-Taylor memorial lecture before the Royal Photographic Society. This lecture dealt with photography by invisible radiations and was made up of a number of excellent demonstrations of ultra-violet and infra-red photography. It was afterwards issued with a set of lantern slides by Messrs. Newton, of Museum Street, London, and, we understand, may still be hired.

Abney's photographs and those shown by Wood were taken in the normal way on plates sensitised for infra-red. Two other methods for the photographic recording of the spectrum have been used, however, and must be mentioned here. Many substances, when excited by ultra-violet or blue light, become phosphorescent, glowing feebly for some time after the exposure to the exciting light has ceased. Infra-red radiation has the peculiar property of increasing the rate of decay of this phosphorescence. If, therefore, a glowing phosphorescent screen be exposed on part of its surface to infra-red, the light will there be extinguished. The screen may now be held in contact with an ordinary photographic plate for a short time, and on developing the plate, the pattern of the infra-red image will be obtained as a positive. Using this method, Lehmann[3] photographed lines as far as 20000 A. The other special method depends on what is called the Herschel effect. When a photographic plate which has been exposed to blue light is given a further exposure to red or infra-red, the latent image produced by the first (blue) exposure is sometimes considerably diminished. Thus the influence of the second exposure can be observed as a positive effect. By applying this method, Terenin[4] photographed a line in the mercury spectrum at 11280 A.

In spite of the very extended spectral region which can be recorded by these special methods, they have not been used very much because of the experimental difficulties involved. Modern developments in infra-red photography have, without exception, been brought about by means of special sensitising dyes added to the emulsions. These add new regions of sensitivity to that lying between 2200 A. and 5000 A. which is possessed by almost all photographic emulsions used for making negatives.

The first dye sensitiser which could be classed with modern infra-red sensitisers was produced by the Hoechst Dye Works in 1906. This was named 'dicyanine', and although it produced its maximum sensitising effect in the visible spectrum at 7100 A., it also conferred a certain amount of sensitivity to radiation of considerably lower frequency, so that Merrill and Meggers[5] in 1918 were able, by using it, to photograph spectra as far as 9600 A.



(*a*) (*b*) (*c*)

FIG. 1. Demonstration of colour-selective scattering from half watt light.
(*a*) Scattered light between 3300 A. and 5000 A.
(*b*) ,, ,, ,, 6000 A. and 7000 A.
(*c*) ,, ,, ,, 7500 A. and 8500 A.
(Photographs by the author.)

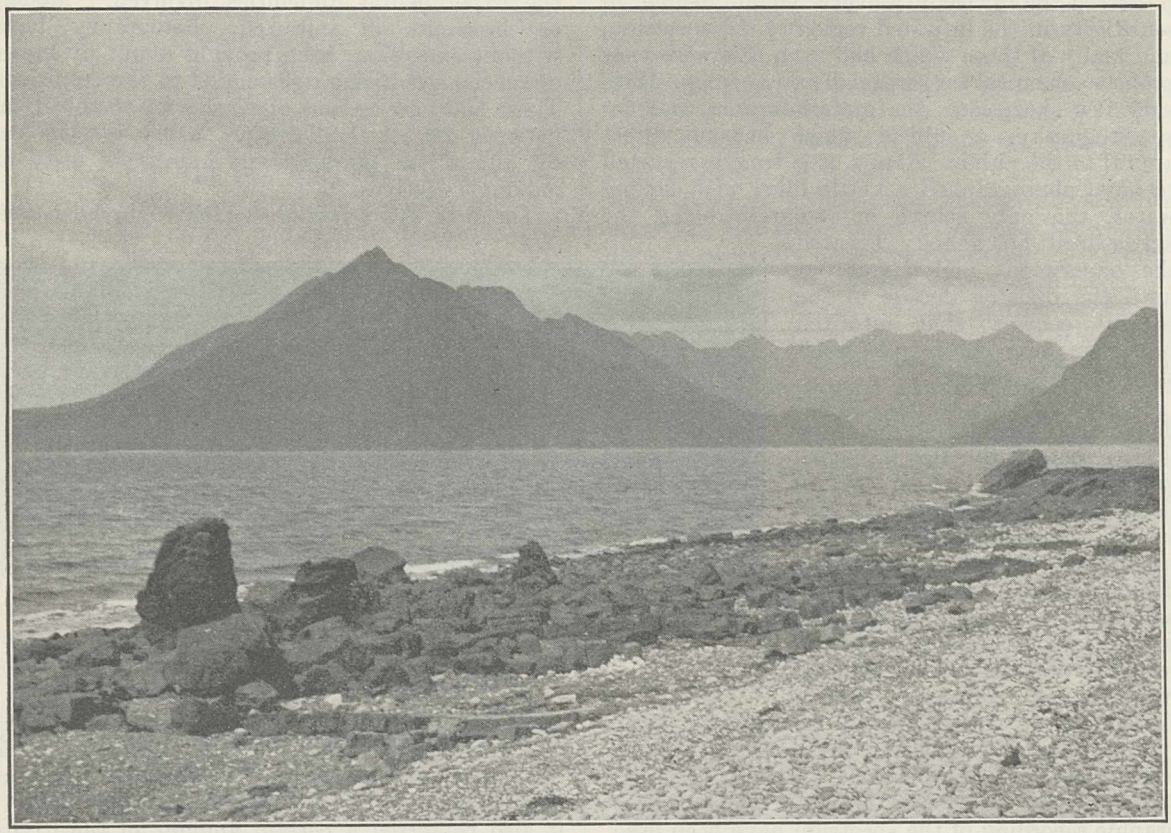
In 1919 Adams and Haller[6] discovered 'krypto-cyanine'. This dye gives a maximum sensitivity between 7500 A. and 7600 A. with a limit somewhere about 9000 A. During the preparation of this dye, it was noticed by H. T. Clarke[7] in 1925 that another dye was formed. This was named 'neocyanine' and was found by Dundon, Schoen and Briggs[8] to give a maximum sensitivity at 8200 A., and by special treatment it was made to respond to radiation beyond 10000 A., the limit being reached by Babcock[9] at 11634 A. in 1930.

Since 1930, several new sensitisers have been discovered. Among these may be mentioned 'meso-cyanine' and 'xenocyanine'. The former

sensitises from 6800 A. to 9400 A., and the latter from 7700 A. to beyond 12000 A. These dyes were synthesised in the laboratories of the Eastman Kodak Company. Another dye, produced in the laboratories of Ilford, Ltd.,[10] has the particular merit of allowing the preparation of infra-red emulsions of considerably higher speed and general cleanliness than has hitherto been possible. It sensitises well between 7000 A. and 9000 A. The chemistry of many of the new sensitisers has recently been described by Brooker, Hamer and Mees[11] and by Hamer and Fisher[12].

The application of infra-red sensitive materials to spectrography is, of course, fairly obvious and was the main goal sought by the earlier workers. The important thing was to extend the power of recording radiations to regions of longer wavelength, and the division between visible and infra-red, lying somewhere in the neighbourhood of 7600 A., was not specially emphasised. R. W. Wood, however, in the lecture already mentioned, foreshadowed the application of infra-red photography to a much wider field, a field to which the name 'infra-red' was more significant. Speaking of the great difference between landscape photographs taken on infra-red plates and those taken on ordinary materials, he said "these [infra-red] pictures show things as they really are quite as truly as our visible impressions of nature". It is indeed when it translates what cannot be seen into visible records that infra-red photography scores most heavily. A great many examples of this have been described during the past few years and a good summary will be found in the report of a lecture given by Mr. Olaf Bloch[13] before the Royal Society of Arts in January this year.

One of the earliest practical applications of infra-red photography—apart from spectrography—was to the penetration of haze. The obscuring effect of mist and haze is largely due to light scattered from the suspended particles. Since this scattered light is often bluish in colour and is very deficient in infra-red, it has very little influence on an infra-red plate provided the latter is shielded from the blue by means of a filter. The variation in the intensity of light scattered from an artificial mist is demonstrated in Fig. 1. For laboratory purposes the mist was made up of cloudy gelatin in water contained in a small glass tank. The light scattered sideways from a beam of light as it passed through the tank was then photographed, precautions being taken to ensure comparable exposures. A small white object placed behind the tank could not be seen owing to the flare of light scattered by the turbid liquid. The infra-red photograph is seen to register this object quite distinctly. This principle applied to open-air work is exemplified in Figs. 2 and 3. The detail of the



Photo] FIG. 2. Photograph on orthochromatic material. [*C. Waller*

distant mountains is easily seen in the infra-red photograph and the somewhat hazy sky is shown to be filled with varied cloud forms.

Some of the problems connected with haze penetration which are now being attacked are aerial surveying and the navigation of ships in fogs. With the former of these, it is essential that greater photographic speed be attained before very much progress can be made; the fastest of the present-day infra-red materials only touches the verge of what is needed, successful exposures of less than 1/80th of a second with a lens working at f 4·5 being possible only with sunshine. With both problems, difficulty will occur with heavy water mist, since radiation of 'photographic infra-red' quality is somewhat heavily absorbed by water.

Another application of haze penetration has been invented by Dr. H. M. Dekking[14] of Nymegen. It was desired to study the iris of an eye in which the cornea had become completely turbid by disease; a successful photograph of the iris was obtained on an infra-red plate.

The other main group of applications for the new plates depends on the absorption characteristics of many coloured substances in the near infra-red. For example, chlorophyll absorbs heavily between 6400 A. and 6800 A.; it transmits a certain amount of green light between 5000 A. and 6000 A., but from 6900 A. down into the infra-red it transmits very freely indeed. Foliage appears green—often of somewhat sombre tone, yet an infra-red plate responds to the immense amount of radiation transmitted between 7000 A. and 9000 A.; this, falling upon the leaves, is allowed to pass on to their cellular tissue, from which it is reflected and passes out again. Infra-red photographs of sunlit foliage and grass thus give the impression of snow scenes.

The occurrence of such great transparency to infra-red in substances which absorb visible light makes possible a great many interesting applications of the new plates. Few more elegant examples will be found than that invented by Dr. Bendikson[15] of the Huntington Library for deciphering some censored passages of an old book. The censor's ink had been effective enough in hiding from view the writing beneath, but it was made with a dark-coloured dye transparent to infra-red, so that at last the original writing was revealed, for it had been made with ink opaque to infra-red.

Photo] FIG. 3. Same scene as Fig. 2 photographed on infra-red material. [*C. Waller*

A more prosaic, but no less useful, application of infra-red photography is to the microscopy of bodies opaque to visible light.

One example of the application of infra-red photography to clinical recording has already been mentioned; others have been found. Prof. Haxthausen[16] of Copenhagen has shown, for

example, that the veins near the surface of the skin may be photographed in this way.

It is difficult to forecast the development of infra-red photography. The materials are being improved very rapidly. Dr. C. E. K. Mees[17], of the Eastman Kodak Company, has just announced a series of emulsions sensitised with meso-cyanine, xenocyanine and other dyes in which higher speed, greater freedom from fog and better keeping properties have been achieved, while the Ilford Company this year has introduced a plate which has double the speed of its predecessor of 1932; the new plate is probably the fastest infra-red material obtainable at the present time. As to what may be done, the variety of the examples which have been cited gives an impression of the breadth of the possibilities; it remains for inventive minds to see other ways of using the new tool. The technique is very simple, being little more difficult than that necessary for using panchromatic plates with filters. One thing may cause a little trouble: the effective focal length of a lens for infra-red is generally different from the normal value for visible light; moreover, few lenses are corrected exactly for infra-red work. The first difficulty scarcely arises with short-focus lenses working at small apertures, and for much ordinary work the second is also negligible. If focusing is markedly different, it is, however, not very difficult to calibrate the focusing scale of a camera by actual photography. For the very best quality work, special lenses are required, such as are made by Messrs. Taylor, Taylor and Hobson, Ltd., and by Messrs. Ross, Ltd. In any event, owners of lenses made by other firms are recommended to consult the makers if they find difficulties of this kind with infra-red materials.

[1] Abney, *Phil. Trans.*, *II*, 171, 653; 1880.
[2] Wood, *Phot. J.*, 50, 329; 1910.
[3] Lehmann, *Z. Instrumentenk.*, 23, 353; 1906.
[4] Terenin, *Z. Physik*, 23, 294; 1924.
[5] Merrill, *Bull. Bureau Stds.*, 14, 487; 1918–19. Meggers, *ibid.*, 14, 371; 1918–19.
[6] Adams and Haller, *J. Amer. Chem. Soc.*, 42, 2661; 1920.
[7] *U.S.P.*, 1, 804, 674; 1926.
[8] Dundon, Schoen and Briggs, *J. Opt. Soc. Amer.*, 12, 397; 1926.
[9] Babcock, *Smithsonian Inst. Ann. Rep.*, 165; 1930.
[10] Hamer and Ilford, Ltd., *B.P.*, 351, 555; 1930; 354, 826; 1930.
[11] Brooker, Hamer and Mees, *Phot. J.*, 73, 258; 1933.
[12] Fisher and Hamer, *J. Chem. Soc.*, 189; 1933.
[13] Bloch, *J. Roy. Soc. Arts*, 81, 261; 1933.
[14] Dekking, *Von Graefes Arch. Ophthalmologie*, 130, 375; 1933.
[15] Bendikson, Quoted from Mr. Bloch's lecture; see Ref. 13.
[16] Haxthausen, *Dermatologische Wochenschr.*, 1289; 1933.
[17] Mees, *Brit. J. Phot.*, 80, 560; 1933.

Storage and Transport of Food

THE report of the Food Investigation Board for 1932* reviews the work carried out by the Board directed to the improvement in quality and the prevention of wastage in our foodstuffs by improved methods of handling and storage. It is pointed out that among the steps which are being taken to promote the more orderly marketing of agricultural produce, the improvement and standardisation of quality and the elimination of waste, in so far as storage and transport are concerned, fall within the province of the Board. Standardisation at a high level of quality depends primarily upon the practice of right methods of production; but for the consumer to reap the full benefit, the conditions of successful transport and storage must be known and provided. In this respect the meat industry has so far been in a better position than the fishing industry. In addition, many foodstuffs are but the raw material of the food industry when they leave the producer, their quality depending upon the operations of curing or canning as much as upon production. In all its work the Board co-operates with related bodies in the oversea parts of the Empire.

Work on the storage of meat and fish has shown that the rate of deterioration in the frozen state is greatest at a temperature of −2° to −3° C. and decreases almost to zero at −20° to −25° C. Three factors appear to be concerned. The process of freezing is responsible for two of them; it increases the concentration of salt by removing water in the form of ice, and this in turn causes a change in the acidity of the tissue. Fall of temperature alone gradually decreases the rate of chemical change. The last factor is responsible for the protection obtained by storage at low temperatures.

The palatability of rapidly frozen (within 30 min.) and slowly frozen (15–20 hours) meat has been compared, duplicate samples being cooked without previous thawing; no difference in palatability was detected. These results raise the question whether rapid freezing is to be regarded as giving a product superior in quality, or merely as being a contribution to the efficiency of the packing house.

Work has been continued on the changes in colour and in the fat of meat during storage and on the effect of superficial infection by bacteria on its keeping properties. Control of the degree of infection to which meat is subjected during handling is almost as important as control of temperature in securing a reasonably long life in store. The problem of storage in a small refrigerator is different from that of storage in a large one, since carcases are stored whole in the latter, but in small joints in the former the moist exposed surface of the lean forms an excellent culture medium. A continually changed supply of hot water for swabbing the carcases in the abattoir materially reduces the bacterial contamination. It has also been found that a concentration of 10 per cent of carbon dioxide will about double the storage life (two months instead of one month) of hindquarters

* Department of Scientific and Industrial Research. Report of the Food Investigation Board for the Year 1932. Pp. x+304. (London: H.M. Stationery Office, 1933.) 5*s*. net.

of chilled beef in ordinary air at or slightly below the freezing point, as judged by freedom from moulds and bacteria and from taste of fat.

Fish can be kept fresh by simple storage in crushed ice for 10–12 days, provided it has been carefully handled with a strict attention to cleanliness. For longer periods of storage, brine-freezing is essential, and the Torry Research Station has now worked out a technique suitable for long-distance trawlers. The fish must be frozen in brine at −20° C. and also stored at a low temperature : it can then be kept in a condition similar to that of fresh fish for three months. It is not necessary to provide brine-freezing for the whole of a catch in a trawler making a round trip of 24 days, of which 14 days are occupied in the journey to and from the fishing ground ; the last two-thirds of the catch can be stored in crushed ice.

A tunnel-shaped kiln has also been designed for experiments in the smoke-curing of fish, and some of the principles underlying its design have already been adopted in new commercial kilns. The processes of curing and smoking are largely separated and individually controlled : sawdust smoke is produced externally in such a way that its temperature and humidity on being blown into the kiln can be regulated. The kiln was exhibited at the North of Scotland Industrial Exhibition in 1932 and demonstrated the evenness with which fish could be cured in the mass, and the brilliance of individual colour, cleanliness and excellence of flavour of the finished product.

An endeavour is being made to determine the extent and the causes of the fluctuations in the potency (from 30 up to 7,600 Carr-Price blue 'units') as regards vitamin A of the oil from halibut liver. No correlations have been found with the position of the fishing ground, the food of the fish, the glycogen in the liver, or the change of season, although all the richest oils were derived from fish caught during May.

An important by-product of the general investigation of the oils and fats of fish is the discovery in fish's liver of the active principle used in the treatment of pernicious anæmia : a palatable and highly active extract can now be obtained.

Small-scale experiments on the gas-storage of bacon show that it can be stored successfully in commercial carbon dioxide for 9 weeks at 5° C. The gas has a specific effect in preventing taint, whilst the absence of oxygen prevents rancidity and gives a better appearance to the bacon. An experiment in which 100 pigs were used has shown that salt-curing gives a more palatable product than tank-curing ; English bacon is mainly dry-salt cured, whilst Danish is tank-cured. Pork has been stored at −1° C. for 17 weeks in an atmosphere of 92 per cent or more of carbon dioxide and not more than 2 per cent of oxygen ; in subsequent cooking tests the meat was found to be excellent, and resembled chicken or veal rather than pork. The practicability of commercial gas storage for pork is as yet unproved, the main difficulty being to keep large stores gas-tight.

The report refers to the remarkable progress in the commercial gas-storage of home-grown apples. The accommodation for this type of storage has rapidly doubled and now amounts to 1,750 tons. Another 1,000 tons is known to be planned and it is anticipated that in a few years the amount will be ten times what it is to-day. This accommodation is, of course, additional to that, amounting to about 8,000 tons, for the ordinary cold storage of fruit. The success attending the commercial gas-storage of Bramley's Seedling apple has led to experiments to define the conditions required by other varieties, since the response of each to abnormal atmospheres is quite different. Suitable conditions of temperature and atmosphere have been found for Lane's Prince Albert, Annie Elizabeth and Ellison's Orange, but further experiments are required in the case of Cox's Orange Pippin.

Following upon an American observation that ripe apples placed among potatoes retarded sprouting, it has been discovered that the growth of young pea seedlings and other seeds is delayed or distorted by exposing them to air which has passed over ripe apples. The active substance is present in very small amount, about one part in 30,000 ; the evidence so far obtained points to its being either ethylene or a body of a similar nature. Although the growth of the seedlings is inhibited by 'apple air', their rate of respiration continues unchanged : the emanation increases the rate of oxidation of other apples. The active substance is given off by the fruit at the 'climacteric', that is, the period at which the respiratory activity of stored fruit suddenly increases for a short time. The climacteric occurs also in tomatoes and bananas : in the latter the yellowing of the skin and ripening of the flesh occur after the fruit has passed through this change. The active substance given off by apples hastens the ripening of green bananas and young apples. Evidence has also been obtained that bananas give off a substance which hastens ripening and counteracts the retarding effect of a reduction in the amount of oxygen in the atmosphere to which they are exposed.

Experiments are also described in the report which indicate that a storage life up to five weeks may be a commercial proposition with English hot-house tomatoes ; during this work it was found that summer grown fruit would tolerate a lower temperature of storage than autumn grown fruit. Earlier experiments having shown that control of temperature alone in the storage of tomatoes was unlikely to yield entirely satisfactory results, a comprehensive research was undertaken on their storage in various artificial atmospheres. The results so far obtained indicate that the best storage conditions are a temperature of 50°–55° F., and an atmosphere containing 5 per cent oxygen and 5 per cent carbon dioxide.

Obituary

M. Paul Painlevé

WHEN I went to see him shortly before his untimely death, Prof. Paul Painlevé was editing, with the aid of an assistant, the second part of his famous lectures on the "Mécanique des Fluides" recently delivered at the Sorbonne. In the dusk of his life, the 'President', as he was familiarly called by his friends, was thus returning to his favourite studies, for it was as a mathematician that M. Painlevé began his extraordinary career. He was slowly recovering from a long and dangerous breakdown and was hoping to give an inaugural lecture in the great hall of the Conservatoire des Arts et Métiers, which was recently named after him in honour of his scientific genius. The hope was not to be fulfilled : instead, it was his coffin which was placed in that very hall before it was borne to the Panthéon. "I am still holding on to life," he was heard to say recently ; "and if I have to let go, I shall try to do it as elegantly as I can!" These prophetic words became true when on October 29, Prof. Painlevé died in his own home from heart failure. In him, France loses one of her most distinguished sons, and the world one of the greatest mathematicians and statesmen of the day.

Painlevé's political career, which culminated in his being Prime Minister of France on three occasions, was a vital part of the Third Republic and of contemporary history. Born in Paris on December 5, 1863, of a modest family, Paul Painlevé, after a brilliant academic career, made his first appearance in public life at the time of the Dreyfus affair when, at the risk of losing his appointment, he took sides with the Radicals. In 1908, he started active propaganda for the organisation of military aviation. From his election to the Chamber of Deputies in 1910, Paul Painlevé was constantly in the public eye. When War broke out, he became head of the Inventions Commission of the Chamber, taking a personal interest in all the plans and models submitted to his department. In October 1915, he was entrusted with the Ministry of Inventions ; and two years later he was given the portfolio of Minister of War in M. Ribot's administration, only to take over from him, soon after, the reins of government.

In 1924 Painlevé was elected president of the Chamber of Deputies; soon after, he was chosen by the Left parties as their candidate for the presidency of the French Republic, but was narrowly defeated by M. Doumergue. In the rapid succession of governments which followed the fall of M. Herriot's administration, Paul Painlevé was twice Prime Minister, in which capacity he attended the momentous meetings of the League of Nations Council in 1925 when the Locarno Treaties were drafted. His wide political experience and his sense of realities had no doubt an important influence on the issues at stake. In all the subsequent administrations but one, Paul Painlevé held office as War Minister or Air Minister, an appointment always close to his heart. Public service, however, taxed his health to the utmost. A year ago, the 'President' collapsed in the Chamber during the fateful discussion of the "Aéropostale" and never recovered full vigour.

Paul Painlevé was well known in scientific circles in England. He had lectured at the Royal Institution on "Modern Conceptions of Matter and Classical Science" ; and the University of Cambridge conferred on him the honorary degree of Doctor of Science. He was also an honorary member of the London Mathematical Society. In the international field, however, he was known not only as president of the International Committee of Intellectual Co-operation, but also as a scholar and a mathematician of the first rank, in which capacity he received many honours from the principal learned institutions of the world. Indeed, Paul Painlevé began his public life as professor of mechanics in the University of Lille at the age of twenty-three years, in 1886, being appointed soon after to the Sorbonne and the Ecole Polytechnique. His first important work was his thesis on "The Singular Lines of Analytical Functions" (1887), in which he investigated a function in the neighbourhood of a singular line. Such cases arise in the discussion of Cauchy's integral or again in Taylor's series when it is convergent in a certain circle. Weierstrass, Tannery, Appell and Hermite have discussed similar cases. Painlevé's treatment of the question led him to the following important theorem : "When a series $F=\Sigma V_n(x,y)$ converges uniformly on the contour s of a closed area S, in the interior of which the functions $V_n(x,y)$ are regular and satisfy the equation $\Delta V_n=0$, then the series F converges uniformly in S, and the series formed by the derivatives of its terms converge uniformly in any area S' interior to S but without any common point with s, and represent the derivatives corresponding to F." He showed further that singular lines may be 'artificial' or 'essential' ; and from the conditions of the first case, he derived several theorems concerning the functions defined by an implicit relation or by a differential equation of the first order.

These theorems are used in the study of the uniform integrals of a differential equation, as Painlevé showed in various applications, such as the finding of all the equations of the form $\frac{du}{dz}=f(z,u)$, taking $f(z,u)$ as uniform, of which the general integral can be uniform. Finally, he discussed the various demonstrations of Mittag-Leffler's theorem and derived from it the important property that any holomorphic function in a convex area can be developed in that area as a series of polynomials. These and his other investi-

gations became so well known that a few years later he was invited to give a course of lectures on his methods at the University of Stockholm.

At Stockholm, Painlevé developed the remarkable theories which he published in 1897 as "Leçons sur la Théorie Analytique des Équations Différentielles", a masterly work closely following his "Conférences sur l'Intégration des Équations de la Mécanique" published two years earlier. As is well-known, at Jacobi's death in the middle of last century, we had a complete method of treating partial differential equations of the first order involving one independent variable, or a system of such equations. There were considerable difficulties in the solution of equations of the second and of higher orders. True, there were the methods worked out by Laplace, Ampère and Darboux ; but rare were the instances when direct integration of such equations was possible. Following certain methods initiated by Cauchy in the calculus of limits, Painlevé discovered several masterly solutions of these types of partial differential equations.

Painlevé's treatment of equations of the second order with fixed critical points the integral of which contains algebraically one or two constants, or of equations of the second order with fixed critical points which are irreducible, opened up new vistas in a branch of higher mathematics illuminated by the labours of Riemann, Mittag-Leffler, Fuchs, Klein, Brioschi, Picard, Appell, Poincaré, Briot, Borel and others. Indeed, it is in this field that Painlevé made his most important discovery, which won for him a seat in the French Academy of Sciences in 1900, when he solved, by means of a certain family of functions which have since been called by his name, certain types of differential equations which had puzzled two masters, Henri Poincaré and Emile Picard. So great was Painlevé's fame as a mathematician at the time, that when the Grand Duke of Baden gave a reception to the members of the International Congress of Mathematics at Heidelberg in 1904, he was asking everyone introduced to him : "Could you show me M. Painlevé ?"

Like all the scientific giants of his generation, Painlevé did not confine himself to pure mathematics. He soon applied his mastery of the calculus to various problems of mechanics, astronomy and the newly-born science of aerodynamics. The foundations of his treatment of applied mathematics is to be found in his "Conférences sur l'Intégration des Équations de la Mécanique" and his "Leçons sur le Frottement" as well as in the last portion of his "Leçons sur la Théorie Analytique des Équations Differentielles". Generally speaking, he follows the methods of Lagrange, Poisson, Hamilton, Jacobi, Legendre and Liouville ; and with this classical tradition he was able to do much original work on the famous problem of three bodies and of n bodies.

After the time of Lagrange, the problem of three bodies had been discussed by Poincaré, who laid the foundations of the new science of dynamical astronomy and won, incidentally, the international prize offered by King Oscar II. With Picard, Charlier, Moulton, Levi-Cività and others, Paul Painlevé continued these researches, in which questions of stability had received much attention ; for example, the stability of the solar system, which was affirmed by the eighteenth century astronomers, had been reopened by Weierstrass. It had been found that expressions for the co-ordinates of the planets do not converge, or converge for only a limited time. Poincaré discovered that some of the series which had been used to calculate the position of the bodies of the solar system are divergent. Would the ultimate divergence of these series, all other things being accounted for, throw doubt on the stability of the solar system and wreck its analytical representation ?

With these premises, Poincaré, Painlevé, Levi-Cività, Brown, Gylden and others, were busily engaged in determining the sufficient conditions for the stability of n bodies in a dynamic system. Painlevé, in particular, tried to determine the criteria in which the stability is made to depend upon that of a certain point transformation associated with the periodic function. His results have been used since for computing the perturbations of certain small planets. Further progress in the transformation and reduction of the n-body problem, in which the principal rôle has been played by the ten known integrals (the six integrals of motion of the centre of gravity, the three integrals of angular momentum and the integral of energy), is essentially related to the non-existence theorems of Bruns, Poincaré and Painlevé.

Celestial mechanics easily led Painlevé to the study of aerodynamics ; when the possibility of flying began to be discussed, he proved to have been something of a prophet. So early as 1906 he definitely stated as his opinion that heavier-than-air machines were a practical possibility. He was the first passenger of Wilbur Wright and flew with him at Auvours for the then record time of one hour and ten minutes. Painlevé was similarly the first passenger taken up by Henry Farman at Mourmelon. He remained an enthusiast for aviation. Painlevé was the author of the first theory of sustentation in aviation, and did much pioneer work in the calculations involved in the construction of aeroplanes. He wrote two books on aviation ; and published a part of the lectures he gave at the Faculty of Sciences in Paris as first holder of the "Chaire de Mécanique des Fluides et Applications" which was founded for him by the State. In these "Leçons sur la Résistance des Fluides non Visqueux" (1930), as well as in his "Cours de Mecanique" (1929) he develops many important views and results on the dynamics of continuous deformable media and on the theory of flying machines and aviation.

Perhaps it was his passion for applied mathematics which was at the root of Painlevé's philosophy of Nature. In his monograph "Les Axiomes de la Mécanique" (1922), where he discusses the assumptions of classical mechanics, the principle of causality, the postulates of relativity and the

propagation of light, Painlevé holds that the axioms of geometry themselves are expressions of actual properties of the natural bodies. At first, he was very cautious about Einstein's theory of relativity, and even presented a qualified criticism of Einstein's assumptions and conclusions at the Paris Academy of Sciences. During a public discussion on this subject at the Sorbonne in 1920, he dazzled his audience by the wealth of alternatives to Einstein's axioms he had discovered, and remained stubborn in his scepticism. The day was rainy, and I happened to offer the shelter of my umbrella to Prof. P. Langevin, the chief opponent of Painlevé at the discussion. "After all," suggested Langevin, "I feel Painlevé would be less obstinate after a good dinner!" A short time afterwards, in a preface written by Paul Painlevé to my translation of Sir Arthur Eddington's lectures on relativity (1924), the great Frenchman acknowledged the profound value of the new picture of the universe, while in his "Cours de Mecanique", delivered at the Ecole Polytechnique, he gave a technical and searching discussion of Newtonian mechanics and Einstein's theories. It cannot be doubted, however, that Painlevé's criticism of the theory of relativity was instrumental in perfecting its details and in developing a clearer explanation of its implications as a new philosophy of Nature.

In appearance, Paul Painlevé was a short and handsome man, sincere and straightforward, with an energetic face, but amiable ways and a kind heart. His life was as simple as it was strenuous. As he believed in doing all his work himself, all his time was taken up by his mathematical work, and his political and administrative duties. He had thus developed great power of concentration which I had an unexpected occasion of witnessing. I saw him during his last electoral campaign, and we were engaged in a discussion of the methods and issues of the elections, when Painlevé had a telephone call: a colleague of his from the Sorbonne wanted some particulars about a mathematical problem. At once Painlevé entered on a rapid and learned conversation on some esoteric parts of the tensor calculus. When he finished his argument, he apologised for the interruption and we carried on our political conversation.

Such was the man whom legend had annexed even during his lifetime. His absent-mindedness, for example, was a source of amusement in France and among his friends. He would often take a taxi home when his own car was waiting for him; or again, give his telephone number to the taxi-driver asking for his address. On one occasion, expecting a friend, he left a note on his door: "Painlevé will be back in fifteen minutes." Returning to his house, he saw his own note and waited on the step for his own return! But now Painlevé is no more. His example, his spirit and his work will, however, live for ever in the hearts and minds of his innumerable disciples and colleagues, who mourn with France and with the scientific world the great memory of the 'President'. THOMAS GREENWOOD.

WE regret to announce the following deaths:

Mr. Donald J. Armour, C.M.G., surgeon to the National Hospital for Nervous Diseases, president of the Medical Society of London in 1929–30, and of the Association of British Neurological Surgeons in 1930–32, an authority on brain and spinal surgery, on October 23, aged sixty-four years.

Sir George Makins, G.C.M.G., C.B., president of the Court of Examiners of the Royal College of Surgeons since 1917, formerly dean of St. Thomas's Hospital Medical School, on November 2, aged seventy-nine years.

Dr. Emile Roux, For. Mem. R.S., director of the Pasteur Institute in 1904–18, known for his work in bacteriology in collaboration with Pasteur and Behring, on November 3, aged eighty years.

Mr. F. H. Stevens, formerly a mathematics master at Clifton College, author and part-author of numerous well-known textbooks of mathematics, on November 1, aged eighty years.

News and Views

Royal Society Medal Awards

HIS MAJESTY THE KING has approved of the following awards this year by the president and council of the Royal Society in respect of the two Royal medals:—Royal medal to Prof. G. I. Taylor, Yarrow research professor, Cambridge, for his mathematical work in physics, geophysics and aerodynamics; and Royal medal to Mr. P. P. Laidlaw, pathologist to the Medical Research Council, for his work on diseases due to viruses, including that on the cause and prevention of distemper in dogs. The following awards of medals have also been made:—Copley medal to Prof. Theobald Smith, director of the Department of Animal Pathology in the Rockefeller Institute, Princeton, for his original research and observation on diseases of animals and man; Davy medal to Dr. W. H. Mills, University lecturer in organic chemistry in the University of Cambridge, for his researches in organic chemistry, and for his work on the syntheses and properties of the cyanine dyes, and more especially for his investigation of novel types of asymmetric molecules; Hughes medal to Prof. E. V. Appleton, Wheatstone professor of physics in King's College, London, for his researches into the effect of the Heaviside layer upon the transmission of wireless signals.

Officers and Council of the Royal Society

THE following is a list of those recommended by the president and council for election to the council of the Royal Society at the anniversary meeting on November 30:—*President:* Sir Frederick Gowland Hopkins; *Treasurer:* Sir Henry Lyons; *Secre-*

taries: Sir Henry Dale and Sir Frank Smith; *Foreign Secretary:* Lord Rayleigh; *Other Members of Council:* Dr. E. J. Butler, Dr. W. T. Calman, Prof. C. H. Desch, Prof. T. R. Elliott, Prof. A. V. Hill, Mr. C. N. Hinshelwood, Prof. A. Hutchinson, Dr. H. Spencer Jones, Prof. J. C. McLennan, Dr. F. H. A. Marshall, Sir Charles Martin, Prof. E. Mellanby, Prof. R. Robinson, Mr. H. T. Tizard, Prof. E. T. Whittaker, Mr. G. U. Yule.

Sir Thomas Middleton, K.C.I.E., K.B.E., C.B.

THE first award of the Gold Medal of the Royal Agricultural Society of England in recognition of distinguished service for agriculture has been made to Sir Thomas Middleton, vice-chairman of the Development Commission. In the early part of his career Sir Thomas was closely associated with farmers in England. Under his guidance a wide and varied scheme of experiments was conducted in the northern counties in the first years of the present century and afterwards in the eastern counties. He was for a time lecturer in agriculture at Aberystwyth, and later professor at Durham, and finally at Cambridge, where his five years' professorship served to put the young department on its feet with funds for a headquarters assured. In 1906 he went from Cambridge to the Board of Agriculture. The War provided much scope for his talents as an administrator. In 1916 he produced his well-known survey of German agriculture and indicated the lines which British farmers might usefully follow to meet the national emergency. When the Food Production Department was set up, he was put in charge of it, and the success it achieved was largely due to his wise guidance and tactful management. A record of the work accomplished and its post-War lessons is to be found in his book "Food Production in War". In 1919 Sir Thomas was appointed to the Development Commission, becoming vice-chairman ten years later. Much of the success of the present system of agricultural education and research is due to him. He was one of the earliest members of the Agricultural Education Association, and was the first president of the newly constituted Section M (Agriculture) of the British Association at the Dundee meeting in 1912. His presidential address at the meeting was "Early Associations for promoting Agriculture and Improving the Improver". The work of a great 'improver' has been suitably recognised.

René Louiche Desfontaines, 1751-1833

AMONG the names of the many eminent naturalists who have worked in the Jardin des Plantes is that of René Louiche Desfontaines, the botanist, who died on November 16, 1833. A contemporary of Antoine Laurent de Jussieu, after attending the college at Rennes, he went to Paris to study medicine, and there came into contact with Louis-Guillaume Le Monnier (1717–1799), professor of botany in what was then known as the Jardin du Roi. In 1783 Desfontaines was elected a member of the Academy of Sciences and that same year set out on a botanical expedition to North Africa. After spending two years exploring Tunis and Algeria, he returned home with valuable collections in all departments of natural history, and in 1786 was chosen to succeed Le Monnier as professor of botany, retaining that position when the title of the gardens was altered to the Jardin des Plantes. In spite of the Revolution, he continued to prosecute the study of botany with vigour and contributed many memoirs to the newly organised Academy of Sciences. Among these was his paper on the structure of monocotyledons, read in 1796. In 1798 he published the first number of his "Flora Atlantica" and this was succeeded by a catalogue of the plants in the Jardin des Plantes, and a work on the history of trees and shrubs which could be cultivated in France in the open air. He continued his active work until he was more than seventy years of age, and his researches were only brought to an end by the failure of his sight. He married late in life, but had one daughter who contributed much to his comfort in his last years.

Cosmic Rays

IN his inaugural address on "Cosmic Rays", delivered at Birkbeck College, London, on November 2, Prof. P. M. S. Blackett gave a comprehensive survey of the history of the subject. In historic order the three main methods of experiment are (*a*) that in which the ionising energy of the radiation is measured at great heights in the atmosphere and great depths below water—in the former case the ionisation is 100,000 times greater than in the latter; (*b*) that in which an idea of the physical nature of the radiation was first obtained, when widely separated Geiger-Müller counters gave simultaneous impulses in the Bothe-Kolhörster experiments; and finally (*c*) the application of the Wilson cloud chambers to the problem by Skobelzyn, Anderson, Auger, Kunze, Occhialini and himself. The last method is undoubtedly the most powerful and direct in studying the nature, if not the origin, of the radiation. In Prof. Blackett's own work, the great economy was introduced of making the ionising particle or radiation set off its own photographic recording devices. The interpretation of these records remains at the moment a matter of some difficulty. Their beauty has removed the scepticism concerning the existence of the positively charged particle of electronic mass, but there remain the problems of the interrelation of the individual members of each group in the showers to each other and of the showers amongst themselves occurring in separated localities.

SPEAKING of larger scale experiments, it is surprising what deductions can be drawn from the negative result, that after suitable allowances are made, there is no greater variation of the ionisation with time than 1 part in 1,000. The particles therefore do not come from the sun; if not from the sun, then not from the stars, or from within the stars, and from their isotropism not from our galaxy, and if not from ours not from 'anybody else's', as galaxies are probably all alike. The idea of their being our special property is too Ptolemaic. Thunderstorms cannot account for the whole phenomenon, and thus

Blackett leans towards the theory which describes the motion of radiation, formed at a time when the laws of physics were different, within a closed universe for which the total absorption is equivalent to only 7 cm. of water. We are on surer ground in discussing the nature of the radiation. Leaving the origin of the primary radiation for a moment, it is certain that in high altitudes particles of energy 10^{10} electron volts are entering the earth's atmosphere. The majority of these come from the west, showing that they are positively charged. An estimate can be made that these positive electrons which are so rare on earth fill the universe, and that they constitute a thousandth of its mass. A further point of interest comes from the work of C. W. Gilbert at the laboratory at Jungfraujoch. Gilbert finds that a study of the curves of energy distribution with numbers of all the secondary particles shows that the average energy decreases downwards. The conclusion seems to be that in the process of formation of these positive and negative secondary particles, the law of conservation of energy is obeyed not only statistically but also in every interaction.

Mount Everest Expedition of 1933

At a meeting of the Royal Geographical Society on November 6, Mr. Hugh Ruttledge described the Mount Everest Expedition of 1933, of which he was leader. The party left for the 350-mile march across Tibet on March 12. The plan this year was to make a slow advance up the East Rongbuk glacier to enable both Europeans and porters to acclimatise without strain. On May 22, five Europeans and twenty porters established Camp 5 at a height of 25,700 ft. on the North ridge, 500 ft. higher than this camp had been placed before. The party had to descend on May 24, but on May 28 a fresh party went up, and on May 29 Wyn Harris, Wager and Longland with eight porters managed to carry a single tent and stores to a height of 27,400 ft., where Camp 6 was established. Next day Wyn Harris and Wager made the first assault. About two hours beyond Camp 6 they found an axe lying on exposed slabs. It is quite certain that this axe must have belonged to either Mallory or Irvine, and it probably marks the scene of a fatal accident. Wyn Harris and Wager started at 5.40 a.m. in great cold, and lost much time in attempting to climb the second step, which was found to be impossible. They decided that it would be better to have a final look at the second step so as to be able to report accurately to Smythe and Shipton, who had meanwhile come up to Camp 6; the latter would then be able to make their assault with undivided minds. They finally reported to Smythe and Shipton, and continued down to Camp 5 for the night.

Next day there was a heavy fall of snow and Smythe and Shipton were not able to make their attempt until June 1. The slabs were in a very unsafe condition. Shipton collapsed with internal trouble near the first step but was able to find his way down alone; and Smythe carried on. He reached exactly the same point as Wyn Harris and Wager at 10 a.m. He would probably have had sufficient time in which to reach the summit and return, but the extra snow on the slabs made them absolutely unclimbable. He got back safely to Camp 6 and spent his third night there, alone. He actually managed to sleep for thirteen hours and descended safely next day through appalling weather to the North Col. The monsoon was already in full swing, but in the hope that a break might occur a third attempt was organised and begun on June 11. By now Mount Everest was practically a snow peak; even the North Col could not be approached, for the fixed ropes were buried to a depth of two feet and avalanches were falling regularly. Fresh snow fell every day, and it was soon realised that it was useless to stay on. Both local opinion and that of the meteorologist in Calcutta held that once the monsoon has set in, Mount Everest is very unlikely to get rid of its mantle of snow until the west winds of Tibet re-establish themselves at the end of September, by which time the days are too short and the cold is too intense for climbing operations. The Expedition therefore left Base Camp on July 2.

Germination of Seeds

In his Friday evening discourse at the Royal Institution on November 3 on "Germination of Seeds", Sir Arthur Hill discussed the many ingenious devices for the protection of the seed and equally ingenious arrangements for the escape of the embryo on germination, which are found in plants. At one end of the scale are the plants, such as mangroves, the seeds of which germinate while still attached to the parent tree, the young seedlings dropping off into the mud. The great majority of seeds, however, have some sort of protective coat. Sometimes it is composed of the outer layer of the seed itself, as in the tomato, and sometimes of the inner layer of the surrounding fruit tissue, as in the plum and the cherry. In the former, under suitable conditions, the seed-coat becomes soft through absorption of water and the radicle emerges through the micropyle. In the second type, various devices have been evolved to allow of the escape of the seed or seeds enclosed in the hard inner wall of the fruit or endocarp. In the plum, the stone or endocarp splits into two halves, while in other cases a shutter-like valve is thrown off by the germinating seed. In the North American tupelos (*Nyssa*), there is one seed and one shutter, and from this type a series can be traced with an increasing number of seeds and corresponding shutters, to the case of *Davidia*, where there are seven or more seeds in each endocarp. Here the problem of overcrowding becomes acute, and many of the seedlings die. Other plants employ such devices as plugs or lids, for example, *Hipparis*, *Hæmotostaphis*, *Dracontomelon*, etc., which are thrown off, leaving a 'window' for the escape of the seedling. Here again, when there are many seeds, deaths occur owing to overcrowding, the extreme case of which is the Brazil nut, *Bertholletia*, where there are fifteen to twenty seeds enclosed in a hard woody fruit; as all germinate at once, only one of the 'prisoners' survives.

Chemical Tests for Vitamins

AT a meeting of the Society of Public Analysts on November 1, a discussion was held on "The Chemical (as distinct from Physiological) Tests for Vitamins". Mr. A. L. Bacharach, in opening the discussion, outlined the present state of knowledge of the chemistry of the individual vitamins, of which one, vitamin C, has been synthesised. Of the others, most is known about the constitution of calciferol (vitamin D) and vitamin A. He enumerated such chemical tests as have been used or suggested for the estimation of vitamins, of which the two most important are the Tillmans-Harris test for ascorbic acid (vitamin C) and the antimony trichloride test for vitamin A. Dr. Leslie Harris, discussing the most accurate methods of applying the antimony trichloride test for vitamin A, said that for quantitative work it is essential to saponify the oil, substances interfering with the production of the blue colour being removed by hydrolysis. For vitamin C a quantitative method based on the use of Tillman's indophenol indicator has been made more nearly specific by a preliminary removal of interfering reducing substances. Prof. J. C. Drummond directed attention to certain defects in the B.P. procedure for the antimony trichloride test. The colours should be matched at the period of maximum intensity, and reliable results can only be obtained with the unsaponifiable matter. Mr. Norman Evers showed that even the blue value of the unsaponifiable matter of cod liver oil might not be the true vitamin value. He pleaded for uniformity in the method of expressing results. Mr. S. K. Crews and Mr. S. J. Cox read a paper on the relationship between the Carr-Price value and 328 mμ absorption coefficient of preparations containing vitamin A. They showed that the purification of vitamin A products removes substances which inhibit the blue colour and that eventually the ratio of the Carr-Price blue colour value to the ultra-violet absorption coefficient rises and tends to become constant.

The Vitamin B Complex

THE present position of research, both chemical and physiological, on the water-soluble B vitamins was outlined by Prof. R. A. Peters, Whitley professor of biochemistry in the University of Oxford, on November 3 at the twenty-third Bedson lecture delivered at Armstrong College, Newcastle upon Tyne. After alluding to the discovery of the vitamins, and the methods of biological assay employed, Prof. Peters sketched the processes used by van Veen, Ohdake, Windaus, and by his own co-workers for the isolation and purification of vitamin B, from rice polishings or yeast, including his own method of selective precipitation as phosphotungstate in solutions of varying *p*H value, tracing the increase of activity in the concentrates, culminating in the various crystalline preparations of the workers mentioned above. He dealt then with the chemical analyses, X-ray crystallographic, and absorption spectra studies of these substances, indicating how his material from yeast differed in activity, and also in carbon and sulphur content, from that prepared from rice polishings. Finally, Prof. Peters set out the evidence, often conflicting, for the elucidation of the chemical natures and biochemical rôles of the B_1, B_2 and B_4 factors in relation to the oxidation processes and enzyme systems of brain tissue.

Association of Scientific Workers

THE report of the Executive Committee presented on October 28 to the Council of the Association of Scientific Workers is a document containing a record of sustained and useful work. The outstanding event of the last half-year has been the formation in conjunction with the British Science Guild of the Parliamentary Science Committee. The Association has also taken an active part, with other scientific bodies, in the endeavour to save the Research Association of British Rubber Manufacturers from disintegration. To that endeavour has been added an inquiry as to the best means of stabilising the finances of the industrial research associations generally. In this connexion, the Association has joined with the British Science Guild in the appointment of a joint committee ; and when the labours of that body are completed it is probable that it will report to the Parliamentary Science Committee with the view of taking action. During the period under review, the University Degrees Bill, promoted by the Association, has received its second reading in the House of Lords without division ; but it is not likely to reach the Statute Book before the session closes. A publication of which the Association may well be proud is "Science in Parliament", a summary of all affairs relating to science dealt with in Parliament. Another achievement has been the establishment of a publicity bureau.

Sir Edward Frankland Memorials at Lancaster

ON October 23 the Mayor of Lancaster (Mrs. A. E. Helme) opened the new technical workshops and craft rooms at Meeting House, and later formally opened the new Frankland Laboratory at the Storey Institute, Lancaster. The Laboratory, which will be devoted to chemistry, was founded in memory of the late Sir Edward Frankland, the eminent chemist. Frankland was born at Churchtown in Lancashire in 1825, but at an early age went to live in Lancaster. He studied chemistry under Playfair, Bunsen and Tyndall, and after carrying out some research under Liebig at Giessen, was elected professor of chemistry at Owens College, Manchester. Later he worked in London at St. Bartholomew's Hospital, the Royal Institution and at the School of Mines. He was elected a fellow of the Royal Society in 1853 and in 1894 he was awarded the Copley medal. On January 18, 1933, the anniversary of Frankland's birth, it was proposed to found a Frankland Society in Lancaster (see NATURE of February 11, p. 197). The proposal was adopted and the Lancastrian Frankland Society came into being with Prof. H. E. Armstrong, Frankland's oldest living pupil, as president. The syllabus for the session 1933–34 of the new society has recently been issued. The meetings are to be held about once a month in the

Storey Institute. An interesting series of lectures has been arranged, not restricted to chemistry, but likely to attract scientific workers and all interested in the progress of science.

Civil Engineering in Local Government

SIR HENRY MAYBURY delivered his presidential address to the Institution of Civil Engineers on November 7, dealing with aspects of engineering associated with local and central government administration in Great Britain. Up to about forty years ago, county and local engineers and surveyors were often part-time officers only. The Locomotives on Highways Act, 1896, by permitting a speed of 12 miles an hour upon the highways, gave great impetus to the construction of the motor-car; this type of traffic imposed a strain upon the roads, which had never been designed or constructed for it, and indeed had received little or no attention since the commencement of the railway era. The Motor Car Act, 1903, allowed increased speed and greater freedom to the motor vehicle, but gave no relief to highway authorities and their officers. Under the Development and Road Improvement Funds Act, 1909, the Road Board was established primarily to receive the moneys derived from this taxation, and to allocate them to local authorities for road improvement works. In 1919 the Ministry of Transport was established, with control of all forms of transport, and in 1920 the passing of the Roads Act made it possible for contributions from the Exchequer to be made to local authorities towards the cost of the maintenance and minor improvement of classified roads, further sums being made available for necessary road and bridge construction and for major improvements. Speaking of the development of the love of travel in post-War years, Sir Henry said that whilst each person in Greater London travelled on an average 283 times on one or other of the rail and road services in 1912, in 1932 the number of journeys per person had risen to 482. In conclusion, Sir Henry said that there are on the roll of the Institution of Civil Engineers nearly 11,000 members resident in all parts of the world, and he appealed particularly to the younger members to fit themselves adequately for the responsibilities of their profession.

A Three Million Volt Testing Laboratory

THE Compagnie Générale d'Electro-Céramique manufactures high-voltage insulators at Ivry, near Paris. In 1923, it erected the first million volt testing laboratory in Europe. It has now installed new plant which enables it to produce electric discharges up to three million volts, the rate of pressure rise being adjustable to any required speed. The discharges are recorded by a 50,000 volt cathode ray oscillograph. The building, which has no windows through its walls, measures 118 ft. in length, 65 ft. in width and 59 ft. in height. In the *Electrical Review* of October 27, there is a picture giving a general view of the inside of the laboratory. The roof is carefully connected to earth in such a way that the building forms a Faraday cage. The transformers giving a million volts have been improved. The discharging spheres are 39 in. in diameter. The new artificial lightning producer is built up of one hundred 0·5 microfarad, 30,000 volt condensers mounted in the form of a tower, one above the other. The earthing circuit of the condenser is completely independent of that of the building. The earthing plates are sunk in the underground water of the Seine and are connected with the condensers by means of two pits. With all the condensers coupled in series, a maximum of 3,000 amperes at three million volts can be obtained. The total energy of the discharge is 22,500 joules and the maximum instantaneous power developed is about nine million kilowatts. To measure the potential of the arc, two brass balls each having a diameter of 6·5 feet and weighing about 10 cwt. are employed. At three million volts the length of the spark exceeds thirteen feet.

Electrically Propelled Tugs

THE two tugs, the *Acklam Cross* and the *Lectro*, recently put into service, are interesting owing to the fact that they are both electrically propelled and, furthermore, the first two tugs in Great Britain utilising the electric drive. As the *Acklam Cross* also has a battery for starting the main Diesel engines, for which purpose the generators are used as motors, it has another claim to distinction, for this is the first occasion that such an arrangement has been used aboard ship. These two tugs will be used on different services, as the *Acklam Cross*, owned by the Tees Towing Co., Ltd., will be on general towage work, whilst the *Lectro*, owned by the Union Lighterage Co., Ltd., will operate on the Thames, towing oil barges between Shell Haven and Fulham. Although the above-mentioned craft are the first of their type in Great Britain, there are more than fifty electric tug boats in the United States, as well as a number in Europe, and the total number of electrically driven ships in the world is considerably more than two hundred. Out of this number, there are now three, including the new tugs, operating entirely in British waters, the other one being the R.M.S. *Lochfyne*, a small passenger ship completed in 1931. All these vessels have Diesel electric propelling machinery. It is significant that even in the present time of economic depression, machinery has been adopted higher in first cost than the steam engine or direct Diesel drive, and it remains to be seen if the advantages claimed for the electrically driven tug will be proved, and result in its adoption in the future on a much wider scale than at present in the British Isles.

Awards of the Institution of Civil Engineers

THE following awards of the Institution of Civil Engineers have recently been made for papers read during the session 1932–33. For papers read and discussed at ordinary meetings: A Telford gold medal and the Indian premium to Mr. Robert Mair (Calcutta); a George Stephenson gold medal and a Webb prize to Mr. H. W. H. Richards (London); a Telford premium jointly

to Messrs. G. Howard Humphreys (London) and I. M. E. Aitken (British Guiana); a Telford premium jointly to Messrs. A. D. Butcher (Egypt) and J. D. Atkinson (Egypt); a Telford premium jointly to Messrs. R. V. Allin (Essex) and Maurice Nachshen (London); a Telford premium jointly to Prof. A. H. Gibson (Manchester) and Mr. William Cowen (Manchester); Telford premiums to Messrs. H. C. E. Cherry (Rangoon, Burma), F. W. Furkert (Wellington, N.Z.), and H. A. Lewis-Dale (London); a Crampton prize to Mr. C. M. Norrie (London). For papers published without discussion as 'selected engineering papers': A Telford premium to Mr. A. C. Vivian (London); a Telford premium jointly to Messrs. R. D. Duncan (Belfast) and E. M. R. Jones (London); a Telford premium jointly to Mr. J. S. Lavery (Oxford) and Prof. R. V. Southwell (Oxford); Telford premiums to Messrs. Alfred Bailey (London), J. B. M. Hay (Ilkley), Harris Booth (London), L. R. East (Victoria, Australia), and C. G. Watson (London). For papers read by students: The James Forrest medal and a Miller prize to Mr. I. C. Easton (Glasgow); the James Prescott Joule medal and a Miller prize to Mr. Norman Parry (Newcastle upon Tyne); Miller prizes to Messrs. J. A. Fisher (London), Herbert Bruce (Glasgow), C. M. Roberts (Glasgow), F. B. S. Grimston (London), J. S. Williams (London), P. W. E. Holloway (London), A. C. Buck (London), and W. M. Ogden (Manchester).

Index to the *Mathematical Gazette*

WE have received an Index to Vols. 1–15, 1894–1931, of the *Mathematical Gazette*. Since the late Mr. W. J. Greenstreet was editor from the later numbers of Vol. 1 to the earlier numbers of Vol. 15, the index is in effect a monument to his life's work. It is an elaborate volume of xii + 164 pages, produced with great care. Of the most important sections, one lists about 600 articles, one about 1,000 notes, and one about 1,800 reviews. The last shows the standing of the *Gazette* with mathematical publishers at home and abroad, and the wealth of expert criticism which it secures for its readers. There is no attempt at a subject classification of articles or notes, but where a title is uninformative, the compilers have inserted a brief indication of the contents; they have also given cross-references, and by an occasional sly extract added a touch of humour to their matter-of-fact pages. Although complete sets of the *Gazette* are scarce, the publishers (Messrs. G. Bell and Sons, Ltd.) and the Mathematical Association hold a considerable stock of individual numbers, and anyone whose interest is aroused by entries in this fascinating index will probably be able to satisfy his curiosity.

Patent Procedure

UNDER the title "Practical Hints on the Patenting and the Development of Inventions" an interesting and useful booklet has been issued by the Imperial Patent Service, First Avenue House, High Holborn, London, W.C.1. The principal of the Service is Mr. M. E. J. Gheury de Bray, author of books on hyperbolics and exponentials, and of a number of papers on astronomical and engineering subjects, including contributions to these columns upon possible secular changes in the velocity of light. The work of the Service is distributed between three sections dealing respectively with research, patents, and economics or development. The second edition of the pamphlet just published affords helpful guidance respecting patent procedure, and also information on trade marks, designs and copyright.

Environment and Race

IN "An Atlas of Environment and Race" (University of Chicago Bookshop, 40 cents), which is issued to accompany a course of lectures broadcast from Chicago by Prof. Griffith Taylor, is a series of 110 maps, of which 65 have not previously been published. The series, in addition to the maps of racial distribution usually accompanying the discussion of this topic, covers matters such as land elevation, climatic variation, vegetation, stratigraphical evidence and cultural distributions. As a whole, the series is both original and stimulating. The course is designed to prove the 'zones and strata' theory, in which, adopting the criteria of skull form and hair character, it is argued that the races of the world are arranged in five zones about central Asia—a theory already advanced by Prof. Taylor in his "Environment and Race" (1927). Prof. Taylor stresses the paramount importance of the study of race to-day on the ground that two thirds of the world is occupied by coloured peoples "often chafing under European domination".

New Sunspot Cycle

A MESSAGE from the New York correspondent of the *Times*, published in the issue of November 4, announces that the beginning of a new sunspot cycle is reported at Mount Wilson. At the present time, sunspot activity is at a minimum, and it would be difficult to ascertain definitely the beginning of the new cycle, which might be masked by a minor fluctuation, but for the fact that the spots in a new cycle tend to occur in high latitudes (as shown by the well known 'butterfly' diagram), and, more definite still, the magnetic polarity of the spots changes alternately in successive cycles. The Greenwich records show a small pair of spots in a moderately high latitude (30°), and presumably the Mount Wilson observers have determined its polarity and found it to be that of the new cycle. That the new sunspot maximum will bring a maximum of disturbance to the earth's magnetic field is well established, but the correlation with other phenomena is less certain.

Announcements

DR. HERBERT LEVINSTEIN will deliver the fifth S. M. Gluckstein memorial lecture before the Institute of Chemistry on Friday, December 15, at 8 p.m. The subject of Dr. Levinstein's lecture will be "The Chemist as a Directing Force in Industry".

MR. WHARTON HUBER, associate curator of birds and mammals in the Academy of Natural Sciences of Philadelphia, has returned from a six months'

expedition to California, the object of which was to make a survey of the faunal geography of that State, with special reference to type localities. Through the courtesy of the California Game Commission, he was enabled to secure a number of interesting mammals for the Academy's laboratory collections, including specimens of the dwarf elk which is now found only in Kern and Colusa counties, California.

THE Lawes Agricultural Trust Committee has appointed Mr. Geoffrey Samuel to be mycologist to the Rothamsted Experimental Station in the Department of Plant Pathology, in succession to Dr. R. H. Stoughton, now professor of horticulture at Reading. Mr. Samuel is plant pathologist at the Waite Agricultural Research Institute, Adelaide, Australia, and has had a distinguished career, first at the University of Adelaide, and then at the Waite Institute. He is especially well known for his work on manganese deficiency as a cause of plant disease and for his investigations into diseases of cereals, tomatoes and fruit.

AT the annual general meeting of the London Mathematical Society to be held in the rooms of the Royal Astronomical Society, Burlington House, at 5 p.m. on Thursday, November 16, the retiring president, Prof. A. C. Dixon, will deliver his presidential address entitled "The Problem of the Rectangular Plate".

THE fifth of the series of exhibitions at the Royal Photographic Society under the general title of "Photography in the Service of Mankind" is devoted to agriculture and fisheries. The exhibition may be seen at the Society's galleries at 35 Russell Square, W.C.1, until November 30; it is open daily to the public from 10 a.m. until 6 p.m. On Wednesday evenings during the exhibition, programmes of cinematograph films of agricultural, horticultural and fisheries topics are being shown. Admission to these meetings is by free ticket only, to be obtained from the Secretary, Royal Photographic Society, 35 Russell Square.

THE ninth annual Norman Lockyer lecture, established by the British Science Guild as a means of periodically directing the attention of the public to the influence of science upon human progress, will be given by Prof. E. V. Appleton, Wheatstone professor of physics in the University of London, in the Goldsmiths' Hall, Foster Lane, London, E.C.2, on Thursday, November 23, at 4.30 p.m. The subject of the lecture will be "Empire Communication". Tickets, for which there is no charge, are obtainable on application to the Secretary of the British Science Guild, 6 John Street, Adelphi, W.C.2.

A SERIES of lectures and demonstrations on tropical hygiene, which are intended for men and women outside the medical profession proceeding to the tropics, will be given by Lieut.-Col. G. E. F. Stammers, on December 4–13, at the London School of Hygiene and Tropical Medicine. The course comprises eight lectures, which will be held from 5 to 6.30 p.m. on each day. These courses of instruction, in addition to providing simple rules for guidance in regard to personal hygiene in the tropics, will also embrace a short account of some of the more common diseases, with advice in regard to measures of protection and self-treatment. Further particulars can be obtained from the Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1.

THE Ministry of Health has issued a special circular relating to blindness (Circular 1353) in which the necessary qualifications of medical practitioners certifying blindness are detailed, the manner of certifying is described, and the official definition of blindness is explained at some length.

THE results of research work carried out at the Onderstepoort Veterinary Research Station, Pretoria, which have hitherto been published in the form of annual reports, will in future be published quarterly in a new journal, the *Onderstepoort Journal of Veterinary Science and Animal Industry*, the first number of which has been issued (July 1933). In format, it resembles the annual reports, of which it is a direct continuation, and is edited by the director of the Institute, Dr. P. J. du Toit. The *Journal* is published by the Government Printer, Pretoria, at the price of 5*s*. per number.

THE Imperial Bureau of Animal Health announces that the immediate issue of the first number of the *Index Veterinarius* will be undertaken, provided an adequate number of subscribers is forthcoming. This work, which will be issued quarterly, is a complete index to publications relating to all branches of veterinary research. The Imperial Bureau also publishes the monthly *Veterinary Bulletin*. Subscriptions for either publication, £4 and £2 respectively per annum, should be forwarded to the Veterinary Laboratory, Ministry of Agriculture and Fisheries, Weybridge, Surrey.

MR. E. OWER has written taking exception to the notice of his book "The Measurement of Air Flow" which appeared in NATURE of October 7, p. 558. The writer of the notice states that his criticism as to confusion in the coefficient α, on second reading, cannot be justified. The coefficient on p. 110 is correctly defined on p. 79.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the Domestic Science Training College, Leicester—The Director of Education, Education Department, Newarke Street, Leicester (Nov. 20). A part-time demonstrator in physics at the London (Royal Free Hospital) School of Medicine for Women—The Warden and Secretary, 8 Hunter Street, Brunswick Square, London, W.C.1 (Nov. 23). An assistant librarian in the Museum of Practical Geology—The Director, Geological Survey and Museum, 28 Jermyn Street, London (Nov. 27). An assistant investigator of roof control and haulage in South Wales coal mines (Safety in Mines Research Board)—Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, London, S.W.1 (Nov. 30).

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.*]

A Suggested Explanation of β-Ray Activity

THE β-ray activity of radioactive bodies has until now proved to be a very baffling problem. The points at issue are summarised in Gamow's "Constitution of Atomic Nuclei", etc. (pp. 52–54), and in "Radiations from Radioactive Bodies" by Rutherford, Chadwick and Ellis (p. 385). They are also discussed at some length by Bohr in his Faraday lecture (1930).

Briefly speaking, the chief points under discussion are the following: the disintegration electrons (β-rays) from a radioactive body are not emitted with a single velocity as in the case of α-rays, but show a distribution of velocities over wide ranges, though the breaking-up of the atom is a unitary process, as is proved by the fact that the life-period is definite and there is one electron for each disintegrating atom. It has further been proved that the continuous distribution of velocities is a nuclear process, and not due to action of the surrounding shell of electrons.

It appears that the β-ray disintegration admits of a very simple explanation on the basis of the recent experiments by Anderson and Neddermeyer, and Curie and Joliot on the production of positrons by the impact of hard γ-rays with the nuclei of elements. These experiments have been interpreted by Blackett and Occhialini as indicating the conversion of a γ-ray quantum into an electron and a positron near the nucleus. Curie and Joliot have brought further evidence in favour of this view by showing that γ-rays of thorium C″ (energy $2{\cdot}6 \times 10^6$ electron volts) are converted inside all matter into an electron (mass 9×10^{-28} gm., energy $m_0c^2 = 0{\cdot}51 \times 10^6\ eV$) and a positron (having the same mass and energy as the electron), the excess energy being distributed as the kinetic energy of the two particles, and the energy of the residual quantum. They have denoted this phenomenon by the term 'materialisation of light quanta'. They have further shown that a proton is a complex structure, being a compound of the neutron and a positron. As pointed out by Blackett and Occhialini, this explains the anomalous absorption of γ-ray quanta observed by Gray and Tarrant, which Gentner has found to commence with the γ-ray possessing the limiting energy 1·1 million electron volts.

The discovery, which is confirmed by so many workers, promises to be of great importance, as it establishes for the first time, on experimental grounds, the splitting up of a quantum into two charged particles of opposite sign. Many astrophysicists have postulated the probability of the annihilation of the proton and the electron with their mass energies converted into quanta, but the actual process, as revealed by these experiments, seems to be very different. For the quantum breaks up into charged particles possessing opposite charges, but having equal mass, and the positron being absorbed by the neutron forms the proton which is thus seen to be complex. The phenomenon is therefore not a "materialisation of the quantum" as Curie and Joliot suggest, for the neutron appears to be the fundamental mass-particle, but it consists in a splitting of the quantum into two fundamental opposite charges. We may call it 'electro-division of the quantum'.

Let us see how we can explain β-ray activity. If the 'electro-division of a quantum' can be brought about by a nucleus when the quantum hits it from the outside, it is much more probable that the γ-rays produced within the nucleus itself should be completely split up into an electron and a positron. The electron will come out as a β-ray, but a positron will not be able to come out if the conversion takes place within the potential barrier. It will attach itself mainly to some one of the numerous neutrons which are present in the nucleus, and thus form a proton. The positive charge of the nucleus will therefore be increased by unity.

It is not difficult to explain the continuous distribution of β-ray energy. The γ-ray may suffer this 'internal electro-division' anywhere within the nucleus, and hence the velocities imparted to the resulting electrons may vary within wide limits. The exact mathematical calculation can be carried out only when more data are forthcoming. The positron combining with the neutron will give rise to the softer γ-rays which are always present in a β-ray disintegration.

According to the above view, the β-ray emission is only a secondary process, the primary phenomenon which starts this chain of events being the generation of a primary γ-ray. We can now ask ourselves: How is this γ-ray generated? It must be due to the passage of an α-particle or proton from one barrier to another. Gamow, and also Condon and Gurney have postulated the existence of only one barrier in a radioactive nucleus for explaining the emission of α-rays, with definite velocity, but several lines of argument indicate that there may be more than one barrier present in the nucleus. When an α-particle crosses from one barrier to the other, the γ-ray responsible for the whole chain of events leading to the β-ray disintegration is emitted. The life-period is therefore determined by the time of leakage of an α-particle or proton from one barrier to another, and this explains why the life-periods of β-ray bodies are of the same order as those of α-ray bodies, and have a definite value.

M. N. SAHA.
D. S. KOTHARI.

Department of Physics,
Allahabad University.
Oct. 20.

A Method for the Measurement of Gaseous Reactions

THE velocity of reaction of a gas A with a gas B may be measured according to the following principle.

The gas A is led through an orifice into a reaction space where it becomes mixed with the gas B. The partial pressure of B is maintained at such a value that the gas A is consumed before it reaches the wall of the reaction vessel. Let the number of atoms (or molecules) of A entering the reaction space per second be n, and let the concentration of B, which we shall assume to be uniform throughout the reaction space, be c. The rate of reaction of A with B in each element of space dv, will be given by

$$kcc'dv,$$

where k is the velocity constant and c' is the

concentration of A at the place in question. The total amount of reaction in the reaction space will be

$$kc\int c'dv$$

taken over the whole reaction space, and does not depend upon the magnitude of this space, provided that the condition is fulfilled that the molecules of A react predominantly in the gas phase. The integral $\int c'dv$ (measured in appropriate units) defines the number N of atoms of A in the reaction space. In the stationary state,

$$n = kcN.$$

The velocity constant k may therefore be calculated if n and C are known and if at the same time the number N of molecules of A present in the reaction space in the stationary state, can be measured.

Another way in which the method may be regarded is that the life period of the molecules of A in the reaction mixture is found as the ratio of N to n, and that the velocity constant of the reaction is given by

$$k = \frac{1}{Lc}$$

where L is the life period at a known concentration (c) of the reaction partner B.

The main point, experimentally, is the determination of the stationary number N, which can be based on various principles. When A is a metal vapour, the absorption of the resonance line provides a very accurate means of measuring N. The principle has been realised for sodium vapour on this basis by L. Frommer, partly in collaboration with H. v. Hartel. The results are in the course of publication.

Another case that has been worked out is that when A is atomic hydrogen. The number N is measured here by adopting the method used by Harteck and Geib[1] of observing the transformation of admixed parahydrogen. This work, by Miss E. Cremer and J. Curry, is also in the course of publication.

It appears that the method has, when the detection of A is sensitive, a very wide applicability. Collision efficiencies ranging from 1 to 10^{-15} should be capable of measurement.

M. Polanyi.

Victoria University,
Manchester.
Oct. 20.

[1] *Z. phys. Chem.*, (B), **15**, 116; 1931.

Calcium and the Resistance of *Nereis* to Brackish Water

Procerodes (*Gunda*) *ulvæ* is a euryhaline platyhelminth which is able to withstand daily changes from sea-water to fresh-water in its estuarine habitat thanks to the calcium content of the fresh-water. In fresh-waters lacking calcium the worm absorbs water, loses salts, and dies[1]. Similarly the permeability to water of the cell membrane of sea urchin eggs is greater in the absence of calcium[2].

Nereis diversicolor is a euryhaline polychæte. When transferred from sea-water to brackish water its weight at first rises, then falls, and the worm survives[3]. Its stenohaline relative *N. cultrifera* treated in the same way swells, does not afterwards shrink, and it then dies[4].

I have tested the influence of calcium on the resistance of *N. diversicolor* to immersion in brackish water by comparing the changes in its weight when placed in diluted sea-water and in artificial sea-water of the same density but lacking calcium. The work was done at Roscoff.

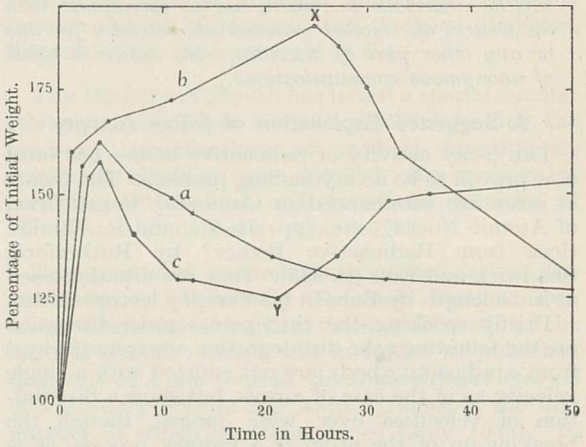


Fig. 1.

Fig. 1 gives the results of three typical experiments. Curve *a* shows the initial increase and subsequent decrease in weight in 17 per cent sea-water, due to absorption and loss of water. Curve *b* shows the rapid initial and slow subsequent gain in weight in 17 per cent sea-water lacking calcium. In this experiment calcium was added 25 hours from the beginning (at X) with a consequent rapid fall in weight. Curve *c* shows the weight changes of a third individual in 17 per cent sea-water. At the end of 21½ hours (at Y) the animal was transferred to calcium-free 17 per cent sea-water, with the result that its weight rose again almost to its previous maximum.

It is clear that for *Nereis diversicolor*, as for *Procerodes*, resistance to immersion in brackish water depends on the presence of calcium in the environment. The action of other ions is now being investigated.

W. G. Ellis.

Zoology Department,
University of Birmingham.
Oct. 18.

[1] Pantin, *J. Exp. Biol.*, **8**, 63, 73, 82; 1931.
[2] McCutcheon and Lucke, *J. Gen. Physiol.*, **12**, 129; 1928.
[3] Schlieper, *Z. vergl. Physiol.*, **9**, 478; 1929.
[4] Beadle, *J. Exp. Biol.*, **8**, 211; 1931.

Transfer of Fixed Nitrogen from Bacterium to Host in Soy Bean

The two principal theories advanced to explain the transfer of fixed nitrogen from bacterium to host in the bacterial symbiosis of the Leguminosæ are, first, that transfer results from digestion of bacteria by host enzymes, and secondly, that it arises from an excretion by the bacteria, into the host cytoplasm, of a part of their fixed nitrogen.

No previous investigator appears to have examined the quantitative features of transfer. In the present work, inoculated soy bean plants have been cultivated under conditions precluding any access to external sources of combined nitrogen. Adequate samples of the population were taken at frequent intervals throughout the life history of the host, and on each occasion the nodules were removed and estimations

made of (*a*) total nitrogen of plants alone, and (*b*) total nitrogen of nodules alone. The increase of (*a*) with time is a measure of the rate of transfer of fixed nitrogen into the plants from their nodules, while the increase of the sum of (*a*) and (*b*) gives an index of the rate of fixation of atmospheric nitrogen by the bacteria associated with the plants.

The results reveal the existence of a definite quantitative relation between fixation and transfer. Throughout practically the whole life cycle of the host, the rate of transfer was persistently 80–90 per cent of the rate of fixation. During the first experimental period in which fixation occurred, as great a proportion of the nitrogen fixed was transferred out of the nodules as during the succeeding periods, indicating that there is little tendency for the products of fixation to be retained within the bacteria for a time before becoming available to the host.

These results favour the theory of excretion, for it is feasible that a roughly constant proportion, apparently 80–90 per cent, of the fixed nitrogen should be excreted by the bacteria with little delay, and be taken over by the plant. On the other hand, transfer by digestion seems unlikely to produce the above quantitative relation between transfer and fixation, but would necessitate a lag in time between the two processes.

In the final experimental period, transfer exceeded fixation, but the very low rate of transfer during this period indicates that no accessory transferring mechanism of any importance came into operation towards the end of the host life cycle.

Certain points are being confirmed prior to publication of full results.

G. BOND.

Botany Department,
University of Glasgow.
Oct. 20.

Spectrum of the Night Sky and of the Zodiacal Light

IN a recent paper[1], one of us has described the general nature of the spectrum of the night sky as observed in India, and pointed out that besides the green line 5577 A. originating in atomic oxygen, there are many other lines which have also to be considered as general characteristics of the spectrum of the night sky at all latitudes of the earth. As has been emphasised by Lord Rayleigh, this spectrum is quite distinct from that of the polar aurora; the second negative bands of nitrogen (N_2^+) which are

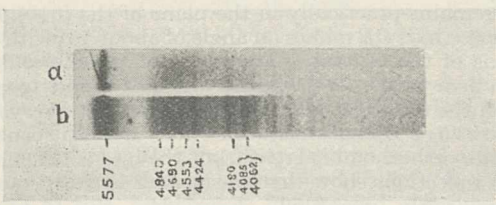


FIG. 1. Spectrum of (*a*) zodiacal light plus night sky; total exposure, 27 hours; (*b*) night sky; exposure, 75 hours.

a conspicuous feature of the spectrum of the polar aurora, are absent or only very faintly present in the night sky spectrum.

During the early part of this year, we succeeded in obtaining exceptionally well-exposed spectra both of the night sky and of the zodiacal light at Poona. Fig. 1, which was obtained with the spectrograph described in the paper referred to above, shows both the spectrum of the night sky (below) and that of the zodiacal light (above). The exposure for the night sky was towards the north at an angle of 20° above the horizon and lasted 75½ hours (April 12–29, 1933), while for the zodiacal light it was mostly towards the west sky at the same angle and of duration 21½ hours. (By an unfortunate oversight, the zodiacal light had superposed on it an additional 5¾ hours' exposure towards the north sky.) The night sky spectrum shows besides the 5577 line, more than thirty 'lines' between 5900 A. and 3700 A., two of which are on the red side of 5577 A. The

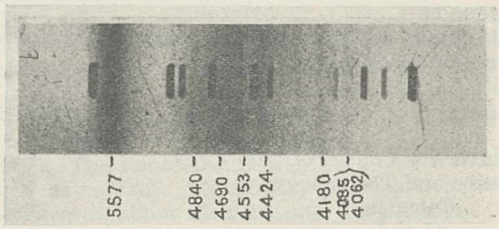


FIG. 2. Spectrum of night sky; exposure, 181 hours; comparison spectrum, helium.

strongest 'lines' occur at 4840, 4690, 4553, 4424, 4180 and 4085 A. and the photographically brightest region of the spectrum lies between 4830 and 4530 A. The spectrum of the zodiacal light also shows the emission lines or bands observed in the night sky. The plate used—Mimosa orthochromatic—was not sensitive to the red.

Fig. 2 shows a spectrum obtained with a spectrograph of higher dispersion (11·4 mm. between 5876 A. and 3900 A.). The exposure lasted 181 hours between March 7 and May 1, 1933. From a comparison with the spectrum of the night sky observed by Dufay[2] in France, it is seen that there is almost an identity between the spectra as observed in India and in France, both as regards the position of the lines and their relative intensities.

It is generally held that the spectrum of the night sky contains a background of continuous spectrum with Fraunhofer lines. In the spectra we have obtained, there is no positive evidence of the existence of Fraunhofer lines.

A fuller discussion of the spectra will be published elsewhere.

K. R. RAMANATHAN.
J. V. KARANDIKAR.

Meteorological Office,
Poona, India.
Sept. 28.

[1] *Ind. J. Phys.*, 7, 405; 1932.
[2] *J. Phys.*, Ser. 7, 4, 221; 1932.

Fluorination of Organic Compounds: Monofluoracetone

IN continuation of the work already described[1] we have recently prepared monofluoracetone. Interaction of monochloracetone and anhydrous thallous fluoride gave negative results. On converting, however, the chloro-compound into the corresponding iodo-derivative and refluxing with anhydrous thallous fluoride in presence of ether, the expected monofluoracetone has been isolated. Swarts[2] has described $CF_3.CO.CH_3$ (trifluor-acetone), the boiling point of which is given as 21·9° C., the boiling point of trichloracetone at 764 mm. being 149° C. The substitution of three chlorine atoms by three fluorine atoms lowers the

boiling point by 127°; that is, on the average, by the substitution of one chlorine by one fluorine, the lowering of boiling point is 42°–43° C. In the present preparation, the difference between the boiling point of monochloracetone (118° C.) and of monofluoracetone (72° C., uncorrected) is 46, which is not far off Swarts's results.

Further investigation on these lines on the preparation of fluorinated aldehydes and other analogous compounds is in progress.

It appears that TlF may be used as a fluorinating agent in cases of certain halogen substituted organic compounds.

The details will appear in due course in the *Journal of the Indian Chemical Society*.

P. C. RÂY.
P. B. SARKAR.
ANIT RÂY.

University College of
Science and Technology,
Calcutta.
Oct. 4.

[1] NATURE, 132, 173, July 29, 1933.
[2] *Bull. Classe des Sci.*, 5, 13, 175.

X-Ray Spectra in the Region 50-250 A.

USING the concave grating methods previously described[1], we have now been able to follow the *L*-series of the X-ray spectra down to element No. 12 (Mg). For this element, the *M*-shell consists of only the two valency electrons. The *L*-series had formerly been measured by several authors down to element No. 20 (Ca) with the plane grating method; one separate line belonging to this series was found by Prins and Takens[2] for element No. 16 (S).

The plates for elements Nos. 19 (K) and 17 (Cl) show for each element a nice doublet with very sharp lines measurable in many orders. Also at element No. 16 (S) the corresponding sharp doublet was found when a sulphate was placed on the anticathode. With pure sulphur on a copper anticathode, two rather strong and diffuse lines were obtained, one on the shorter and one on the longer wave-length side of the sharp doublet. Element No. 15 (P) gives a group of five rather broad lines in the region 98–118 A. Elements 14 (Si), 13 (Al) and 12 (Mg) show very broad lines with a sharp limit on the short wave-length side. This limit, at 126, 170 and 250 A. respectively, seems to correspond to the absorption edge. This phenomenon may be interpreted as emission due to transition of electrons from the free levels of the crystal grating to an empty inner level. Quite an analogous structure is found in the K-series of the lighter elements, especially of element No. 4 (Be).

In addition to the more prominent lines mentioned above, the plates show several other lines belonging to these elements. A detailed report will be given elsewhere.

MANNE SIEGBAHN.
TORSTEN MAGNUSSON.

Physics Laboratory of the University,
Uppsala.
Oct. 16.

[1] M. Siegbahn, *Proc. Phys. Soc.*, 45, 689; 1933.
[2] J. A. Prins and A. J. Takens, *Z. Phys.*, 77, 795; 1932.

Structure of Chrysene and 1:2:5:6-Dibenzanthracene in the Crystalline State

THE exact crystal analysis of these two compounds is of importance owing to the fundamental position occupied by the chrysene type of carbon skeleton in sterol and œstrin chemistry on one hand, and to the carcinogenic properties of dibenzanthracene on the other[1].

Following the complete determination of the anthracene and durene structures[2], the obvious method consists of basing plane hexagon models on the chemical structure and endeavouring to obtain agreement between the measured and the calculated structure factors.

Chrysene crystallises in the monoclinic system with $a = 8{\cdot}34$, $b = 6{\cdot}18$, $c = 25{\cdot}0$ A.; $\beta = 115{\cdot}8°$. The general planes are halved when $h + k + l$ is odd, and all the (*hol*) planes are halved. The space group is therefore C_{2h}^6 or C_s^4, but the analysis given below indicates the former. Each of the four molecules in the unit cell may thus be assumed to have the centre of symmetry permitted by the chemical formula. The centre of the reflected (or rotated) molecule might lie either half-way along the *a* or half-way along the *c* axis, but the strong reflections from the (035), (037), (0315), (0317), etc., conclusively indicate the latter alternative.

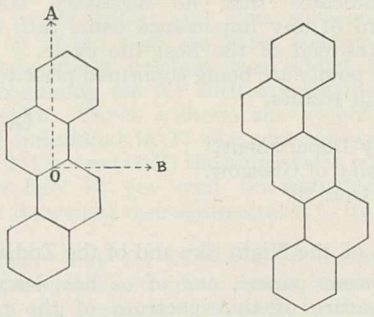


FIG. 1.

Assuming a planar molecule of the anthracene type (carbon to carbon distance, 1·41 A.), the following orientation has been found, which leads to good agreement between the measured and calculated values of about eighty structure factors. The long axis of the molecule *OA* (Fig. 1) is tilted about 10° away from the normal to the (001) towards the *c* axis, but remains practically in the plane of the (010), and the cross axis *OB* makes an angle of about 16° with the *b* axis of the crystal. The plane of the molecule is thus near to the $(20\bar{2})$ plane, which is found to give much the strongest reflection observed in the crystal.

1:2:5:6-Dibenzanthracene has a face centred pseudo-orthorhombic lattice, but the intensities of the (*hol*) reflections show that the system is really monoclinic with $a = 6{\cdot}59$, $b = 7{\cdot}84$, $c = 14{\cdot}17$ A.; $\beta = 103{\cdot}5°$. The only halving is the (010), so that the space group is C_{2h}^2 or C_2^2 with two molecules per unit cell. The strong tendency for the crystals to develop on the (001) plane in the form of very large thin flakes makes the accurate measurement of intensities a difficult matter, but the enhancement of certain orders such as the (0013), and some of the (*hk*6) and (*hk*7) reflections, together with the cell dimensions, are sufficient to show that the molecules again stand nearly upright on the (001) plane. Much the strongest reflection from the crystal is given by

the (020), showing that the planes of the molecules must lie near to this crystal plane. The structure is thus similar to chrysene if the *a* and *b* axes are interchanged. The detailed proof of these structures will be given later, but it may be noted that the results seem sufficiently good to justify the assumption of a regular plane hexagon structure for these molecules.

We are greatly indebted to Dr. J. W. Cook of the Research Institute, The Cancer Hospital (Free), for supplying pure specimens of these compounds, and to Mr. J. D. Bernal for some preliminary crystal data for chrysene.

JOHN IBALL.
J. MONTEATH ROBERTSON.
Davy Faraday Laboratory,
Royal Institution.
Oct. 13.

[1] Cook, Hieger, Kennaway and Mayneord, *Proc. Roy. Soc.*, B, 111, 455 ; 1932.
[2] Robertson, *Proc. Roy. Soc.*, A., 140, 79 ; 141, 594 ; 1933.

The following preliminary optical examinations have been made. Chrysene crystallised in monoclinic plates showing the forms (001), (110) and (100). There is a marked tendency to twin on the *c* face. (010) is the optic axial plane with γ making 10° to the *c* axis in the obtuse angle. The birefringence is very high and negative with a fairly large optic axial angle.

Dibenzanthracene occurs in ill-bounded plates apparently orthorhombic, but the crystals were not good enough to detect an error of less than 3° in the bisectrix direction. α lies along *b*, and γ nearly or quite perpendicular to (001). The birefringence is high, negative but with a large optic axial angle, 78°.

From these observations the orientation of the molecules would be predicted in both cases to be almost exactly similar to those arrived at quite independently by X-ray analysis.

J. D. BERNAL.
Dept. of Mineralogy
and Petrology,
Cambridge.

Foul Brood of the Honey Bee

BRITISH bee-keepers are much concerned at present by the spread of a disease of the larvæ of the honey bee known as foul brood.

Experiments which have already been published establish, without doubt, that the casual organism is bacterial ; but considerable difference of opinion exists in Great Britain as to the specific organism responsible.

In 1886 Cheshire and Cheyne isolated *Bacillus alvei* and claimed this to be the cause of foul brood. In 1906 White, in America, questioned this work and suggested that *Bacillus larvæ* was the casual organism and that *Bacillus alvei* was merely saprophytic. In spite of this, bee-keepers in England still hold that the organism isolated by Cheshire and Cheyne is pathogenic. No systematic work has been carried on in England to confirm or refute these statements and to clear up the confusion which exists.

Investigations, however, have been made in these laboratories over a period of two years, and an organism has been isolated from diseased larvæ having characters similar to those described for *Bacillus larvæ* by White. This organism is capable of producing foul brood in healthy bee larvæ and has been re-isolated from such larvæ after artificial infection.

So far, the experiments on the pathogenicity of *Bacillus alvei* have proved negative.

It is hoped that further work, now in progress, will definitely establish the causes of foul brood as found in England, and also devise methods of control.

C. H. CHALMERS.
WILLIAM HAMILTON.
Department of Agriculture,
The University, Leeds.
Oct. 13.

Vitamins and the Prevention of Abortion in Sheep

IN many areas in Scotland, abortion is very prevalent in ewes. This abortion seems to be due to some nutritional disorder. There is no evidence that it is either contagious or of bacterial origin. During last breeding season, 36 ewes were fed during the in-lamb period with a concentrate of vitamins A, D and E. The remainder of the flock, about 650 ewes, acted as controls. Normally, the abortion rate on this farm is about 20 per cent. Last season, owing probably to the exceptionally open winter, the abortion rate in the controls fell to 13 per cent. There was only one abortion in the 36 ewes in the experimental group.

The calculated value of P is 0·08, which indicates that there is a 1 in 12 chance of this difference in favour of the experimental ewes being a random one. Admittedly the number of animals treated was too small to give results of certain significance. It is considered sufficiently suggestive, however, to warrant a repetition of the experiment on a larger scale during the forthcoming breeding season.

The work was done in collaboration with Mr. A. L. Bacharach, Chief Chemist, Glaxo Laboratories (Messrs. Joseph Nathan and Co., Ltd.), who prepared the vitamin concentrate and provided a supply of material sufficient to carry through the experiment.

H. DRYERRE.
Animal Diseases Research Association,
Moredun Institute,
Gilmerton, Edinburgh.
Oct. 19.

Oil Glands of Citrus Fruits as an Avenue of Infection

IN the course of certain inoculation experiments with *Penicillium digitatum* into freshly picked oranges through needle punctures, it was observed that occasional fruits failed to decay. Closer inspection of these fruits showed that the punctures had all been made between the oil glands, and that in no case had a single gland been ruptured.

Repeated experiments showed that both shallow and deep needle inoculations into oil glands caused from 80 to 100 per cent of the fruits to decay. Deep wounds between the oil glands rarely permitted infection, whilst with shallow wounds the degree of infection was negligible.

To test the toxicity of the oil alone towards the spores of some common orange-rotting fungi, a small quantity of oil, extracted by the sponge process from Valencia oranges, was placed in test tubes together with a heavy inoculum of spores. Duplicate series were held at constant temperatures of 39° and 67° F. Small loopfuls of the suspension were removed at intervals and spread on hardened prune agar in petri dishes.

The thin-walled spores of *Oospora citri-aurantii* and *Colletotrichum glœosporioides* were killed instantaneously by the oil at both temperatures. Spores of

Penicillium digitatum, however, germinated after about seven hours' but not after eight hours' treatment at 67° F. Germination was markedly retarded though not inhibited after fifty hours' treatment at 39°. *P. italicum* spores were affected in approximately the same manner as those of *P. digitatum*.

It does not appear to have been noticed previously that the oil glands of citrus fruits provide a favourable avenue for infection by *Penicillium*. That they do so further emphasises the necessity for the utmost care during the handling of citrus fruits.

G. R. BATES.

The British South Africa Company's
Citrus Experimental Station,
P.O. Mazoe, S. Rhodesia.
Oct. 12.

Zostera marina on Anticosti Island

DURING a short visit to Anticosti Island in August this year it was observed that considerable quantities of *Zostera marina* were washed up on the beach at Ellis Bay. On closer examination it was found that many seeds nearly ripe were present in the material. The conclusion seems warranted that in this area at any rate there are no symptoms of the plant dying off, whatever the cause may have been in other localities[1].

The species is mentioned as occurring on Anticosti Island in Macoun's "Catalogue of Canadian Plants", Part 4, published in 1888; it is also mentioned in Schmitt's "Monographie de l'Île d'Anticosti" published in 1904, as being present in Ellis Bay and several other places on the coast of the island.

J. ADAMS.

Central Experimental Farm,
Ottawa.
Sept. 28.

[1] NATURE, 132, 277, Aug. 19; 483, Sept. 23; 1933.

Characteristic Intervals of English Vowels

IN an experimental research conducted in 1928 in collaboration with H. D. Bouman[1] I was chiefly concerned in verifying by a suitable method of synthesis the frequency values determined by Sir Richard Paget as representing the 'double-resonances' of English vowels. The experimental technique we employed consisted of two oscillating circuits which were put in parallel and produced a compound sound in a loud-speaker.

The chief results we obtained may be summarised as follows:

(1) The 'frequency-couples' determined by Sir Richard Paget produce effectively, when combined in a loud-speaker, quite satisfactory vowels.

(2) The vocal quality depends not only upon a particular combination of two characteristic tones but also implies a definite ratio of their intensities.

I attempted, in 1932, to make a similar study in French vowels. As previously, the starting point of the research were the resonance frequencies of these vowels determined by Sir Richard Paget and published in his book "Human Speech"[2].

In this research[3] some other aspects of the structure of vowels were brought to light. It was shown, for example, that each vowel is founded upon a definite musical interval, that is, that the two resonance frequencies must fall exactly in the harmonic series of tones; an attempt was made, besides, to transpose the characteristic vowel-intervals in different regions of the tonal scale. It could be demonstrated that all vowels may be 'transposed' for a range of two or one and a half octaves. The ratio of intensities varies, however, with the tonal region.

It seemed worth while, therefore, to test once more the resonances of English vowels in the light of these facts. The experiments which were carried out gave full confirmation of previous results.

In several cases the vocal quality of transposed 'chords' appeared uncertain when appreciated in comparison with natural speech. Yet, as regards 'transposing', it might be argued that the chords thus produced should be compared between themselves and envisaged in the first place as instances of particular 'timbres'.

The following table gives the corresponding interval for each vowel, the normal or resonance frequencies and the lower as well as the higher limit on the tonal scale for which the transposition was made:

/eat/	3 octaves + second	300–2700		350–3150
/it/	2 octaves + sixth	350–2333	326–2173	500–3333
/hay/	2 octaves + third	430–2150	300–1500	600–3000
/men/	2 octaves	500–2000	430–1720	700–2800
/hat/	1 octave + fourth	700–1866	500–1333	1256–3339
/earth/	1 octave + dim. seventh	500–1750	400–1400	1086–3301
/sofa/	1 octave + maj. third	600–1500	326–815	1256–3140
/up/	small seventh	720–1296	600–1080	1256–2260,8
/calm/	diminished seventh	800–1400	600–1050	1256–2148
/not/	major sixth	700–1166	600–1000	1256–2093
/all/	minor sixth	600–960	500–800	1256–2009,6
/who/	seventh	400–750	372–697,5	700–1312,5
/put/	1 octave + fourth	390–1040	326–869	600–1600

The experimental data above stated enable one to draw the following conclusions:

1. The vocal quality bears no relationship to absolute tonal pitch. The 'timbre' of vowels is likely to depend (approximately as that of instruments) upon the ratio of intensities presented by partial tones which occupy in the harmonic series relative but constant positions.

2. Any vowel is primarily characterised by a constant interval between two tones corresponding in natural speech to front and back resonances.

3. The double-resonance theory as worked out by Sir Richard Paget receives a satisfactory corroboration.

P. KUCHARSKI.

Laboratoire de Physiologie
des Sensations du Collège de France,
Paris.
Oct. 11.

[1] H. D. Bouman and P. Kucharski, Synthèses de voyelles au moyen de deux sons simples, *Arch. Neerl. de Phonetique experimentale*, Tome 4, 1929.
[2] Sir Richard Paget, "Human Speech", London, 1930.
[3] P. Kucharski, Recherches sur la structure des voyelles, *C.R.*, 195, 979; 1932.

The Sycamore Fungus

IN NATURE of September 9, I noted that I had failed in July to find a single spot of *Rhytisma acerinum* on the foliage of sycamores at Corrour in Inverness-shire. Never having hitherto found sycamores free from the characteristic blotches caused by this fungus, I suggested that if *Rhytisma* is disseminated by wind-borne spores, the sycamores at Corrour might owe their escape from infection to the altitude of 1,200–1,400 ft. at which they are growing, besides being far distant from any other woodland.

Since I wrote, however, the fungus has developed on the leaves of a few of these sycamores in September, leaving the problem of the means of its dispersal still unsolved.

HERBERT MAXWELL.

Monreith.

Research Items

Zande Blood-Brotherhood. Prof. E. E. Evans-Prichard describes in *Africa* for October the institution of blood-brotherhood and the ritual of the pact among the Azande of the Nile-Welle Divide. In pre-European days a man did not enter lightly into blood-brotherhood, as his kin, as well as himself, were bound by its obligation. Only rarely was the pact made between the sexes, and then only in the case of a favourite and well-beloved wife. It was made for various reasons, of which one of the most important was commercial. When travelling in a foreign country a man would make a pact of blood-brotherhood with a native, who would then become responsible for his safety. It might also be made when there was no personal danger, but a man had difficulty in obtaining luxuries plentiful in distant districts. Generally, however, it was made with neighbours, not only for protection or to secure favourable economic conditions, but also for a variety of reasons. Chiefs did not as a rule enter into blood-brotherhood pacts. The ceremony is a typical magical rite. It does not support the view of those who hold that in blood-brotherhood the blood represents the unity of the clan, and its exchange the means by which a stranger enters into a psycho-physical kinship with the clansmen. Nor does it support those who hold that it is a form of homœopathic magic, depending on the sacred nature of the blood itself. Rather it lends itself to the theory that it is the vehicle of a 'conditional curse'. In Zande society, kinship is not thought of primarily in terms of blood-relationship. The tie is not dependent on the fact that by drinking a man's blood you have become one of his kin, but on the fact that his blood is a concrete magical substance, impregnated with a spell embodying a 'conditional curse'.

Philippine Alcyonaria. In the January and April numbers of the *Philippine Journal of Science*, vol. 50, Nos. 1 and 4, 1933, Prof. Hilario A. Roxas of the University of the Philippines, Manila, describes in detail a large number of alcyonarians belonging to the families Cornulariidæ, Xeniidæ, Alcyoniidæ and Nephthyidæ based on littoral material collected from various parts of the Philippine Archipelago. The work was carried out under the joint auspices of the University of the Philippines and the John Simon Guggenheim memorial foundation, the author having worked in Europe whilst comparing his extensive collections with those already in Breslau and Berlin. The family Xeniidæ is peculiarly interesting. Prof. Roxas has adopted a uniform method for studying and preserving the members of this specially difficult group. The animal, and, if possible, the piece of stone to which it is attached, is lifted carefully and placed in a blue pan with a sufficient amount of sea-water to cover it. Its colour, the general conditions of the tentacles and pinnules, such as their shape and extent, are studied. The animal is then transferred to another pan and anæsthetised by the use of a gradually dissolving bag of magnesium sulphate. When it is fully expanded and shows no sign of capacity to contract, it is transferred to a 10 per cent solution of formalin in sea-water. Further study is made in the laboratory. By this means errors arising from the difference in state of contraction of the tentacles and pinnules (which are of taxonomic value) are eliminated to a great extent. *Heteroxenia*, being very common, was studied in special detail as the existence or non-existence of polyp dimorphism in the genus has been much discussed. Seven new species are described besides the well-known *Heteroxenia elizabethæ*, Kölliker. All these show distinct dimorphism.

Suppression of Crossing-Over in Male *Drosophila*. Studies of spermatogenesis in *Drosophila* have been chiefly remarkable for the lack of precision in the results, apparently owing to technical difficulties with the material. Various attempts have been made to find a cytological explanation for the lack of genetical crossing-over in the males. Dr. P. Ch. Koller and Miss Thelma Townson (*Proc. Roy. Soc. Edin.*, vol. 53, pt. 2) have studied the spermatogenesis of *D. obscura*, which has five pairs of chromosomes, the *X* being *V*-shaped with two long arms. They show that the spermatogonial chromosomes are rather closely paired, and conclude that races with attached *X*'s arise at this time through fusion of the two terminal attachment constrictions. They find that in *D. obscura* the homologous chromosomes enter the meiotic prophase already associated at their proximal ends, and that during the heterotypic prophase the chiasmata or loci of association gradually move towards the distal ends. They conclude that cytological crossing-over takes place (although the evidence for the occurrence of chiasmata is not very certain), the homologous chromosomes being finally associated at metaphase only by their distal ends. To explain the absence of genetical crossing-over, it is assumed that this takes place only between the genetically inert portion of the *X* and the *Y*. The inert part of the *X* is near the spindle fibre attachment, which is median in *D. obscura* and terminal in *D. melanogaster*. It therefore seems, on the whole, more likely that the failure of crossing-over in all chromosomes of the male is due to a gene, as similar genes are now known in other organisms.

Canadian Helminths. W. E. Swales (*Canadian J. Research*, vol. 8, No. 5, May 1933) contributes a list of parasitic worms which have been recorded from economically important mammals and birds in Canada, and adds a list of the species which he has found in horses, cattle, sheep, swine, domestic and game birds and in a few miscellaneous hosts. A few cestodes, additional to those in these lists, are recorded from lambs, dogs and cats by Wardle in the same journal for April 1933.

Hot Water Treatment of Narcissus Bulbs. The ravages of eelworm upon many bulbs, particularly narcissus bulbs, are very severe, and are not generally combatted effectively by English growers. In order to effect control, the bulbs must be placed in water, raised to a temperature between 110° and 112° F., and maintained for three hours. There has been some tendency to shorten the treatment, following the publication of a paper by Mr. L. N. Staniland, who showed that the eelworms could be killed by about 80 minutes' exposure to a temperature of 112° F. A paper by Mr. R. J. Hastings, in the *Gardeners' Chronicle* of October 21 ("Treatment of Narcissus Bulbs with Hot Water", pp. 313–314) shows that Mr. Staniland was working with a strain of nematodes very susceptible to heat-inactivation. Mr. Hastings' eelworms were not definitely killed

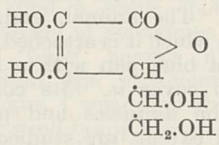
by 150 minutes' exposure to a temperature of 112° F. This demonstration of the existence of various strains of eelworm is of importance to gardeners, who must use the full three hours' sterilisation, if the practice is to be successful.

The Ice Age in Northern Labrador. In a paper in the *Geographical Journal* of September and October on the mountains of Northern Labrador, Mr. N. E. Odell has some important observations to offer on the thickness of the Pleistocene ice sheet. In the Torngat and Kaumajet Ranges, rounded summits with a covering of rock debris suggest an escape from ice planation and have been held to represent nunataks that stood above the ice and may have been the refuge of a pre-glacial flora. Mr. Odell believes, however, that the atmospheric weathering that has given rise to the characteristic appearance of such peaks does not necessarily entail a time longer than the post-glacial period. He argues that this weathering is fairly rapid on high ground near the sea with ample moisture-laden winds in a region of intense frost action. He cites a similar effect on certain Spitsbergen peaks. In partial confirmation of his contention was his discovery of ice-polished surfaces at 4,700 ft. in the Central Torngats, which is some three thousand feet above what is generally believed to have been the maximum ice-level. Rounded surfaces were found also on one of the highest summits of the Kaumajet Range. The existence of a 250-ft. raised beach at Nachvak is further confirmatory evidence of the heavy ice load of the region in the past.

Thunderstorms in South India. A contribution to the study of the climates of India is to be found in a paper by S. P. Venkiteshwaran entitled "Thunderstorms in South India during the Post-Monsoon Months, October and November, 1929" (*Sci. Notes India Meteorol. Dept.*, 5, No. 52). This can be regarded as a continuation of an earlier study by the same author dealing with the thunderstorms of the pre-monsoon months of April and May (4, No. 44). The season dealt with in the paper under review is that in which a large part of south India excluding the west coast receives most of its annual rainfall, during the retreat of the monsoon. The average number of thunderstorms exceeds ten in both October and November over a large proportion of the area, but the main subject of inquiry is not so much a statistical study of their distribution, as an attempt to explain their mode of occurrence, making full use of the data provided by self-recording meteorological instruments, and by all information available about the upper winds in these months. Maps are shown giving the mean lines of flow over India generally for each month at heights of 1, 2 and 3 km., based on the results of pilot-balloon ascents, and also the lines of flow on a number of individual occasions, with the corresponding rainfall during the following 24 hours. The principal difference between the pre-monsoon and post-monsoon conditions appears to be that in the latter the moist air has had a long trajectory over the Bay, being part of the circulation round a low pressure area over the southern part of the Bay, while in April and May air at the same levels tends to be drawn over the land from the Arabian Sea.

The Ionosphere. In a discussion held by the Royal Society on June 22 (*Proc. Roy. Soc.*, A, Sept. See also NATURE of July 1, p. 13), Prof. E. V. Appleton gave a general account of the ionised layers of the upper atmosphere as revealed by wireless wave exploration. The methods used consist in projecting waves into the upper atmosphere and observing the group-time of flight of the waves up and down, the polarisation and intensity of the downcoming waves. The method reveals a layer for which the group-time corresponds to a height of about 100 km. (*E* layer). Shorter waves penetrate this and may be reflected from the *F* layer at about 180 km. There may also be an intermediate reflecting region. The maximum ionisation in the *E* region occurs about local noon; that in region *F* probably a little later. Experiments made with an automatic recorder show an occasional nocturnal increase in *E* ionisation which is correlated with magnetic disturbances. Eclipse measurements show that the normal ionising agency is ultra-violet light from the sun; the formation and disappearance of the charged particles was discussed by Prof. S. Chapman. Prof. C. T. R. Wilson pointed out the possibility of ionisation by electrons escaping from the top of a thundercloud and bent in the earth's magnetic field, and Mr. R. A. Watson Watt has observed sudden increases in *E* ionisation in the summer and particularly during local thunderstorms. Prof. F. A. Lindemann pointed out the difficulty in correlating geophysical and ionospheric phenomena, due to the fact that the group velocities of the wave-trains are quite unknown, and the equivalent heights cannot therefore be connected with real heights. The probable occurrence of very anomalous velocities is shown by the wireless echoes of several seconds delay which have been observed from time to time.

Constitution of Ascorbic Acid. A crystalline substance of the formula $C_6H_8O_6$, discovered in 1928 by Szent-Györgyi and called hexuronic acid, was found to possess strong antiscorbutic properties, and hence the name was changed to ascorbic acid. Much evidence has accumulated on the relationship between ascorbic acid and the antiscorbutic factor (vitamin C), and the view is held by many workers that ascorbic acid is vitamin C in a pure crystalline condition, although the biological problem is one of great complexity and the claim that ascorbic acid is to be regarded as the only antiscorbutic agent must be accepted with caution. Herbert, Hirst, Percival, Reynolds and Smith (*J. Chem. Soc.*, Sept.) now describe experiments which are held to show that ascorbic acid does not contain a carboxyl group, its acid properties being due to an activated $-CH.OH$ group adjacent to a $-CO-$ group, giving a reactive group of the type $-C(OH):C(OH)-$. A study of the oxidation of the substance led to interesting results, and with other evidence recorded in the paper, lead the authors to the conclusion that ascorbic acid has the structural formula:



The substance may, however, react in more than one tautomeric form. Important evidence in favour of this structure is furnished by X-ray results (Cox, NATURE, 130, 205, Aug. 6, 1932), which show that it possesses a very flat molecule. The structure proposed shows that of the total of 12 carbon and oxygen atoms, all but one can be accommodated in one plane without appreciable valency strain, whilst the remaining carbon atom lies less than 1 A. above the plane.

Organisation of Agriculture*

IT used to be said that the greatest public benefactor was the man who could make two blades of grass grow where one grew before. Not so to-day, when the nations are considering agreements to restrict output and even destroying the products of the soil. The man of science must take up an apologetic attitude at the present time with regard to agriculture. For two generations he has been entreated to make the land more productive and to reduce costs; but as an American professor of agriculture writes to me: "Ten million acres of cotton and some thousands of tobacco have been ploughed under. The latest move is the killing of some 5 million pigs weighing under 100 lb. and the slaughter of some 200,000 prospective mother sows. If this will bring national prosperity I have wasted my life." The man of science may be forgiven if he concludes that he is no longer wanted and may retire to his ivory tower, but whatever food for irony the world spectacle presents he will not be allowed to enjoy it in detachment, for if the deluge comes he will be swept down with the rest.

I propose to inquire a little into the causes of this paradoxical situation. In the first place, the agriculture of the world is predominantly a peasant industry. In Great Britain, we have developed in such an exceptional fashion, for only 6·6 per cent of our workers are engaged on the land, that we do not always realise how much we stand apart. But in France 41 per cent, in Germany 34 per cent, in Czechoslovakia 40 per cent, in Poland 76 per cent, in the United States 26 per cent are so occupied. At the extremity of the scale, in the East, the proportion of the population engaged upon the land may rise to 80 per cent, and in large districts in China even to 90 per cent. Taken alone, these figures do not tell the whole story; more significant is the fact that they are mostly made up of single-handed independent occupiers of land, employing only their own labour and that of their family. In all the European countries except Holland, the independent holders of land outnumber the paid labourers.

The typical English farm is one of about two or three hundred acres carrying half a dozen or so hired labourers. There are, of course, capitalist farms, often of large size, in all countries, as for example the great demesnes of eastern Europe, though the whole trend of policies since the War has been to break these up into single family units.

The advent of science has enormously strengthened the economic position of large-scale capitalist farming, particularly the recent progress in power machinery, of which the full effects have not yet been realised. Efficiency of production has advanced to a degree difficult of estimation; indeed, were agriculture, like any other industry, governed only by the free play of competition in the pursuit of profits, the family farm would long ago have been displaced. But two opposing factors have been at work; in no old settled country is land a free commodity; custom, even law, tends to perpetuate the old divisions of the land, and the capitalist can rarely buy an area for extensive farming as he can buy a factory site. Despite the increased use of machinery, manual labour is still a large factor in agricultural production; the capitalist has to pay for labour, but the peasant does not count his long hours or the assistance of his wife and children.

A century ago the factory did not all at once displace the hand loom, and in the case of agriculture the solitary worker has the additional advantage in the struggle that he is at least producing food for his family. But the final outcome cannot be in doubt; organisation with capital, power and science at command, in other words the machine, must win, provided free competition is allowed to rule.

State organisation of agriculture in some form has become inevitable; many branches of farming in Great Britain would perish if they were not 'nursed'. The question remains, what form shall the organisation take?

We have one example before us in the Russian plan. This represents what we might call an engineer's lay-out to obtain maximum efficiency of production from the land, given a perfectly clean sheet as to land, labour and capital, without any hampering conditions other than those imposed by soil and climate. It is the method of industrial exploitation such as we see at work in some of the great farms of the United States and of tropical countries, raised to a higher power, from thousands to millions of acres, by the all-controlling State organisation. Its aim is to secure from the soil the food and other raw materials required by the nation by the minimum employment of man-power, made effective by the application of science and machinery, thus liberating the greater proportion of the labour hitherto so employed for other forms of production which will add to the real wealth of the community. It demands for its realisation a wealth of directive skill and a technique of national organisation which only began to be attempted during the War. It necessitates a social revolution which no other country is prepared to carry through.

What alternatives are there, methods that will give play to economic efficiency and yet be tender of the initiative and enterprise of the individual? Can we eventually transform the social structure of the countryside without beginning by breaking it? In the organisations that have been set up to bring the producers of each commodity into selling corporations, we see the beginnings of such a system. It is perhaps not generally realised how fundamental a change in the conduct of the agricultural industry of Great Britain has been wrought by recent legislation. Provided a certain proportion of the producers of a given commodity demonstrate their case to the Minister of Agriculture, he can give to their combination a monopoly of the right of sale; no producer outside the combination may sell to the public, all the members of the combination must sell through it. These powers of combination and control can be extended to any intermediary manufacturing process intervening between the producer and the retailer; prices will be fixed and production regulated by the limitation the corporation will put on the amounts it will sell for each producer. The power to determine internal prices will ultimately depend on the regulation of the volume of imports and the duties that are to be imposed. The Government has undertaken to apply one or other of these measures as a necessary part of the new policy to stimulate home production. The

* From the Alexander Pedler lecture of the British Science Guild delivered before the Cambridge Philosophical Society by Sir Daniel Hall, K.C.B., F.R.S., on November 6.

object is to ensure stable prices, no longer subject to the devastating influence of foreign competition, often forced and illegitimate. In brief, producers and processors of any agricultural commodity can now form a guild, which will be endowed with a monopoly, and directly or indirectly will exercise complete control of all production for sale.

The organisation aims at removing the great criticism that can be levelled against the agricultural community, that its average practice is much below the performance of the best farmers. In future, if a farmer is to sell pigs at all he will have to forgo many of his preferences for particular breeds or methods of feeding, and to bring forward pigs that have been bred and fed on the lines laid down by the corporation, on instructions that are the outcome of knowledge and experiment. Hitherto such knowledge, in so far as research has made it available, has been left to permeate by means of advice, but the results have always been slow and imperfect because the economic advantage of the improved method is generally of an order that is easily obscured by the accidentals of farming, especially as accurate recording has not been common practice. Such a co-operative but controlled organisation is the only one I can see that can compete with the Russian plan of complete unification of the industry, and at the same time retain the essential freedom of the individual.

Such corporations will be able and, if they are to be acceptable, will have to enforce certain reformations in their particular industry which may not be of any great profit to the farming community but may be required by the consumers. To state one such case, it is possible to free the dairy herd of the country from bovine tuberculosis, which would not only mean greater safety to the health of the general population but also would cheapen the production of milk by reducing one of the considerable items of cost—the relatively short life of the average dairy cow. In so far as the milk producers as a body have to be paid for the costs of production, whatever they may be, no gain to them would accrue by the elimination of tuberculosis; the new cheapness would be passed on to the consumers. The controlling corporation, which must consider the interests of the general public because from them it derives its monopoly and price-fixing power, can embark upon such a scheme. It can take the long view and adopt a scheme which despite its prime cost will ultimately both cheapen and improve the product.

It is indeed a necessary part of the new system, if these corporations are to become efficient elements of the national economy, that there should be some superior organisation planning and directing their work in the national interest. Otherwise the corporations may easily degenerate into guilds concerned only in maintaining a price-level that will enable their members to carry on automatically on the old lines. It would be for this central body, personified in the Minister of Agriculture, to decide which branches of the agricultural business in Great Britain should be encouraged to develop and which should be subjected to the brunt of economic pressure, whereby they would be either transformed or abandoned. To take an example, it is inevitable that there will be, in the future as in the past, strong pressure from an important section of farmers to maintain a remunerative price for wheat. Now while wheat may be almost a necessary element in the current rotation on certain types of English soil, it should be regarded as a by-product rather than as the main object of the farming system. For our farming can and should pick and choose, specialising upon the higher grade products rather than on the primary commodities like wheat. Considering the ratio that our land fit for cultivation bears to our population, we cannot be self-supporting as regards food, except at fantastic cost or by reducing excessively the standard of living. In Western agriculture as at present carried on, two acres and upwards of land are employed in producing the food, etc., consumed by one unit of the population. Since in round figures the cultivated area in Great Britain is only 45 million acres, to provide for an approximate population of 45 million, it will be seen that the land available is far from sufficient except under an intensification of production that is impracticable.

The fundamental truth is that, whatever may be the increased efficiency of production that science has put at man's disposal, it will be still insufficient to satisfy the reasonable demands of the population, when each in turn is producing some commodity that can be freely exchanged. It is precisely in this difficulty of exchange that the plight of the agriculturist resides, all the world over, and if we take a world point of view, we see that agriculture cannot lift itself out of its depression by its own efforts. Farmers are the primary producers, the first sellers in the chain of commerce, but they are waiting upon a renewal of the power to buy on the part of their customers, that is, the industrialists and the people at large. Whatever may be our power to revive British agriculture, because within our borders there is such an immense margin between our actual production and our consumption, yet world agriculture cannot revive until the wheels of international trade begin to go round more freely.

Combustion of Hydrocarbons

AS the outcome of much controversy towards the end of last century, former erroneous notions of a preferential burning whether of hydrogen or of carbon in hydrocarbon combustion were finally overthrown and the way opened for new interpretations of the mechanism of the process; and more particularly for one, originally suggested by H. E. Armstrong so far back as 1874, namely, that its successive stages involve the transient formation of unstable hydroxylated molecules which, according to circumstances, decompose more or less rapidly under the influence of heat, giving rise to simpler intermediate products, and finally to steam and oxides of carbon.

As was shown by Prof. W. A. Bone in a public lecture arranged by the Chemical Society and delivered at the Royal Institution on October 19, this view has been substantiated by the results of the systematic researches of his collaborators and himself upon the slow combustion of hydrocarbons (but chiefly methane, ethane, propane, ethylene and acetylene) from 1898 up to the present day. These

have proved the successive intermediate formation of alcohols, aldehydes and acids, as for example, with methane, methyl alcohol, formaldehyde and formic acid; with ethane, ethyl and methyl alcohols, acet- and formaldehydes, acetic and formic acids; and with ethylene, vinyl alcohol (and its isomers ethylene oxide and acetaldehyde), formaldehyde and formic acid. Pressure so favours the stabilisation of the mon-hydroxy product (that is, the alcohol) that at high pressure it can easily be isolated in quantity from among the oxidation products. The latest development in this connexion is the recent isolation of vinyl alcohol as the initial product of the oxidation of ethylene, together with the proof of its undergoing reversible transformation into its isomers, ethylene oxide and acetaldehyde, in such wise that there results a triangular equilibrium between them, the relative proportion of the three isomers depending on temperature and pressure.

Passing on to the subject of explosive combustion, Prof. Bone said that although the conditions prevailing in hydrocarbon flames and explosions are obviously much more complex than those of slow combustion, the experimental evidence strongly supports the view that the result of the initial encounter between hydrocarbon and oxygen is the same in both, namely, the formation of a hydroxylated molecule. Undoubtedly, at the high temperature of flames, secondary thermal decompositions set in at an earlier stage, and play a more conspicuous rôle, than in slow combustion, but they do not precede the onslaught of the oxygen upon the hydrocarbon, but arise in consequence thereof. Moreover, it seems probable that in explosive combustion, whenever the oxygen supply suffices, there is, so to speak, a 'non-stop' run through the *mon-hydroxy* to the *di-hydroxy* stage before thermal decomposition sets in; albeit, in default of such oxygen sufficiency, more or less decomposition at the mon-hydroxy stage would occur.

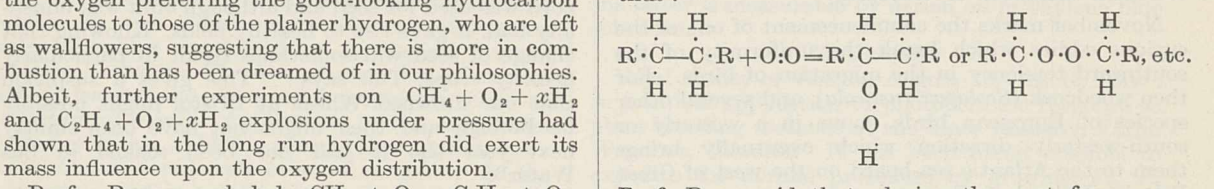
Prof. Bone elaborated this view and demonstrated experimentally its applicability to the explosive combustion of all known gaseous hydrocarbons. First of all, he showed some striking explosions of $C_2H_2 + O_2 + 2H_2$, $C_2H_4 + O_2 + H_2$, etc., mixtures, proving, from the fact that in neither case does carbon separate nor any steam condense on cooling, owing to the hydrocarbon practically monopolising the oxygen in burning to carbonic oxide and hydrogen, how vastly greater is the affinity of a hydrocarbon than that of hydrogen for oxygen in flames. Such results are practically unaffected, Prof. Bone said, by dilution of the explosive media with an equal volume of helium, argon or nitrogen respectively. At first sight it might seem to be scarcely a question of kinetics at all, but rather one of ballroom tactics, the oxygen preferring the good-looking hydrocarbon molecules to those of the plainer hydrogen, who are left as wallflowers, suggesting that there is more in combustion than has been dreamed of in our philosophies. Albeit, further experiments on $CH_4 + O_2 + xH_2$ and $C_2H_4 + O_2 + xH_2$ explosions under pressure had shown that in the long run hydrogen did exert its mass influence upon the oxygen distribution.

Prof. Bone exploded $CH_4 + O_2$, $C_2H_6 + O_2$, $C_2H_4 + O_2$, $C_2H_2 + O_2$ mixtures in stout glass vessels, showing that the behaviour of each fulfils the 'hydroxylation' theory. The behaviours of olefines and paraffins on exploding with proportions of oxygen corresponding with $C_nH_{2n} + \frac{n}{2}O_2$ and $C_nH_{2n+2} + \frac{n}{2}O_2$ (that is, with just sufficient oxygen in each case to burn the carbon to carbonic oxide leaving the hydrogen intact) are quite different. For whereas the olefines yield substantially carbonic oxide and hydrogen only, without any carbon deposition—as though by a preferential combustion of carbon—the paraffins yield abundance of carbon, methane, hydrogen and steam as well as oxides of carbon. Such behaviours are, however, quite in harmony with the hydroxylation theory.

Another remarkable feature of the explosion of olefine-oxygen mixtures was demonstrated by exploding the mixtures $3C_2H_4 + 2O_2$, $C_3H_6 + 1\frac{1}{4}O_2$ and $C_4H_8 + 1\frac{1}{2}O_2$, each containing less oxygen than the $C_nH_{2n} + \frac{n}{2}O_2$ proportion. Whereas with the last-named little or no steam is produced on explosion, both separation of carbon and condensation of steam now occur, showing that when the oxygen present is inadequate to eliminate *all* the postulated $:CH_2$ units as $H_2 : C : O$, a breakdown must occur of a $CH : CHOH$ complex, with production of both steam and carbon.

Prof. Bone then referred to an important new discovery concerning the influence of pressure upon the spontaneous ignition of hydrocarbon-air mixtures made by Dr. D. T. A. Townend in his laboratory which has a direct bearing upon the problem of 'knock'. So far, experiments have comprised the explosive ranges of *n*- and *iso*-butane and *n*-pentane and are being extended to other hydrocarbons. It has been discovered that as the pressure is progressively raised from 1 to 15 atmospheres in each case, the observed ignition temperatures fall into two well-defined groups separated by a temperature range in which no ignition points occur. Transference of an ignition point from the higher to the lower groups occurs at a definite critical transition pressure which varies slightly with the composition of the mixture; moreover, the presence of an 'anti-knock' compound at pressures near the critical transition pressure effects a transfer of the ignition point from the lower to the higher group. The phenomenon is probably connected with the influence of pressure on the stability of some one or other of the oxygenated compounds intermedially formed.

In concluding, Prof. Bone stated that as the outcome of a vast amount of experimental work embracing every condition between slow combustion and detonation, and including pressures between $\frac{1}{3}$ and 100 atmospheres, the cumulative weight of evidence leaves no doubt in his mind that 'hydroxylation' affords the best general view of the normal course of hydrocarbon combustion. In recent years, however, there has been much talk of the initial association of hydrocarbon and oxygen resulting in a 'peroxide' rather than an hydroxylated molecule, thus :—



Prof. Bone said that, during the past four years, he and his colleagues have sought diligently but wholly in vain for experimental evidence of such initial peroxide in the slow combustion of methane, ethane, propane and ethylene; and although unmistakable signs of secondary 'peroxidation' of aldehydes

have been found, there have been none of any primary peroxidation of the hydrocarbon itself. Thus, in the case of a $2C_2H_4 + O_2$ mixture at 300° C., no trace whatever of peroxide during the induction period was found, although aldehyde was always discernible; in the subsequent 'reaction period', no peroxide appeared until after there was a fair accumulation of formaldehyde, and it disappeared before the end of the experiment while free oxygen was still in the system. The conclusion that such peroxide formation is an accidental rather than a normal and constant feature has been strongly reinforced by the high-pressure oxidation experiments, for while alcohols, aldehydes and acids in large quantities have been isolated, no trace of peroxide has ever been detected. Finally, it can be urged against the 'peroxidation theory' that in slow combustion of hydrocarbons the most reactive mixture is not the equimolecular, but that in which the hydrocarbon-oxygen ratio is 2 : 1. With higher hydrocarbons than those referred to, the series of changes involved is more complex and there is more room for side reactions of all kinds, some of which may involve incidental 'peroxidation' especially of aldehydes. Prof. Bone thus rejects the 'peroxide' theory as applied to the main and normal course of hydrocarbon combustion, although he does not exclude incidental peroxidation of intermediate products. As regards 'knock', he thinks that nothing as yet has been really proved.

Calendar of Nature Topics

Alpine Winter

In the Alpine winter health resorts, the permanent snow cover at moderate heights of a few thousand feet usually forms about the middle of November, though above 7,000 ft. snow lies most years in October. This marks the beginning of the famous Alpine winter. At this season, a long tongue of high pressure extends from the Siberian anticyclone across Russia to Switzerland, the sky is generally clear, while such clouds as do form are at a low level. The higher resorts are above the clouds and are bathed in sunshine throughout the day. Owing to the decreased pressure at high levels and the dryness of the air, the intensity of the sun's rays is very great, and their power is increased by reflection from the dazzling snow surface. The keen bracing air and bright sunshine make the climate at this season very attractive for winter sports. The snow cover begins to disappear in March at the lower levels, but at a height of 7,000 ft. it lasts well into June.

Westward Movement of Woodcock

November marks the commencement of one of the curious eddies which break the uniformity of the southward tendency in the migration of birds. For then woodcock (*Scolopax rusticola*), and several other species of European birds, move in a westerly or south-westerly direction which eventually brings them to the Atlantic sea-board on the west of Great Britain, Ireland or France.

Aberdeenshire woodcock have been found in Northern Ireland, and Einar Lönnberg has shown that individuals ringed in Sweden move westwards to the British Isles or France (Proc. Seventh Internat. Ornith. Cong., 1931, p. 389). Most often the journey is directly across the North Sea, for large numbers of drowned woodcock were seen floating between Norway and Hull after a storm towards the end of November 1928. But occasionally the records suggest that secondary movements carry the birds by less direct routes. The records also suggest that the migratory movement in November starts with young woodcock, and that old birds linger longer, even into December, in Sweden. It has been noted, both in southern and in mid-Sweden, that ringed birds have returned in following seasons to the area where they were born and in some cases even to the very place of their birth.

Beet Tops

Passing through the eastern counties of England at this time of year, one sees field after field strewn with beet tops after the roots have been delivered to the factory. Regarded in the early days rather as an encumbrance, beet tops have gradually taken their place as an essential feeding stuff on arable farms in this area. In a good growing season with a generous nitrogen supply, the tops almost equal the roots in weight, and on rich fen land 20 tons or more of green stuff per acre is not uncommon. Owing to the long summer drought, however, the crop of leaves and crowns will be considerably less than usual this year. Skilful use of this by-product has enabled farmers to devote much of their root land to a cash crop and at the same time maintain their usual head of stock. Certain precautions must be observed in feeding the tops, for fresh beet leaves are liable to contain oxalic acid, and poisoning may occur if large quantities are consumed. If the leaves are allowed to wilt, the quantity of acid is reduced to a harmless amount, and as a further safeguard a small amount of chalk may be fed which renders the remaining acid inocuous.

Any tops not utilised are ploughed in as green manure, when the considerable nitrogen and mineral content of the leaves is returned to the soil. The sugar contained in the crown, while accounting for much of the feeding value, somewhat delays the action of the manure by immobilising temporarily a corresponding amount of quick-acting nitrogen.

Seed Borne Diseases

The pickling of seed wheat against bunt is a very old practice. The early method of soaking the seed in brine is said to have arisen through the observation that wheat damaged by sea-water usually gave a crop very free from smut when used for seed. Jethro Tull in his well-known book "Horse Hoeing Husbandry" (1733) in discussing this question, quotes the case of a cargo of wheat sunk at Bristol. The corn was used for seed and although bunt was unusually bad, it gave rise to healthy fields. Knowing that change of seed will sometimes result in particularly healthy crops, Tull says: "This gives a suspicion that our drowned Wheat at Bristol might possibly be Foreign and then might not have been smutty next year tho it had not been soaked in Sea Water".

Much of the seed of winter cereals now being sown will be delivered to farmers ready treated with one of the newer organic mercurial dusts as a protection against fungus infection carried on the outside of the grain. Bunt of wheat and leaf stripe of oats are two diseases in question. They may be controlled

by wet treatment of the seed with copper sulphate or formalin solution, but the dry dressings, being more handy to use, and lending themselves to large scale application at the source of supply, are steadily gaining ground. The use of the mercurial dusts forms a notable development in agricultural practice.

Societies and Academies

LONDON

Royal Society, November 2. J. GRAY and C. OUELLET: Apparent mitogenetic inactivity of active cells. A photoelectric counter of the Geiger-Müller type, sensitive to 50 quanta per cm.^{2} per sec. at 2500 A., failed to detect the emission of radiant energy (varying in wave-length from 1800 A. to 2800 A.) from the fertilised eggs of sea-urchins at any phase of their mitotic cycle. No radiation was observed from cultures of active spermatozoa or of growing yeast. Misleading results can be obtained if water vapour or other volatile material is allowed to condense on the surface of the counter. W. S. STILES and B. H. CRAWFORD: The liminal brightness increment as a function of wave-length for different conditions of the foveal and parafoveal retina. The eye was brought to a definite condition by viewing a known distribution of brightness in the visual field, made up of a small centre field of uniform brightness B surrounded by an area of uniform brightness B_s together with, at times, a bright spot of light 3° above the centre of the field. Concentric with the centre field, a small rectangular patch (0·7° × 0·16°) of monochromatic light of variable brightness was presented to the subject's view and the measurements consisted in determining the least brightness (U_λ) of this patch such that the subject could just detect its presence. The minimum brightness U_λ has been termed the 'liminal brightness increment' and in this work its value has been determined in absolute energy units for various wave-lengths λ throughout the spectrum. The results are expressed by plotting log $(1/U_\lambda)$ against λ for each condition of the eye studied and for foveal and 5°-parafoveal vision. The foveal and parafoveal curves of log $(1/U_\lambda)$ against λ obtained with the totally dark-adapted eye ($B = B_s = 0$), have the same shape as curves obtained under similar conditions by Abney and Watson; for wave-lengths greater than 0·62 μ, foveal and parafoveal values are nearly the same, but as shorter wave-lengths are approached the parafoveal value of log $(1/U_\lambda)$ becomes increasingly greater than the foveal value, that is, the parafovea becomes much more sensitive than the fovea.

PARIS

Academy of Sciences, September 18 (*C.R.*, 197, 605–624). S. MICHLIN: The fundamental biharmonic problem in two dimensions. ANDRÉ MARKOFF: Vectorial spaces considered as topological groups. JACQUES VALENSI: The law of variation of step of vortices leaving the vanes of a propulsive screw as a function of V/nD. Application to the calculation of the circulation, velocity, power. MARCEL SCHWOB: The electrical double refraction of camphor. In the liquid state and in solution in various solvents, the electrical double refraction of camphor is normal. The variation of the electric double refraction of camphor in solution in paraffin obeys Langevin's law. The nature of the solvent has an influence on the specific double refraction. ROGER DOLIQUE and ANDRÉ GRANGIENS: The two forms of phosphorous acid. Dubrisay's method of capillary analysis is applied to the problem. The experimental results are in agreement with the view that two forms of phosphorous acid exist in equilibrium. H. GAULT and L. A. GERMANN: Methylene-butanolone. C. V. GHEORGHIU: The ionic dissociation of the derivatives of 2.thiotetrahydro–1.2.3.4.quinazoline.

September 25 (*C.R.*, 197, 625–660). A. LACROIX: The potassic eruptive rocks, leucitic or non-leucitic, of western Tonkin. This series of rocks has a very special character, recalling that of certain regions of Montana. JEAN PERRIN: Remarks on the subject of neutrons. A discussion based on the view that the neutron is simple but not the proton, the latter being regarded as a complex $\omega\beta^+$, formed by the combination of a neutron ω with a positron β^+. Some consequences of this hypothesis are developed. EDGAR BATICLE: The problem of distribution. A. DEMOULIN: Some classes of W congruences. SILVIO MINETTI: The geometry of the holospace of holomorph functions in a given domain and its relations with the theory of ordinary differential equations. H. R. CRANE, C. C. LAURITSEN and A. SOLTAN: The artificial production of neutrons. Results obtained with a special form of discharge tube by means of which neutrons are artificially produced by bombarding beryllium with helium ions accelerated by a suitable fall of potential. G. A. BOUTRY: The influence of the aperture of the pencil utilised in the measurement of photographic densities. There are three definitions of photographic density in current use: the density in parallel light, density in diffused light and useful density; there is no experimental arrangement in use which can give measurements made under conditions rigorously corresponding to these definitions. The experiments detailed show why densitometers, utilising objectives of small and different apertures, do not give comparable results. H. HULUBEI and MLLE. Y. CAUCHOIS: The characteristic X-emission of elements in the gaseous state. The K-spectra of xenon (emission and absorption). ANDRÉ GIBERTON: A method for the colorimetric estimation of hydrogen sulphide, sulphide and thiosulphates. R. LEVAILLANT: The preparation of some esters of chlorsulphonic acid or of sulphuric acid. JACQUES FROMAGET: The presence of alkaline intrusive rocks in the Neotriassic drift zone in the limestone plateaux of western Tonkin. MME. Y. LABROUSTE: Contribution to the characterisation of magnetic agitation. PAUL WINTREBERT: Mosaic, regulation, epigenesis. FERNAND CHODAT and FERNAND WYSS-CHODAT: Dehydrogenases during staphylolysis. A method for the evaluation of the bacterial lysis. The bacterial debris resulting from the lysis are deprived of enzyme activity, so far as the latter is measurable by action on methylene blue solutions.

MELBOURNE

Royal Society of Victoria, August 10. A. R. RAW: A practical application of photoperiodic response to plant-breeding methods at the State Research Farm, Werribee, Victoria. It has been found possible to expedite the normal procedure by growing F_1, F_2 and F_3 generations of barley and some wheats in one year by artificially lengthening the daily period of illumination during one generation. If seeds were taken from the ear before maturity, germination percentage was not very seriously depressed, provided that the grains were dried before planting.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, November 13

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Major Gordon Fowler: "The Extinct Waterways of the Fens".

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. Margaret A. Murray: "Religion and Ritual in the Study of Man"*.

Tuesday, November 14

UNIVERSITY OF LONDON, at 5.—(at the London School of Economics). Prof. Emile Borel: "Quelques Applications de la Statistique aux prévisions économiques (crises) et aux prévisions météorologiques (succeeding lectures on Nov. 15 and 16)*.

UNIVERSITY OF LONDON, at 5.15.—(at the Imperial College of Science and Technology).—Prof. Fritz Paneth: "Helium Researches" (succeeding lectures on Nov. 21 and 28)*.

UNIVERSITY OF LONDON, at 5.30.—(at University College).—Sir Henry Lyons: "Science Museums and the History of Science and Technology" (succeeding lectures on Nov. 21 and 28)*.

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP)—(at the Royal Agricultural Hall, Islington, London, N.).—Full-day conference on "The Mechanical Testing of Road Materials".

Wednesday, November 15

INSTITUTION OF CHEMICAL ENGINEERS, at 6.—Dr. Friedrich Bergius: "The Utilisation of Wood for the Production of Foodstuffs, Alcohol and Glucose".

ROYAL SOCIETY OF ARTS, at 8.—A. Howard: "The Waste Products of Agriculture: their Utilization as Humus".

Thursday, November 16

KING'S COLLEGE, LONDON, at 3.—C. J. Gadd: "The Earliest History of the Babylonians"*.

ROYAL SOCIETY OF ARTS, at 4.30.—Dr. S. S. Nehru: "The Application of Electricity to Agriculture and Horticulture".

LONDON MATHEMATICAL SOCIETY, at 5.—(in the rooms of the Royal Astronomical Society, Burlington House, Piccadilly, W.1).—Prof. A. C. Dixon: "The Problem of the Rectangular Plate" (Presidential Address).

CHEMICAL SOCIETY, at 8.—Discussion on "Condensed Aromatic Ring Systems" to be opened by Dr. R. Fraser Thomson.

Friday, November 17

PHYSICAL SOCIETY, at 5.—(at the Imperial College of Science and Technology, South Kensington, London, S.W.7).—Prof. A. O. Rankine: "The Measurement of Magnetic Field Distortion" (Presidential Address).

Official Publications Received

GREAT BRITAIN AND IRELAND

Proceedings of the Royal Society of Edinburgh, Session 1932–1933. Vol. 53, Part 3, No. 20: On the Theory of Statistical Regression. By M. S. Bartlett. Pp. 260–283. 2*s*. Vol. 53, Part 3, No. 21: Geology and Petrology of the Dolerites of Spitsbergen. By Dr. G. W. Tyrrell and Dr. K. S. Sandford. Pp. 284–321. 3*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 3, No. 29: A Contribution to the Experimental Morphology of Lycopodium Selago, with Special Reference to the Development of Adventitious Shoots. By Dr. S. Williams. Pp. 711–737+3 plates. 4*s*. 6*d*. Vol. 57, Part 3, No. 30: On the Feeding Mechanism of certain Marine Ostracods. By Dr. H. Graham Cannon. Pp. 739–764. 3*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 73, No. 442, October. Pp. 321–456+xiv. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Fourth Annual Reports of the National Radium Trust and Radium Commission, 1932–1933. Pp. 31. (London: H.M. Stationery Office.)

Report of the Council of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, intended to be presented at the Annual Meeting of the Society, 31st October 1933. Pp. 40. (Newcastle-upon-Tyne.)

Memoirs of the Cotton Research Station, Trinidad. Series B: Physiology, No. 4: Studies on the Transport of Carbohydrates in the Cotton Plant, 3: The Polar Distribution of Sugar in the Foliage Leaf. By E. Phillis and T. G. Mason. Pp. 585–634+plate 23. (London: Empire Cotton Growing Corporation.) 2*s*. 6*d*.

The West of Scotland Agricultural College: Department of Plant Husbandry. Research Bulletin No. 3: The Helminthosporium Disease of Oats. Pp. 74+23 plates. (Glasgow.)

Index to the Mathematical Gazette, Vols. 1–15, April 1894 to December 1931, Nos. 1–216. (Published for the Mathematical Association.) Pp. xii+164. (London: G. Bell and Son, Ltd.)

OTHER COUNTRIES

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 42: Meteorological Data for certain Australian Localities. Pp. 55. Pamphlet No. 43: Investigations on the Buffalo Fly *Lyperosia exigua* de Meij. By Dr. B. J. Krijgsman and G. L. Windred. Pp. 40. (Melbourne: Government Printer.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 85. Zoological Results of the Dolan West China Expedition of 1931, Part 1: Birds. By Witmer Stone. Pp. 165–222. Meteorites in the Collections of the Academy of Natural Sciences of Philadelphia. By Samuel G. Gordon. Pp. 223–231. (Philadelphia.)

Union of South Africa: Department of Agriculture. The Onderstepoort Journal of Veterinary Science and Animal Husbandry. Edited by P. J. du Toit. Vol. 1, No. 1, July. Pp. 401. (Pretoria: Government Printer.) 5*s*.

Fiskeridirektoratets Skrifter, Serie Havundersøkelser. Vol. 4, No. 1: On the Age and Growth of the Cod (*Gadus callarias* L.) from the Norwegian Skagerrack Coast. By Ald Dannevig. Pp. 145+4 plates. Vol. 4, No. 2: Connected Frequency-Distributions, a Preliminary Account. By Einar Lea. Pp. 12. Vol. 4, No. 3: The Otoliths of the Cod, Preliminary Report. By Gunnar Rollefsen. Pp. 14+3 plates. (Bergen: A.-S. John Griegs Boktrykkeri.)

Publications of the Observatory of the University of Michigan. Vol. 5, No. 8: The Spectroheliokinematograph. By Robert R. McMath and Robert M. Petrie. Pp. 103–117+10 plates. Vol. 5, No. 9: A Note on the Spectrum of Nova Ophiuchi No. 3 (RS Ophiuchi). By Dean B. McLaughlin. Pp. 119–121+1 plate. (Ann Arbor.)

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 11, No. 3, September, Research Papers Nos. 593–599. Pp. 309–440. (Washington, D.C.: Government Printing Office.) 25 cents.

Mental Effort in relation to Gaseous Exchange, Heart Rate and Mechanics of Respiration. By Francis G. Benedict and Cornelia Golay Benedict. (Publication No. 446.) Pp. 83+2 plates. (Washington, D.C.: Carnegie Institution.)

Bulletin of the American Museum of Natural History. Vol. 66, Article 2: The Sarcophaginæ of Panama (Diptera: Calliphoridæ.) By David G. Hall. Pp. 251–285. (New York City.)

Smithsonian Miscellaneous Collections. Vol. 89, No. 9: New Arctic Foraminifera collected by Capt. R. A. Bartlett from Fox Basin and off the Northeast Coast of Greenland. By Joseph A. Cushman. (Publication 3221.) Pp. 8+2 plates. (Washington, D.C.: Smithsonian Institution.)

Proceedings of the United States National Museum. Vol. 82, Art. 24: A New Fresh-Water Sponge from South Carolina. By James T. Penney. No. 2965. Pp. 5. Vol. 82, Art. 29: Three New Chigger Mites of the Genus Trombicula from Panama, with a Key to the known Adults of Trombicula of the New World. By H. E. Ewing. (No. 2970.) Pp. 6. (Washington, D.C.: Government Printing Office.)

U.S. Department of Agriculture. Circular No. 24: United States Grades, Color Standards and Packing Requirements for Honey. Prepared by the Bureaus of Entomology and Agricultural Economics. Revised edition. Pp. 28. 5 cents. Circular No. 302: Fight Grasshoppers by Plowing Stubble. By J. R. Parker. Pp. 4. 5 cents. Technical Bulletin No. 372: A Classification of North American Agallian Leaf Hoppers. By P. W. Oman. Pp. 94+4 plates. 10 cents. (Washington, D.C.: Government Printing Office.)

University of California Publications in American Archæology and Ethnology. Vol. 33, No. 3: Ethnography of the Owens Valley Paiute. By Julian H. Steward. Pp. iv+233–350+10 plates. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 1.25 dollars.

Transactions of the San Diego Society of Natural History. Vol. 7, No. 24: A New Solitary Vireo from Central America. By A. J. van Rossem. Pp. 285–286. Vol. 7, No. 25: The Canada Jays of Northern Idaho. By Alden H. Miller. Pp. 287–298. Vol. 7, No. 26: Transposed Hinge Structures in Lamellibranchs. By W. P. Popenoe and W. A. Findlay. Pp. 299–318+plate 19. Vol. 7, No. 27: Notes on *Parapinnixa affinis* Holmes and its Allies. By Steve A. Glassell. Pp. 319–330+plates 20–21. Vol. 7, No. 28: Descriptions of Five New Species of Brachyura collected on the West Coast of Mexico. By Steve A. Glassell. Pp. 331–344+plates 22–26. (San Diego, Calif.)

Bergens Museums Arbok, 1933. Hefte 1, Naturvidenskapelig rekke. Pp. 17+16+53+25+8+173. (Bergen: A.-S. John Griegs Boktrykkeri.)

Department of Agriculture: Straits Settlements and Federated Malay States. General Series, No. 14: Reports of the Research, Economic and Agricultural Education Branches for the Year 1932. Pp. iii+86. 50 cents. Scientific Series, No. 13: A List of Insects with their Parasites and Predators in Malaya. Compiled by G. H. Corbett and N. C. E. Miller from the Records obtained in the Entomological Laboratory 1920–1932. Pp. ii+15. 50 cents. (Kuala Lumpur.)

Mysore Geological Department. Records, Vol. 31, 1932. Pp. iv+60+4 plates. (Bangalore: Government Press.) 2 rupees.

The Victorian Bush Nursing Association. Report and Statement of Accounts to 30th June, 1933. Pp. 264. (Melbourne: Victorian Bush Nursing Association.)